Environmental Product Declaration

according to ISO 14025

EGGER
Laminate Flooring

Declaration number
EPD-EHW-2008211-E

Institut Bauen und Umwelt e.V.
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Summary

Umwelt-Produktdeklaration

Environmental Product-Declaration

Institut Bauen und Umwelt e.V. **www.bau-umwelt.com**	**Program holder**
EGGER Retail Products GmbH & Co. KG Im Kissen 19 D – 59929 Brilon	**Declaration holder**
EPD-EHW-2008211-E	**Declaration number**
Egger Retail Products laminate flooring – class of application 31, 32 and 33 (AC3 through AC5) This declaration is an environmental product declaration according to ISO 14025 and describes the environmental rating of the building products listed herein. It is intended to further the development of environmentally compatible and sustainable construction methods. All relevant environmental data is disclosed in this validated declaration. The declaration is based on the PCR document "Wood-based materials", year 2007.	**Declared building products**
This validated declaration authorises the holder to bear the official stamp of the Institut Bauen und Umwelt. It only applies to the listed products for one year from the date of issue. The declaration holder is liable for the information and evidence on which the declaration is based.	**Validity**
The declaration is complete and contains in its full form: - Product definition and physical building-related data - details of raw materials and material origin - description of how the product is manufactured - instructions on how to process the product - data on usage condition, unusual effects and end of life phase - life cycle analysis results - evidence and tests	**Content of the declaration**
9. April 2011	**Date of issue**
Prof. Dr.-Ing. Horst J. Bossenmayer (President of the Institut Bauen und Umwelt)	**Signatures**
This declaration and the rules on which it is based have been examined by an independent expert committee (SVA) in accordance with ISO 14025.	**Verification of the declaration**
Prof. Dr.-Ing. Hans-Wolf Reinhardt (chairman of the expert committee) Dr. Frank Werner (tester appointed by the expert committee)	**Signatures**

Summary

Umwelt-Produktdeklaration

Environmental Product-Declaration

Product description

The listed products are decorative hard surface flooring elements according to EN 13329 with a highly abrasion-resistant surface, which are installed as floating floor without glue using a click connection. The decorative design is achieved through the use of printed decorative paper. Corundum is added to the uppermost layer in order to achieve a highly abrasion-resistant surface.

Application

The applications for the declared laminate flooring are:

Interior areas; laid as floating floor either on concrete or other existing subfloor such as wood, tile, PVC, etc. A skilled end user can install the flooring themselves. Due to the low panel thickness the flooring can also be used for renovating.

Scope of the LCA

The **Life Cycle Assessment (LCA)** was performed according to DIN ISO 14040 following the requirements of the Institut Bauen und Umwelt guideline for type III declarations. Both specific data from the reviewed products and data from the "GaBi 4" database were used. The life cycle assessment encompasses the raw material and energy production, raw material transport, the actual manufacturing phase and the end of life as waste incineration with energy recovery. The laminate flooring product mix was declared.

Results of the LCA

Laminate Flooring

Evaluation variable	Unit per m²	Total	Manufacturing	End of Life
Primary energy, non renewable	[MJ]	67.8	125.2	-57.3
Primary energy, renewable	[MJ]	119.9	120.8	-0.94
Global warming potential (GWP 100 years)	[kg CO_2 eqv.]	3.05	-3.09	6.14
Ozone depletion potential (ODP)	[kg R11 eqv.]	2.58E-07	4.55E-07	-1.97E-07
Acidification potential (AP)	[kg SO_2 eqv.]	0.037	0.022	0.015
Eutrophication potential (EP)	[kg Phosphate eqv.]	0.0095	0.0063	0.0032
Photochemical oxidant formation potential (POCP)	[kg Ethylene eqv.]	0.00857	0.00810	0.00045

Prepared by: PE INTERNATIONAL, Leinfelden-Echterdingen
in cooperation with EGGER Retail Products GmbH & Co. KG

PE INTERNATIONAL
EXPERTS IN SUSTAINABILITY

Evidence and verifications

In addition, the results of the following tests are shown in the environmental product declaration:

- VOC emissions according to AgBB (German operational fire protection working committee) method
  Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut
- Formaldehyde:
  Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut
- Toxicity of the fire gases:
  Testing institute: MFPA Leipzig GmbH
- PCP / lindane
  Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut
- EOX (extractable organic halogen compounds)
  Testing institute: MFPA Leipzig GmbH
- Eluate analysis according to DIN 38406-4
  Testing institute: MFPA Leipzig GmbH

Area of application This document refers to the Egger Retail Products laminate flooring manufactured in Germany

0 Product definition

Product definition Egger Retail Products laminate flooring are decorative hard surface flooring elements according to EN 13329 with a highly abrasion-resistant surface, which are installed as floating floor without glue using a click connection. The decorative design is achieved through the use of printed decorative paper. Corundum is added to the uppermost layer in order to achieve a highly abrasion-resistant surface. A high-density wood fibre board is typically used as coreboard. The coreboard and the decorative paper are pressed together in a hot press to form an element, the so-called master board. At the same time, a corresponding feel can also be applied to the surface during pressing. After a corresponding cooling phase the master board is cut into the respective plank sizes and a click profile is added to the edges. The milled planks are packaged in packets and protected against dirt and damage with a film.

Laminate flooring is divided into different classes of application– a description of the classes is found in the EN 13329 requirements.

The classes of application are primarily differentiated or divided based on the abrasion resistance (abrasion test see EN 13329:2006, appendices E and H):

- AC 1: abrasion resistance ≥ 900 revolutions in the Taber Test
- AC 2: abrasion resistance ≥ 1500 revolutions
- AC 3: abrasion resistance ≥ 2000 revolutions
- AC 4: abrasion resistance ≥ 4000 revolutions
- AC 5: abrasion resistance ≥ 6000 revolutions

Application Laminate flooring is laid as floating floor in interior areas, either on concrete or other existing subfloor such as wood, tile, PVC, etc. The big advantage of the product is that a skilled end user can install the flooring themselves without a problem. Due to the low panel thickness the flooring can also be used for renovating.

Product standard / approval

- DIN EN 13329 - laminate flooring
- DIN EN 14041 – CE labelling
- DIBt national technical approval for flame-resistant laminate flooring
- DIN EN 622-5 Fibreboard – manufacturing using the dry method

Accreditation

- CE-labelling according to EN 14041 – Notified Body WKI – Braunschweig, D
- DIBt Z-156.606-429 and Z-156.606-430 – External monitoring by WKI Braunschweig, Germany
- PEFC, Chain of Custody HCA-CoC-183
- EN ISO 9001:2000 – ÖQS Vienna, Austria

Product group	Wood-based material Laminate flooring	Version
Declaration holder:	Egger Retail Products GmbH & Co. KG	09-04-2008
Declaration number:	EPD-EHW-2008211-E	

Delivery status, characteristics

Table 1: General properties (also see EN 13329, table 1)

Property	Testing method	Unit	Class 31	Class 32	Class 33
Composition			**DPL**	**DPL**	**CML**
Coreboard			**HDF board**	**HDF board**	**HDF board**
Type			**Plank**	**Plank**	**Plank**
Thickness of the elements					
Element thickness	EN 13329	mm	6.0 / 7.0 ± 0.5	7.0 / 8.0 ± 0.5	8.0 ± 0.5
optional Silenzio sound-proofing underlay		mm	1.0 ± 0.2	1.0 ± 0.2 2.5 ± 0.2	1.0 ± 0.2 2.5 ± 0.2
Length of the overlay					
Overlay length measurement	EN 13329	mm	1292.0 ± 0.2	1292.0 ± 0.2	1292.0 ± 0.2
Width of the overlay					
Overlay width measurement	EN 13329	mm	192.0 ± 0.1	192.0 ± 0.1	192.0 ± 0.1
Usage class					
Wear class	EN 13329		31	32	33
Light fastness					
Greyscale part B02	EN 20105		≥ level 6	≥ level 6	≥ level 6
Greyscale part A02	EN 20105		≥ level 4	≥ level 4	≥ level 4
Suitability for in-floor heat-ing					
Warm water systems			Yes	Yes	Yes
Measured in m² K/W	EN 12664		0.07	0.07	0.07
Impression after constant load					
Static compressive strength with straight steel cylinder Ø11.30 mm	EN 433		< 0.01	< 0.01	< 0.01
Surface soundness					
Surface soundness	EN 13329	N/mm²	≥ 1.4	≥ 1.4	≥ 1.4

Table 2: Classification requirements (1) (see EN 13329, table 2):

Class	**21**	**22**	**23**	**31**	**32**	**33**	
Symbols							
Wear classes		**Residential**			**Commercial**		**Testing method**
	Moder-ate	Normal	High	Moderate	Normal	High	
Resistance to abrasion	AC 1 IP ≥ 900	AC 2 IP ≥ 1500	AC 3 IP ≥ 2000		AC 4 IP ≥ 4000	AC 5 IP ≥ 6000	EN 13329 Appendix E
Resistance to impacts Small sphere [N], Large sphere [mm]	IC 1 ≥10 N / ≥800 mm or ≥8 N / ≥1000 mm				IC 2 ≥15N/≥1000mm or ≥12N/≥1300mm	IC 3 ≥20N/≥1200mm or ≥15N/≥1600mm	EN 13329 Appendix F
Resistance to stains Groups 1 + 2 Group 3	Level 4 Level 3	Level 5 Level 4					EN 438
Resistance to cigarette burns	-----	Level 4					EN 438
Behaviour under simulation of sliding a furniture foot			no visible damage under testing with test item type 0				EN 424
Chair castor test			no visible changes or damage				EN 425
Thickness swelling	≤ 20 %			≤ 18 %			EN 13329 Appendix G

Table 3 Classification requirements (2)

Property	Class 31	Class 32	Class 33	Testing method
Formaldehyde emissions	E 1	E 1	E 1	EN 717
Resistance to light	Level 6	Level 6	Level 6	EN 438-2
Fire rating	C_{fl}	C_{fl}	C_{fl}	EN ISO 11925 - 2
Chair castor test for office chairs	Type W	Type W	Type W	DIN 68131

Table 4: Other general requirements (see EN 13329, table 1):

Lengthwise evenness	concave	∪	< 0,50 %	< 6.50 mm
Crosswise evenness	concave	∪	< 0.15 %	< 0.28 mm
Lengthwise evenness	convex	∩	< 1.00 %	< 13.0 mm
Crosswise evenness	convex	∩	< 0.20%	< 0.40 mm
Straightness of edges (banana shape)	lengthwise		< 0.30mm / m	< 0.30 mm
Squareness	crosswise			< 0.20 mm
Height offset	length-wise/cross wise	Average value ≤ 0.1 mm, Individual values ≤ 0.15 mm allowable		

Raw density 880 kg/m³ (5 – 7 % moisture content)

Noise protection No standards exist in this regard, but the optional sound-proofing underlay can be used to improve sound-proofing.

Fire protection The laminate flooring meets the fire rating C_{fl} according to EN 13501-1.

1 Raw materials

Raw materials Primary products HDF coreboard with thicknesses between 6 and 8 mm with an average density of 880kg/m³ consisting of (specified in mass % per 1 m³ of production):

- Wood fibres, primarily spruce and pine wood, approx. 82%

Secondary materials / additives

- Water approx. 5-7%
- UMF glue (melamine urea resin) approx. 11%
- Paraffin wax emulsion <1%

Decorative, overlay, and balancer papers with a grammage of 20 to 120g/m²

- Melamine formaldehyde resin
- Corundum

Material explanation **Wood compound:** The production of HDF coreboard utilises only fresh, debarked wood from thinning measures as well as sawmill leftovers, primarily spruce and pine wood.

UMF glue: Mixed resin consisting of urea-melamine-formaldehyde resins. The aminoplastic adhesive hardens fully during the pressing process through polycondensation.

Paraffin wax emulsion: A paraffin wax emulsion is added to the formulation for hydrophobising (improving resistance to moisture) during the gluing process.

Raw material extraction and origin Wood from indigenous, predominantly regional forest stands is used in the production of Egger Retail Products laminate flooring. The wood is sourced from forests within a radius of approx. 250 km from the production site. The short transportation distances contribute a considerable measure to minimizing the logistical costs of raw materials acquisition. In the selection process, preference is given to woods that are certified according to PEFC regulations.

PEFC certified finished goods are indicated separately by the manufacturer and do not represent the entire product range. The bonding agents and impregnating resins or, as the case may be, the raw materials for manufacturing them come from suppliers located at a maximum distance of 800 km from the production site.

Local and general availability of the raw materials

The wood used in the production of Egger Retail Products laminate flooring is sourced exclusively from cultivated forests managed in a sustainable manner. The selection is composed exclusively out of greenwood from thinning and silviculture as well as sawmill leftovers (wood chips, shavings). The bonding agents and/or impregnating resins MUF and urea as well as the paraffin emulsion are synthesised out of crude oil, a fossil raw material with limited availability.

2 Manufacturing of the building product

Manufacturing of the building product

Structure of the manufacturing process:

2.1 Manufacturing of the rawboard:

1. Debarking of the logs
2. Chipping of the wood
3. Boiling the chips
4. Defibration in the refiner
5. Drying the fibres to approx. 2-3% residual moisture content
6. Gluing of the fibres with resins
7. Spreading of the glued fibres onto a moulding conveyor
8. Compression of the fibre mat using a continuous hot press
9. Cutting and edge-trimming of the fibre strip to rough board sizes
10. Cooling of the rawboard in radial coolers
11. Destacking onto large stacks
12. After acclimatisation phase, sanding of the top and bottom surfaces

2.2 Manufacturing of the impregnating substances:

1. Unrolling of the base papers
2. Uptake of impregnating resin (MUF) in the system
3. Drying the impregnated paper in heated dryers
4. Dimensioning the endless paper by a crosscutter
5. De-stacking the dimensioned boards onto pallets

2.3 Manufacturing of the laminated master boards:

1. Placement of the impregnating material on the top and bottom surfaces of the rawboard
2. Pressing of the board in a hot press using various textured pressing plates / bands
3. Quality sorting and destacking
4. Acclimatisation phase of up to 14 days

2.4 Manufacturing of the finished laminated flooring planks:

1. Cutting of the laminated boards into plank sizes using a four-blade circular saw
2. Milling the sides of the rough plank sizes along the length and width
3. Possibly laminating the back with sound-proofing underlay
4. Quality sorting and packaging in cartons
5. Destacking and shrink-wrapping on the pallet

All leftovers which arise during production (trimming, cutting, and milling leftovers) are, without exception, routed to a thermal utilisation process.

Production health

Measures to avoid hazards to health / exposures during the production process:

and safety Due to the manufacturing conditions, no health and safety measures above and beyond the ones required by law and other regulations are required. At all points on site, readings fall significantly below (Germany's) maximum allowable concentration values.

Environmental protection during production

- Air: The exhaust air resulting from production processes is cleaned according to legal requirements. Emissions are significantly below TA Luft (Technical Instructions on Air Quality Control).
- Water/soil: Contamination of water and soil does not occur. Effluent resulting from production processes is processed internally and routed back to production.
- Noise protection measurements have shown that all readings from inside and outside the production plant fall below German limit levels. Noise-intensive system parts such as debarking and chipping are structurally enclosed.

3 Working with the building product

Processing recommendations Egger Retail Products laminate flooring can be sawn and drilled with normal (electric) tools. Hard metal-tipped tools are recommended, especially for circular saws. Wear a respiratory mask if using hand tools without a dust extraction device.

Job safety, Environmental protection Apply all standard safety measures when processing / installing Egger Retail Products laminate flooring (safety glasses, face mask if dust is produced). Observe all liability insurance association regulations for commercial processing operations.

Residual material Residual material and packaging: Waste material accumulated on site (cutting waste and packaging) shall be collected and separated into waste types. Disposal shall comply with local waste disposal authority instructions and instructions given in no. 6 "End of life phase".

Packaging Wood pallets, paperboard, PET strapping and recyclable PE film are used.

4 Usage condition

Components **Components in usage condition:**

The components of Egger Retail Products laminate flooring correspond in their fractions to those of the material composition in point 1 "Raw Materials". During pressing the aminoplastic resin (MUF) is cross-linked three-dimensionally through a non-reversible polycondensation reaction under the influence of heat. The binding agents are chemically inert and bonded firmly to the wood. Very small quantities of formaldehyde are emitted (see formaldehyde certificate chapter 8.1).

Interactions Environment - Health **Environmental protection:**

According to the current state of knowledge, hazards to water, air, and soil cannot occur during proper use of the described products (see point 8. Evidence).

Health protection:

Health aspects: No damage to health or impairment is expected under normal use corresponding to the intended use of laminate flooring. With the exception of small quantities of formaldehyde harmless to health, no emission of pollutants can be detected (see Evidence 8.1 Formaldehyde, 8.2 Toxicity of the fire gases, 8.3 PCP/lindane, 8.4 EOX, 8.5 Radioactivity). The MDI certificate is not used, since MDI is not used in the manufacturing process.

Long term durability in usage condition The durability under usage conditions is defined through the class of application (AC 1 – AC 5) under consideration of the resistance to abrasion (see chapter 0 “Product definition" as well as tables 1 and 2).

5 Unusual effects

Fire

Reaction to fire: Flammability rating C_{fl} according to EN 13501-1 (test report 3093/5855 – 4/06)
Smoke development S1 – slightly smoky
Toxicity of fire gases (test report chapter 8)
Change of phase (dripping by combustion/precipitation): Dripping by combustion is not possible since the Egger Retail Products laminate flooring does not liquefy when hot.

Water effects

No component materials which could be hazardous to water are washed out. Laminate flooring is not resistant to sustained exposure to water, but damaged areas can be replaced easily on site.

Mechanical destruction

The breaking pattern of laminate flooring illustrates relatively brittle behaviour, and sharp edges can form at the breaking edges of the boards (risk of injury).

Abrasion and impact loading classification: See chapter 0 product definition.

6 End of life phase

Deconstruction

During remodelling or at the end of the utilisation phase of a building, laminate flooring laid without using glue can easily be separated and used again for the same application.

Reuse and subsequent use

Laminate flooring laid without glue can easily be separated and used again for the same application.

Reuse and further utilisation

If it has been sorted correctly, Egger Retail Products laminate flooring can be processed and used again in a wood-based material manufacturing process.

Energy utilisation (in correspondingly approved systems): With a high calorific value of approx. 17 MJ/kg, energy utilisation for the generation of process energy and electricity (cogeneration systems) from laminate flooring construction leftovers and laminate flooring from deconstruction measures is preferable to putting it in the landfill.

Disposal

Laminate flooring: Egger Retail Products laminate flooring leftovers which arise on the construction site as well as those from deconstruction measures should primarily be routed to a material utilisation stream. If this is not possible, then they must be used for energy utilisation rather than being placed in the landfill (refuse code according to European Waste Catalogue: 170201/030103).

Packaging: The transport packaging paper/cardboard and PVC strapping can be recycled if they are sorted correctly. External disposal can be arranged with the manufacturer on an individual basis.

7 Life cycle assessment

7.1 Manufacturing of Laminate Flooring

Declared unit

The declaration refers to the manufacturing of one square meter of average finished laminate flooring (product mix).

The raw density of the laminate flooring is 900 kg/m³ (+/- 20 kg, 5-7 % moisture).

The end of life is calculated as thermal utilisation in a waste incinerator (wet method) with energy recovery.

System boundaries

The selected system boundaries encompass manufacturing of the laminate floor including raw materials production through to the final packaged product at the factory gate (cradle to gate).

The database GaBi 2006 was used for the energy generation and transport. In detail, the observed parameters encompass:

- Forestry processes for the provisioning and transporting of wood
- Production of all raw materials, primary products and secondary materials including the associated relevant transportation
- Relevant transportation and packaging of raw materials and primary products
- Production processes for the laminate flooring (energy, waste, thermal utilisation, production wastes, emissions) and energy provisioning ex resource
- Packaging

All reviewed products were produced in the Wismar plant.

The usage phase of the laminate flooring was not investigated in this declaration. The end of life scenario was assumed to be waste incineration (wet method) with energy utilisation (credits according to substitution approach) ("gate to grave"). The assessment region begins at the factory gate of the utilisation facility. On the output side, it is assumed that the produced ash is placed in a landfill.

Cut-off criteria

On the input side, at least all those material streams which enter into the system and comprise more than 1% of its entire mass or contribute more than 1% to the primary energy consumption are considered. The output side involves at least all those material flows out of the system whose environmental impacts comprise more than 1% of the total environmental effects of a considered effect category. The processes which were not modelled were disregarded due to their low volumes and low primary energy consumption.

Transportation

Transport of the raw materials and secondary materials used is included in principle.

Period under consideration

The data used refer to the actual production processes during the business year 1/5/2006 to 30/4/2007. The life cycle assessment was prepared for the reference area of Germany. This has the effect that in addition to the production processes under these framework conditions, the preliminary stages such as electricity or energy source provisioning which are relevant for Germany were used.

Background data

To model the life cycle for the manufacturing and disposal of Egger Retail Products, the software system for comprehensive accounting “GaBi 4” was used (GaBi 2006). All background data sets relevant to the manufacturing and disposal were taken from the GaBi 4 software database. The upstream chain for the harvesting was accounted for according to Schweinle & Thoroe 2001.

Assumptions

The results of the life cycle assessment are based on the following assumptions:

The transportation of all raw materials and/or secondary materials is calculated according to the means of transportation (truck, bulk carrier - ocean-going vessel, conveyor belt) with data from the GaBi database.

The energy carriers and sources used at the production site were considered for the energy supply.

All leftovers which arise during production and finishing (trimming, cutting, and milling leftovers) are routed to a thermal utilisation process as “combustible materials”. The credits from the energy extraction of the combustion systems are included in the balance sheet calculation.

The end of life scenario was assumed to be thermal utilisation in a waste incinerator and modelled according to the composition of the laminate flooring.

The results of the inventory life cycle and impact assessment are specified as product mix, in which the differences between the individual laminate flooring classes of application are small.

Data quality

The age of the utilised data is less than 5 years.

Data capture for the laminate flooring took place directly in the production facility of the

Wismar plant. All input and output data of the Egger company were made available. Therefore it can be assumed that the data is very representative.

The predominant part of the data for the upstream chain comes from industrial sources, which were collected under consistent time and methodical framework conditions. The process data and the utilised background data are consistent. Great value was placed on a high degree of completeness in the capturing of environmentally relevant material and energy flows.

The delivered data (processes) were checked for plausibility. They come from the operational data capturing and measurements and the data quality can therefore be described as very good.

Allocation

Allocation refers to the allocation of the input and output flows of a life cycle assessment module to the product system under investigation /ISO 14040/.

The laminate flooring manufacturing system in question and the associated energy supply do not require any allocations; waste materials are utilised as a source of energy. The combustion is accounted for using GaBi 2006 and, similar to end of life, energy credits are assigned.

The modelled thermal utilisation of removed flooring in the end of life process was combustion in a household waste incinerator. The allocation of energy credits for the electricity and gas produced in the waste incineration plant is done based on the calorific value of the input. The credit for the gas is calculated based on “steam from natural gas”; the credit for electricity from the German power mix. The calculation of emissions (e.g. CO_2, HCl, SO_2 or heavy metals) which are dependant on the input is performed based on the material composition of the introduced range. The technology-dependant emissions (e.g. CO) are assigned based on the exhaust gas volume.

Notes on usage phase

The usage condition and possible associated unusual effects were not researched in the life cycle assessment. For system comparisons, the lifespan must be accounted for under consideration of the stress and loading aspects and care/maintenance of the flooring.

7.2 Results of the assessment

Life cycle inventory

In the following chapter, the life cycle inventory assessment with regard to the primary energy consumption and wastes and, in following, the impact assessment is shown.

Primary energy

Table 5 shows the primary energy consumption (renewable and non-renewable, lower calorific value H_u respectively) subdivided for the sum total, production, and end of life for one square meter of laminate flooring.

The consumption of non-renewable primary energy for the manufacturing of laminate flooring is 125 MJ per m². Within the provisioning of raw materials, the raw materials for glue (urea, bonding system) and resin (mainly melamine and formaldehyde) form the most significant portion.

In addition, another 121 MJ of renewable energy (98.6 % of the solar energy stored in the biomass as well as about 1.5 % wind and water power) are used to produce one square meter of laminate flooring.

Table 5: Primary energy consumption for the manufacturing of 1 square meter of laminate flooring

Laminate flooring (product mix)				
Evaluation variable	**Unit per m²**	**Total**	**Production**	**End of Life**
Primary energy (non-renewable)	[MJ]	67.8	125.2	-57.3
Primary energy (renewable)	[MJ]	120	121	-0.94

A closer investigation of the composition of the primary energy consumption indicates that energy stored in the raw material through photosynthesis mainly stays in the laminate flooring product until its “end of life”. 1 m² of finished laminate flooring has a lower calorific value of approx. 105 MJ.

A more detailed analysis of the non-renewable energy consumption for the manufacturing of one square meter of laminate flooring (figure 1) shows that natural gas is used as a primary energy source which makes up approx. 79.5 MJ (over 63.5 %) of the primary energy consumption. About 10.3 MJ (8.3 %) of the energy consumption is covered by hard coal and 11.2 MJ (8.9 %) by brown coal, with crude oil covering another 7.3 MJ (5.8%). The relatively high proportion of uranium in the primary energy consumption at 16.9 MJ (13.5%) is due to the use of third-party power (see figure 2) from the German public network, which is filled by a power mix which also includes atomic energy.

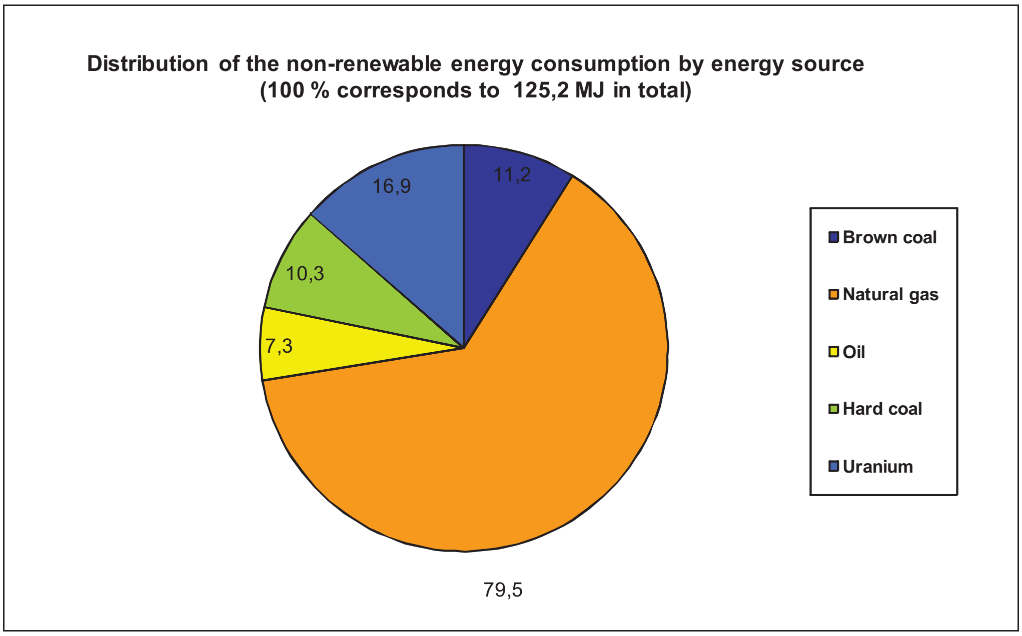

Figure 1: **Distribution of the non-renewable energy consumption by energy source for the production of 1 m² of laminate flooring**

Figure 2 provides a further level of detail for the non-renewable energy consumption. While the energy consumption for the processing of fibres and production of HDF board including provisioning of wood is relatively low at 9.4 MJ/m² of laminate flooring (corresponding to a scant 8 %) the production of glue and resin together require about 88 MJ/m² of finished laminate flooring, which corresponds to nearly 70 % of the entire non-renewable energy consumption. Impregnating the paper requires approx. 4.0 MJ/m² (3 %), finishing and shipping require another approx. 2.3 MJ/m² (a scant 2 %).

Energy for the production processes throughout the entire production chain is supplied through an in-house energy supply system. The non-renewable energy sources are natural gas and electricity purchased from the public network. In addition, production waste and biomass is used to supply energy. The energy supply system joined to the production site also supplies excess power to the public network and steam to external processes.

The exclusively thermal utilisation of production waste is modelled as the average incineration of household waste in Germany with steam and electricity generation. This results in electricity credits through the substitution of electricity in the public network according to the German power mix as well as a steam credit calculated according to the average production of steam from natural gas in Germany.

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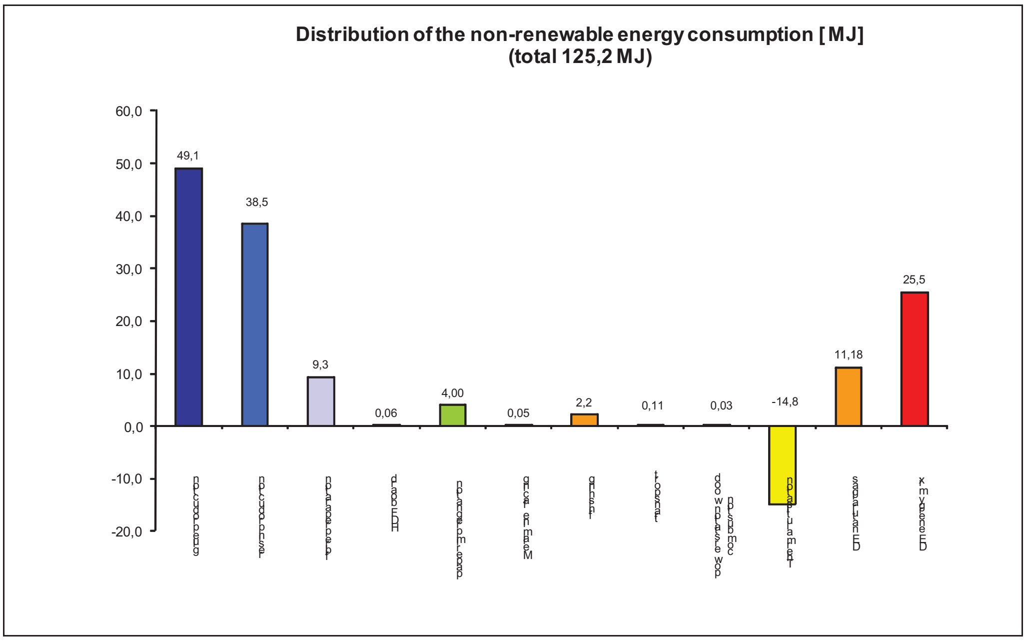

Figure 2: Distribution of the non-renewable energy consumption for the production of one square meter of laminate flooring.

If one considers manufacturing and end of life (combustion of the laminate flooring in a garbage incinerator with a thermal output between 20 and 70 MW; thermal efficiency approx. 90%; overall energy generation efficiency approx. 75%, conditional upon the low amount of electricity (12.4%) being generated), then one discovers that the energy credit for electricity and steam (credit for German power mix and combustion of natural gas) is considerable at 57.3 MJ of non-renewable energy sources per m^2 of laminate flooring (figure 3). This reduces the non-renewable primary energy consumption of 125.2 MJ/m² to approx. 67.8 MJ/m² when manufacturing and combustion are calculated. In this way the energy stored in the laminate flooring is still used to generate usable energy.

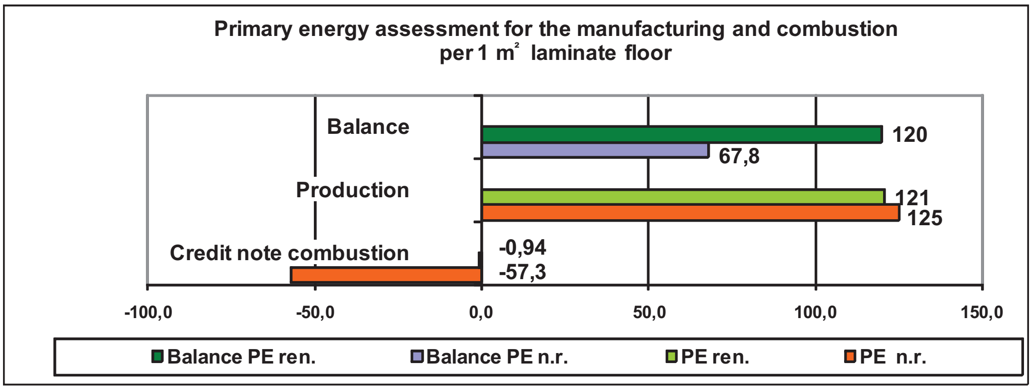

Figure 3 Primary energy assessment of renewable and non-renewable energy sources for the manufacturing and combustion of 1 m² of laminate flooring.

CO_2 balance sheet

Die CO_2 balance sheet in figure 4 shows that the manufacturing of one m^2 of laminate flooring (product mix) causes 8.95 kg of CO_2 emissions, of which 4.90 kg of CO_2 comes from the direct thermal utilisation of wood during the production phase and an additional 4.05 kg of CO_2 are fossil emissions. On the other hand, through manufacturing a total of 12.87 kg of CO_2 per m² of laminate flooring is removed from the air and stored in the wood through photosynthesis as the trees grow, of which 7.97 kg of CO_2 per m^2 remains bound. The CO_2 component bound in the wood of the laminate flooring is only released again at the end of the lifecycle, that is, during the thermal utilisation of the board. If one allocates the manufacturing CO_2 intake (intake bar) and CO_2 emissions (output bar), one obtains, on balance, a CO_2 reduction for this phase of the lifecycle of 3.92 kg per m^2 of laminate flooring (top bar) through binding in the product and substitution of non-renewable energy sources.

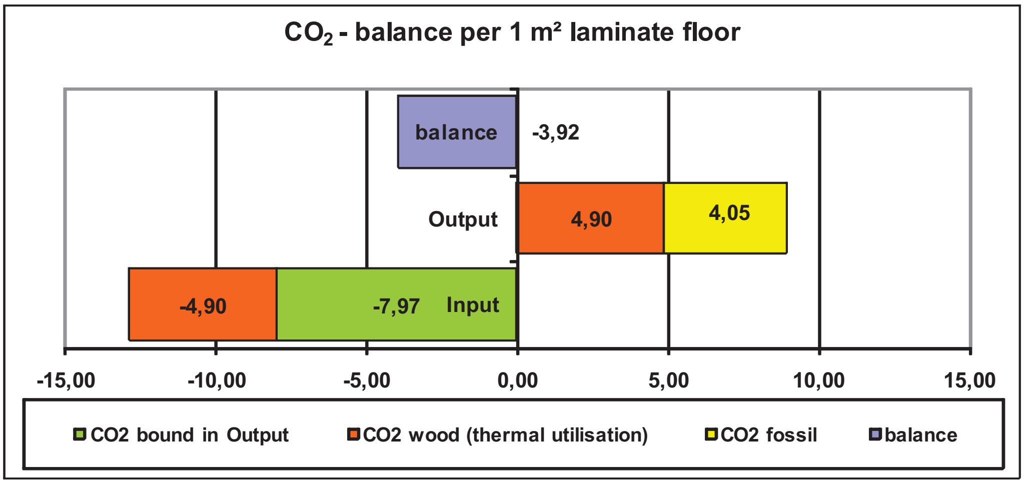

Figure 4 **CO_2 balance sheet for the manufacturing of 1 m^2 of laminate flooring.**

Waste

The evaluation of waste produced to manufacture 1 m^2 of average laminate flooring (product mix) is shown separately for the three segments construction/mining debris (including ore processing residues), municipal waste (including household waste and commercial waste) and hazardous waste including radioactive wastes (table 6).

Table 6: **Waste accumulation during the manufacturing and combustion of 1 m^2 of laminate flooring.**

	Waste [kg / m^2 of laminate flooring]		
Evaluation variable	**Total**	**Production**	**End of Life**
Residues / mining debris	8.76	15.19	-6.51
Municipal waste	0.036	0.036	0.00005
Hazardous waste	0.0164	0.018	-0.0019

For the **mining debris** the rubble is by far the largest quantity, followed by ore dressing residues and construction debris. Rubble is produced mainly in the upstream chain to generate electricity (coal mining). Rubble is produced primarily during the mining of mineral raw materials and coal in the production of raw materials and energy sources. The combustion of the laminate flooring at the end of its lifecycle substitutes mining debris in energy production in the amount of 6.5 kg/m² of laminate flooring.

Significant fractions within the **municipal waste** segment are approx. equal proportions of non-specific waste and non-specific paper. All other fractions play a minor role. The combustion at EoL results in a minor increase in total waste production.

Hazardous waste here is primarily the waste produced during the upstream stages. The “hazardous waste stored below ground” fraction makes up the largest amount of hazardous waste.

The radioactive waste is due to the consumption of electricity (nuclear power consumption from the power mix). The combustion at EoL reduces the radioactive waste through substitution of the German power mix.

Impact assessment

The following table shows the absolute contributions from the production and combustion of 1 m² of laminate flooring to the impact categories global warming potential (GWP 100), ozone depletion potential (ODP), acidification potential (AP), eutrophication potential (EP), and photochemical oxidation formation potential (summer smog potential POCP). In addition the renewable primary energy (PE reg.) and the non-renewable primary energy (PE ne) are listed again.

Table 7a: Absolute contributions of manufacturing and end of life per square meter of laminate flooring mix to PE ne, PE reg, GWP 100, and ODP.

	PE non-renewable	PE renewable	Global warming potential GWP 100	Ozone depletion potential (ODP)
Unit	MJ	MJ	kg CO_2 eqv.	kg R11 eqv.
Raw materials	98.47	-27.5	-7.27	2.28E-07
Production	22.38	147.4	4.05	2.21E-07
Transportation	1.76	0.002	0.13	2.12E-10
Packaging	2.57	0.87	0.00	5.97E-09
Σ Manufacturing	**125.2**	**120.8**	**-3.09**	**4.55E-07**
End of Life	-57.3	-0.94	6.14	-1.97E-07
Total	**67.8**	**119.9**	**3.05**	**2.58E-07**

Table 7b: Absolute contributions of manufacturing and end of life per square meter of finished laminate flooring mix to AP, EP and POCP.

	Acidification potential (AP)	Eutrophication potential (EP)	Photochemical oxidant formation potential (POCP)
Unit	kg SO_2 eqv.	kg PO_4 eqv.	kg ethylene eqv.
Raw materials	0.012	0.0048	0.00214
Production	0.009	0.0013	0.00585
Transportation	0.001	0.0001	0.00009
Packaging	0.0003	0.0001	0.00004
Σ Manufacturing	**0.022**	**0.0063**	**0.00810**
End of Life	0.015	0.0032	0.00045
Total	**0.037**	**0.0095**	**0.00857**

When considering the **manufacturing system boundary under consideration of the end of life** in a waste incinerator using the wet method, the significance of the method of utilisation or disposal on the environmental impact over the entire life cycle becomes apparent. The resulting additional emissions or related substitution effects in the energy supply system are shown graphically in figure 5.

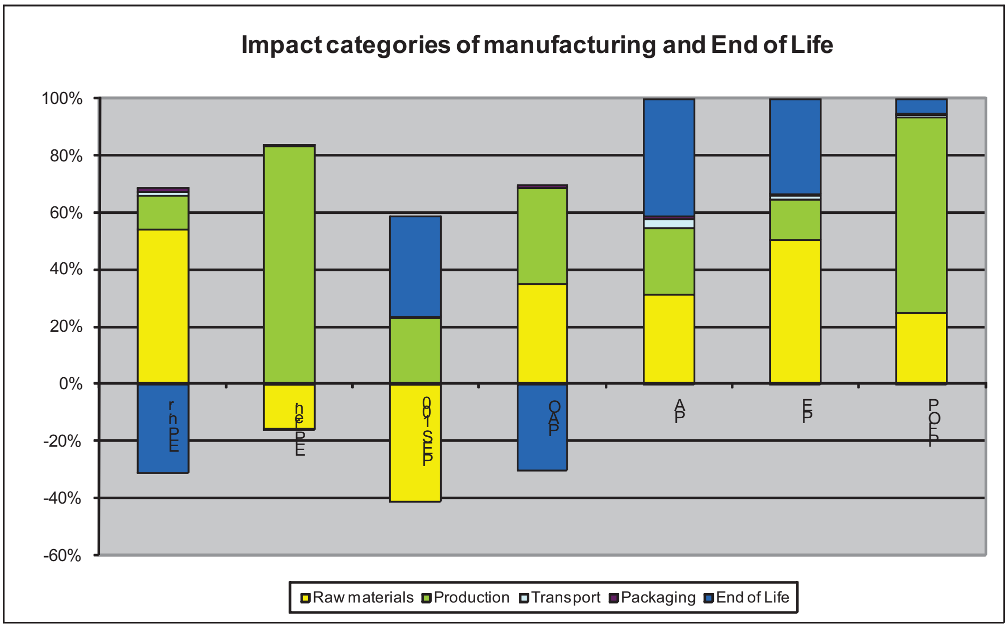

Figure 5 **Proportion of the processes relative to the impact categories – factory gate system boundary and combustion of the laminate flooring at end of life.**

The illustrated end of life fractions result from the allocation of the emissions resulting from the combustion process against the emissions avoided through the generation of electricity and steam. This is the difference between the emissions for combustion of the laminate flooring and the emissions avoided as a result in the average German energy generation (credits). The substitution effect at end of life reduces the demand for non-renewable energy sources and the ozone depletion potential. All other environmental impact categories show an increase between 10 % (POCP) and 75 % (acidification potential). This increase in emissions occurs during combustion of the laminate flooring in the assumed garbage incinerator (thermal output between 20 and 70 MW; thermal efficiency approx. 90%; overall energy generation efficiency approx. 75%, conditional upon the low amount of electricity (12.4%) being generated). If the laminate flooring is burned in a more efficient facility, then these increased emissions can be reduced through an increase in the energy substitution effects. If combustion takes place in less efficient facilities, then this increases the contribution of the end of life processes to the overall emissions.

The **global warming potential** in manufacturing is dominated by carbon dioxide. Per m² of laminate flooring, 12.9 kg of CO_2 are bound in the re-growing raw material input. This binding of CO_2 in the tree growth phase is offset by further CO_2 emissions during the provisioning of raw materials, production, transportation, and packaging of 8.96 kg CO_2 equivalent. Barely 91 % of the emissions are carbon dioxide, 4 % is nitrous oxide, and 5 % are VOC emissions (especially methane). Therefore 3.92 kg of CO_2 equivalent is stored in the product over its lifespan. The emission values at the end of life result from the combustion less the credit (substitution effect in the German power mix as well as the average German steam production) for the energy utilisation of 1 m² of finished laminate flooring (6.16 kg). Within the system being considered (manufacturing and end of life) this results in a global warming potential of 3.05 kg/m² of finished laminate flooring.

The main contributors to the **ozone depletion potential** are provisioning of raw materials (50%) and production (48%) with roughly equal contributions. The largest proportion of the ozone depletion potential during manufacturing is the electricity consumption during the production process (around 50 %). But the manufacturing of glue (around 25 %) and resin (about 15 %) are also significant. The substitution of electricity at the end of life causes a significant reduction in the ozone depletion potential from

4.55E-07 kg R11 equivalent to approx. 2.58E-07 kg R11 equivalent. (Reduction of approx. 40 %).

Both manufacturing and combustion of the laminate flooring contribute to the **acidification potential.** The emissions from combustion are higher than the emission credits due to energy utilisation of the laminate flooring at its end of life. When considering both manufacturing and end of life, provisioning of raw materials contributes about 31 %, production 23 %, transportation 3.5 %, and end of life about 41 % to the acidification potential. Therefore, the choice of the end of life process has the largest environmental impact in this category. Looking at the individual processes shows that, always with respect to the manufacturing process, the production of glue holds a 27 % share, the production of resin 13 %, processing of fibres about 25 %, provisioning of energy (electricity, natural gas, biomass) approx. 20 % and thermal utilisation around 8 %.

The **eutrophication potential** situation looks about the same as the acidification potential, with the provisioning of raw materials having the most significance. When considering both manufacturing and end of life, provisioning of raw materials contributes about 50 %, production 14 %, transportation and packaging between 0.5 % and 1.5 %, and end of life about 34 % to the eutrophication potential. The acidification and eutrophication potentials show that the selected EoL option can have a large effect on the environmental impacts for different types of environmental impact.

For the **summer smog potential (ground-level ozone formation)** the provisioning of raw materials makes up about 25 %, production about 68 %, and transportation and packaging each less than 1 %. The EoL makes up about 5 %. If one considers the system on the process level for manufacturing only (cradle to factory gate), then it becomes apparent that the production of glue makes up about 17 %, processing of fibres around 73 %, and the production of resin around 3.5 %. Formaldehyde and NMVOC (unspecific) in particular play an important role.

8 Evidence and verifications

VOC Emissions

Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut

Test report: Determination of the VOC emissions from laminate flooring according to AgBB (German operation fire protection working committee) method (inspection report number: 1861/2005) from 13/09/2005.

Method: Testing in a 0.25 m^3 chamber on the basis of the AgBB method /AgBB/.

Result according to AgBB evaluation method, test description A1163/P2725:

Test description		Crystal Silenzio/Quell Stop plus	
AGBB overview of results		3 days [$\mu g/m^3$] Measured value	28 days [$\mu g/m^3$] Measured value
[A]	TVOC (C6-C16)	**11**	**<1**
[B]	Σ SVOC (C16-C22)	**no requirements**	**<1**
[C]	R (dimensionless)	**no requirements**	**0.00**
[D]	Σ VOC or NIK	**no requirements**	**<1**
[E]	Σ Carcinogenic substances	**<1**	**<1**
This section provides additional information			
[F]	VVOC (< C6)	-	-

Formaldehyde

Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut

Testing, monitoring, and certification site, Braunschweig, Germany

Test report, date: B1732-07 laminated HDF boards from 14/06/2007

B1726-07 rough HDF boards from 14/06/2007

Result: The testing of the formaldehyde content was performed according to the perforator method according to DIN EN 120 and according to the test chamber method according to DIN EN 717-2. The results for the rough boards are well below the maximum permissible value of 8.0 mg HCHO/100g dry matter (at 6.5% material moisture content) according to the DIBt guideline 100 corresponding to the Chemikalienverbotsverordnung (banned chemicals provision) appendix to section 1, paragraph 3 in conjunction with publishing of the BGA (German health authority) in the Bundesgesundheitsblatt (German health gazette) dated October 1991 regarding the "test procedure for wood-based materials". The average results for a coreboard thickness of 7mm are:

- rough HDF boards 6.1 mg HCHO/100g according to DIN EN 120
- laminated HDF boards 0.7mg HCHO/m²h according to DIN EN 717-2

Toxicity of the fire gases

Testing institute: MFPA Leipzig GmbH, Division I – Construction Materials

Accredited testing laboratory, Leipzig Corporation for Materials Research and Testing for the Construction Industry, Leipzig, Germany

Test report, date: UB 1.1 / 07 – 520 - 01 Egger laminate flooring (DPL) from 29/02/2008

Result: The toxic fire gases where determined according to DIN 38406-4 as well as DIN 4102 part 1 – class A at 400° C. The results show that after 30 minutes, 5000 ppm of carbon monoxide was measured in the inhalation space, while all other chemical compounds were not detectable within this timeframe. After 60 minutes, the following concentrations were found in the inhalation space: Carbon monoxide 11 000 ppm (hence calculated >50% COHb), carbon dioxide 10 000 ppm, hydrogen cyanide 80 ppm and ammonia 1000 ppm. Hydrogen chloride, nitrous gases, nitrogen dioxide, and sulphur dioxide were not detectable. The relative weight reduction at a test temperature of 400° C was 65.5 %.

At the end of the test, dense white smoke was present in the inhalation space. The emissions released under the selected test conditions contain 1000 ppm of ammonia.

PCP / Lindane

Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut

Testing, monitoring, and certification site, Braunschweig, Germany

Test report, date:

B43/07 external monitoring of the PCP and lindane content from 09/01/2007

B357/04 external monitoring of the PCP and lindane content from 17/02/2004

Result: After extraction of the contained substances, the solutions were separated, processed, and then analysed using gas chromatography. The values for PCP and lindane are below the detection limit of 0.1 mg/kg.

EOX (extractable organic halogen compounds)

Testing institute: MFPA Leipzig GmbH, Division I – Construction Materials

Accredited testing laboratory, Leipzig Corporation for Materials Research and Testing for the Construction Industry, Leipzig, Germany

Test report, date: UB 1.1 / 07 – 520 - 01 Egger laminate flooring (DPL) from 29/02/2008

Result: Determination of the extractable organic compounds (EOX) was performed according to DIN 38414-S17 and resulted in a measured value <2 mg/kg.

Eluate analysis

Testing institute: MFPA Leipzig GmbH, Division I – Construction Materials

Accredited testing laboratory, Leipzig Corporation for Materials Research and Testing for the Construction Industry, Leipzig, Germany

Test report, date:

UB 1.1 / 07 – 520 - 01 Egger laminate flooring (DPL) from 29/02/2008

Result: The analysis was performed according to DIN 38406-4, the selection of the eluate criteria according to DIN 38414-S4. The following values were determined [mg/l]: Arsenic <0.001, lead 0.003, cadmium 0.0009, chrome VI <0.02, copper 0.008, nickel 0.005, mercury <0.0001, zinc 0.09, barium 0.05, chrome total <0.002, molybdenum <0.01, antimony <0.01 and selenium <0.01.

9 PCR Document and Verification

The declaration is based on the PCR document "Wood-based materials", year 2007.

Review of the PCR document by the expert committee. Chairman of the expert committee: Prof. Dr.-Ing. Hans-Wolf Reinhardt (University of Stuttgart, IWB (Institute for Materials in Construction))
Independent verification of the declaration according to ISO 14025: ☐ internal ☒ external
Validation of the declaration: Dr. Frank Werner

10 References

For further literature see the PCR document

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