ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804

Owner of the Declaration	**IVPU Industrieverband Polyurethan-Hartschaum e.V.**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
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Valid to	19/01/2020

PU thermal insulation boards with 50 µm aluminium facing

IVPU Industrieverband Polyurethan-Hartschaum e.V.

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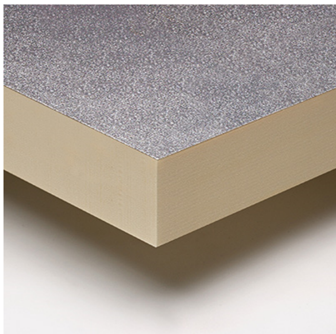

1. General Information

IVPU e.V.	PU thermal insulation boards with 50 µm aluminium facing
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** **IVPU e.V.** Im Kaisemer 5 D-70191 Stuttgart
Declaration number EPD-IVP-20140207-IBE1-EN	**Declared product / Declared unit** 1 m² of installed PU thermal insulation board with 50 µm aluminium facing (on both sides) and a thickness of 12 cm and a thermal conductivity (WLS) of 0.023 W/(m·K).
This Declaration is based on the Product Category Rules: Insulating materials made of foam plastics, 07.2014 (PCR tested and approved by the SVR) **Issue date** 20/01/2015 **Valid to** 19/01/2020	**Scope:** This EPD applies to all declared products of the IVPU's member companies Karl Bachl GmbH & Co KG, Paul Bauder GmbH & Co KG, IKO Insulation BV, Kingspan Insulation GmbH & Co KG, Linzmeier Bauelemente GmbH, puren gmbh, Recticel Dämmsysteme GmbH, Steinbacher Dämmstoff-GmbH, Unilin Insulation bv. The IVPU represents more than 90% of the companies within the German polyurethane insulating materials market. This EPD is based on weighted averages, which have been determined on the basis of the single values originating from the afore-mentioned manufacturing companies' factories (see section 3.1). The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	**Verification** The CEN Norm /EN 15804/ serves as the core PCR Independent verification of the declaration according to /ISO 14025/ ☐ internally ☒ externally
Dr. Burkhart Lehmann (Managing Director IBU)	Prof. Dr. Birgit Grahl (Independent verifier appointed by SVR)

2. Product

2.1 Product description

Polyurethane rigid foam (PU) is a closed-cell foam and factory-made thermal insulating material, which is used in the form of insulation boards with or without facings for insulating buildings, as well as for insulation of building equipment and industrial installations. The polyurethane insulating material (PU) product family comprises the product variants polyurethane (PUR) and polyisocyanurate (PIR) - see /EN 13165/. PU insulating materials are produced as block foam and insulation boards with flexible facings.
This Product Declaration covers PU insulation boards with 50 µm aluminium facings on both sides.

2.2 Application

The scope of application of PU rigid foam insulation materials includes thermal insulation in building construction (e.g. pitched roofs, flat roofs, floors, ceilings and exterior walls (inside and outside)).
Furthermore, PU rigid foam is used for insulating building equipment and industrial installations.

2.3 Technical Data

For determining technical data, testing methods as stated in / DIN EN 13165 / are used. The gross density of PU insulation boards with 50 µm aluminium facings for building construction is approx. 31 kg/m³. The boards are manufactured with thermal conductivity level (WLS) 023. This level is equivalent to a thermal conductivity design value of 0.023 W/(m·K).

Nominal compressive stress or nominal compressive strength at 10% deformation is 100 kPa (dh) or 150 kPa (ds) acc. to / DIN 4108-10 /. Higher compressive strength is possible. Nominal tensile strength is 40 kPa. Higher tensile strength is possible.
PU insulation boards with 50 µm aluminium facings are impermeable to water vapour and do not absorb moisture.

Polyurethane rigid foam is a distinctive thermosetting material and therefore cannot be melted.

Constructional data

Name	Value	Unit
Gross density	31	kg/m^3
Compressive strength acc. to DIN EN 826	≥ 100	kPa
Tensile strength acc. to DIN EN 1607	≥ 40	kPa
Modulus of elasticity acc. to DIN EN 826	≥ 4	MPa
Design value of thermal conductivity (Germany)	0.023	W/(m•K)
Nominal value of thermal conductivity acc. to DIN EN 13165	0.022	W/(m•K)
Water vapour diffusion resistance factor acc. to DIN EN 12088	∞	-
Creep behaviour at long-term compressive stress acc. to DIN EN 1606	≥ 20	kPa

2.4 Placing on the market / Application rules

When placing the product in the EU/EFTA market (except for Switzerland), the regulation (EU) no. 305/2011 dated 09.03.2011 shall apply. The products require a Declaration of Performance taking into account the /EN 13165:2012 Thermal insulation products for buildings - Factory made rigid polyurethane foam (PU) products - Specification/ and the CE marking.

When using the products, the respective national regulations shall apply. In Germany, design values for building construction are defined in /DIN 4108-10/. Hygrothermal design values are regulated in /DIN 4108-4/.

2.5 Delivery status

Polyurethane insulation boards with 50 µm aluminium facings are manufactured with plane-parallel surfaces or as tapered insulation boards in a thickness range of 20 to 300 mm. This Product Declaration refers to a board thickness of 120 mm.
The format of the boards depends on the planned application. The width can be up to 1,250 mm and the length up to 5,000 mm. After passing the double belt line, the foam boards are cut to the desired dimensions.

2.6 Base materials / Ancillary materials

The 12 cm thick PU board with 50 µm aluminium facings consists of 3.72 kg/m² PU rigid foam and 0.27 kg/m² 50 µm aluminium facings. Polyurethane rigid foam is formed by the chemical reaction of MDI (approx. 55-65 %) and polyol (approx. 20-30 %) adding low boiling point blowing agents (approx. 4-6 %). Insulation boards with flexible facings are foamed exclusively with the hydrocarbon pentane. Due to the closed-cell structure, the blowing agent remains within the foam cells.
Water (approx. 0.2 - 0.4 %), foam stabilisers and catalysts (approx. 2 - 3 %), as well as flame retardants (approx. 3 - 5 %) are added as ancillary materials.

The raw materials used for the production of polyurethane rigid foam are mainly obtained from crude oil, undergoing several production stages. Polyols can be produced from renewable raw materials (industrial sugar, glycerine, sorbitol or plant oil). Polyurethane rigid foam materials meet all relevant requirements regarding the use of certain substances (/Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)/). In accordance with the current REACH candidate list, the foam formulations contain no SVHC substances. Polyurethane rigid foam does not contain volatile isocyanates.
50 µm aluminium facings consist of lacquered aluminium foil.

2.7 Manufacture

Polyurethane rigid foam insulation boards with flexible 50 µm aluminium facings are produced in a continuous process on a double belt line. In this process, the polyurethane reaction mixture pours from a mixing head onto the bottom aluminium facing where it foams up and glues – still within the line's pressure area – with the top aluminium facing. After passing the double belt line, the foam boards are cut to the desired dimensions.

Quality assurance

The declared products bear the quality mark of "Überwachungsgemeinschaft Polyurethan-Hartschaum". Quality assurance is based on surveillance and certification by independent Notified Bodies.

2.8 Environment and health during manufacturing

No health protection measures extending beyond the legally-mandated work protection measures for industrial businesses are required during the entire manufacturing process. No special environmental protection measures apart from the legal provisions are required.

2.9 Product processing/Installation

Polyurethane insulation boards can be cut, sawed, milled, and abraded with conventional construction tools and portable machines. In general, the boards are fixed mechanically (pitched and flat roofs, cavity core insulation). Alternatively, PU insulation boards can be laid loosely, e.g. on floors. Observing the manufacturer's recommendations, it is also possible to glue the boards together by using either hot-setting or cold-setting adhesives. Joints between cut insulation boards on roof ridges, hips or valleys are to be sealed with polyurethane in-situ foam without thermal bridges.

While sawing, abrading, and milling insulation boards, dust is generated. When working on an industrial scale, workers who carry out these processes are to protect themselves by wearing an appropriate dust filter mask (see leaflet of the "Berufsgenossenschaft der Chemischen Industrie" on respiratory protection). Dust concentration in the air (general limit of dust concentration as per /TRGS 900/, Technische Regeln für Gefahrstoffe) must not exceed the following values:
- 10 mg/m³ (measured as inhalable fraction)
- 1.25 mg/m³ (measured as alveolar fraction)

These limits are time-weighted averages assuming an 8-hour exposure per day, 5 days a week, during working lifetime.
Cutting leftovers can be thermally utilised in waste incineration plants or returned to the manufacturer for material recycling.

2.10 Packaging
Primarily plastic foils are used for packaging.

2.11 Condition of use
Under normal conditions of use, the material does not undergo any changes in terms of substance during its service life. Polyurethane is resistant to most chemicals used in construction and does not rot.

2.12 Environment and health during use
The requirements of the Committee for Health-related Evaluation of Building Products (/AgBB/) have been met. Measurements of emissions using testing chambers in accordance with the relevant testing norms (/DIN EN 717-1/ and /DIN (EN) ISO 16000-6, 9 and 11/) showed that volatile organic substances (VVOC, VOC) are only emitted in small quantities in the form of the hydrocarbon pentane.

Regarding the current REACH candidate list, the foam formulations contain no SVHC substances (see section 2.6).

Polyurethane insulating materials are odourless.

2.13 Reference service life
When used properly, the service life of polyurethane rigid foam corresponds to the service life of the insulated construction components. The insulating performance stays the same over the entire service life.

2.14 Extraordinary effects

Fire
According to national approvals, polyurethane insulating materials are classified either as normally ignitable (B2 acc. to /DIN 4102-1/ or E acc. to /DIN EN 13501-1/) or as non-readily ignitable (B1 acc. to/ DIN 4102-1/ or C acc. to /DIN EN 13501-1/).

Pitched roof constructions with polyurethane insulation are classified REI 30 (fire-retardant) according to the technical approval P-MPA-E-04-025.

Roof structures with top-side polyurethane insulation acc. to /DIN 18234-2/ meet the fire-protection requirements stated in the Industrial Building Guideline even for fire containment or fire fighting sections with a roof surface of more than 2,500 m². In case of fire, PU rigid foam carbonises without dripping off burning droplets and does not tend to smoulder.

When burning, sooty products, water vapour, carbon monoxide, carbon dioxide, nitrogen oxides, as well as traces of hydrogen cyanide are formed. The composition of the smoke gas is the same as with other nitrogen-containing organic substances.
The toxicity of the combustion gases mainly depends on the amount of burned material in relation to the size of the room in which the gases are distributed. It also depends on the ventilation conditions in the affected area.

Water
Due to the predominant closed-cell structure, insulating materials made of polyurethane rigid foam absorb water only in small quantities. They are not hygroscopic, i.e. they do not absorb water vapour from the air. When unexpectedly exposed to water (e.g. flood), only very small amounts of soluble substances are emitted.

Mechanical destruction
If the product is mechanically destroyed, there are no relevant effects on the environment.

2.15 Re-use phase
Dismantling polyurethane insulating materials as well as sorting and waste identifying can be done without difficulties, since they are usually mounted mechanically or laid loosely.
Clean and undamaged polyurethane insulation boards can be re-used, re-utilised from material recycling, or recycled as raw material (glycolysis). Glycolysis means that at approx. 200°C, polyurethane rigid foam waste is transformed into a fluid substance called glycolysis polyol, which can be used again as raw material in the production of polyurethane.

When re-utilised from material recycling, polyurethane rigid foam waste is used to produce press boards. In this process, cutting and mounting leftovers, as well as construction waste, are mechanically shredded and subsequently pressed into board-shaped products while adding binding agents. PU pressed adhesive boards are a high-quality material which are used to insulate window frames and thermal bridges et al.

2.16 Disposal
According to the Waste Disposal Regulation and the Regulation on the European List of Waste Materials (/AVV/), polyurethane insulating material shall not be disposed of without prior treatment. The waste disposal code for construction waste is 170604. With thermal treatment, the energy content of the insulating material is recovered.

2.17 Further information
Please visit www.ivpu.de and www.daemmt-besser.de for further information on PU insulating materials.

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is 1 m² of installed PU thermal insulation board with 50 µm aluminium facing (on both sides) and has the following specifications:

Declared unit

Name	Value	Unit
Declared unit	1	m^2
Gross density of PU foam	31	kg/m^3
Declared unit	-	λ
Thickness	12	cm
Thermal conductivity	0.023	W/(m•K)
Thermal resistance (R value)	5.20	m²·W/K
Weight of the declared unit	3.998	kg/m²
Conversion factor to 1 kg	0.250	m²/kg

This EPD is based on weighted averages, which have been determined on the basis of the single values originating from the factories of the 9 above-mentioned IVPU members. Average energy consumption for producing PU boards has been weighted according to the quantities of produced PU rigid foam in m^3. Raw material consumption has been weighted according to used quantities in kg. Rigid foam waste is weighted according to the quantities of produced PU rigid foam in m^3 whereas facing waste is weighted according to used quantities of facings in m^2.

3.2 System boundary

Type of EPD: cradle to gate - with options
Life cycle assessment considers the following steps of the life cycle:

· production and supply of raw materials (A1)
· transporting raw materials (A2)
· production including packaging (A3)
· transport to construction site (A4)
· installation in buildings (recycling or thermal treatment of cutting leftovers and packaging waste) (A5)
· transport to End of Life (C2)
· waste treatment: energy for shredders (C3)
· thermal treatment (PU foam) or recycling (aluminium) (C4)
· recycling or use potentials beyond the system's boundary (D).

3.3 Estimates and assumptions

For all input, specific GaBi data sets were available. Currently, waste from PU foam production and leftovers from cutting on construction sites are handled using mainly material recycling (see 2.15). Using a worst-case approach, only the incineration and the consequent energy benefit beyond the system boundary have been considered in this EPD.

3.4 Cut-off criteria

In this study, all available data from the production are taken into account, i.e. all used raw materials, used thermal energy, as well as electrical power consumption. Therefore, even materials and power consumption levels that have a share of less than 1 % are considered.
It can be assumed that all neglected processes put together account for no more than 5 % of total power and mass consumption. The manufacturers have provided data on transport expenditures for all relevant material flows. Machinery and installations required for the production are neglected.

3.5 Background data

Background data originates from the GaBi software database from PE INTERNATIONAL (/GaBi 6 2013B/). The German electrical power mix has been used. The last revision of the used data was less than 6 years ago.

3.6 Data quality

The data used are primary data originating from the industry and were gathered by the IVPU in 2013. 9 IVPU members (see above) participated in this data gathering. The IVPU represents more than 90% of the companies within the German polyurethane insulating materials market. This EPD is based on weighted averages, which have been determined on the basis of the single values originating from the factories of the afore-mentioned manufacturing companies.
The data's quality as well as its technological, geographical, and chronological significance can be classified as very good.

3.7 Period under review

The data basis is based on production data from 2013. The used quantities of raw materials, energy, as well as ancillary materials and fuels are averages compiled over a time span of 12 months.

3.8 Allocation

When thermally treated in waste incineration plants (MVA), recycling as well as use potentials beyond the system boundary for power and thermal energy in module D are taken into account in an input-specific manner considering elemental composition as well as thermal values. Due to manufacturing locations and distribution throughout all of Europe, the substitution processes refer to reference area EU-27.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account.

4. LCA: Scenarios and additional technical information

The following technical information serves as the basis for the declared modules. If modules are not declared (MND), it may also be used for developing specific scenarios in the context of a building assessment.

Transport to construction site (A4)

Name	Value	Unit
Litres of fuel	0.00159	l/100km
Transport distance	500	km
Gross density of products transported	31	kg/m^3
Capacity utilisation (including empty runs)	85	%

Installation in buildings (A5)

Name	Value	Unit
Material loss	2	%
Packaging waste	0.35	kg

End of life cycle (C1-C4)

Name	Value	Unit
Waste processing (C3) energy for shredders	0.793	MJ
Reuse	0	kg
Recycling (aluminium)	0.27	kg
Energy recovery	3.72	kg
Landfilling	0	kg

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² of installed PU insulation board with 50 µm aluminium facing

Parameter	Unit	A1-A3	A4	A5	C2	C3	C4	D
GWP	[kg CO_2-Eq.]	15.00	0.30	0.30	0.30	0.30	8.23	-6.75
ODP	[kg CFC11-Eq.]	1.90E-5	5.22E-12	4.21E-12	5.22E-12	4.21E-12	8.22E-11	-2.18E-9
AP	[kg SO_2-Eq.]	4.40E-2	1.75E-3	8.79E-5	1.75E-3	8.79E-5	3.39E-3	-2.64E-2
EP	[kg $(PO_4)^{3-}$-Eq.]	4.78E-3	4.16E-4	1.92E-5	4.16E-4	1.92E-5	8.39E-4	-1.43E-3
POCP	[kg ethene-Eq.]	9.24E-3	-6.95E-4	6.13E-6	-6.95E-4	6.13E-6	2.26E-4	-1.64E-3
ADPE	[kg Sb-Eq.]	2.10E-5	1.11E-8	2.08E-9	1.11E-8	2.08E-9	5.74E-8	-1.22E-6
ADPF	[MJ]	286.00	4.12	0.08	4.12	0.08	2.03	-84.80

Caption	GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources

RESULTS OF THE LCA - RESOURCE USE: 1 m² of installed PU insulation board with 50 µm aluminium facing

Parameter	Unit	A1-A3	A4	A5	C2	C3	C4	D
PERE	[MJ]	22.40	-	-	-	-	-	-
PERM	[MJ]	0.00	-	-	-	-	-	-
PERT	[MJ]	22.40	0.16	0.01	0.03	0.31	0.13	-16.60
PENRE	[MJ]	219.00	-	-	-	-	-	-
PENRM	[MJ]	93.00	-	-	-	-	-	-
PENRT	[MJ]	312.00	4.13	0.10	0.80	1.89	2.29	-100.00
SM	[kg]	-	-	-	-	-	-	-
RSF	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m³]	-	-	-	-	-	-	-

Caption	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m² of installed PU insulation board with 50 µm aluminium facing

Parameter	Unit	A1-A3	A4	A5	C2	C3	C4	D
HWD	[kg]	-	-	-	-	-	-	-
NHWD	[kg]	-	-	-	-	-	-	-
RWD	[kg]	-	-	-	-	-	-	-
CRU	[kg]	-	-	-	-	-	-	0.00
MFR	[kg]	-	-	-	-	-	-	0.27
MER	[kg]	-	-	-	-	-	-	3.72
EEE	[MJ]	0.00	0.00	0.50	0.00	0.00	12.20	-
EET	[MJ]	0.00	0.00	1.36	0.00	0.00	33.40	-

Caption	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

*FW, HWD, NHWD, RWD: Not all background datasets used are compatible with the methodical approach for the declaration of waste and water indicators. All material quantities shown by these data inventories contribute significantly (>3 % in relation to declared mass - module A1-A3) to the manufacturing of the product. Therefore, these indicators are not included (Resolution of the SVA dated 07.01.2013)
**SM: Only the primary system is taken into account.

6. LCA: Interpretation

Modules A1-A3: Impacts on the environment during the production stage are mainly determined by raw material production and processing in A1: for nearly all categories (and also for renewable energy consumption), these impacts can mostly be attributed to the PU foam (>70 %), and to a lesser extent to the 50 µm aluminium facings (<35 %). Due to the production of isocyanate, ODP can almost exclusively be attributed to the PU foam.
The production of isocyanate (approx. 50 %) and polyols (approx. 30 %) is the main reason for the PU foam's GWP.

85 % of non-renewable primary energy is consumed by the PU core and 53 % of renewable primary energy by the facings.

Module C4: The biggest part of environmental load in C4 is caused by combustion. Thermal recovery is considered a possible scenario for the PU core's End of Life.

Module D: The utilisation potential for the next product system originates from using primary energy generated from MVAs which burn PU cores in order to generate power and steam. Additionally, Module D possesses the recycling potential of the aluminium used.

7. Requisite evidence

7.1 VOC emissions
Emission tests on PU boards with 50 µm aluminium facings found that the VOC values are significantly below the limits determined by the AgBB scheme (/PU Europe Technical Dossier/). The tests were conducted by the research organisations Eurofins/Denmark, VTT/Finland and WKI/Germany, among others.

VOC emissions

Name	Value	Unit
Overview of Results (28 days)	-	µg/m³
TVOC (C6 - C16)	0 - 100	µg/m³
Sum SVOC (C16 - C22)	0 - 10	µg/m³
R (dimensionless)	0 - 0.5	-
VOC without NIK	0 - 100	µg/m³
Carcinogenic Substances	0	µg/m³

7.2 Isocyanate emission
In the analysis conducted by the Fraunhofer Institut für Holzforschung, Wilhelm-Klauditz-Institut /WKI (1998)/, no isocyanate emission could be detected in the 1m³ test chamber. SUPELCO cartridges have been used for detecting MDI. The detection limit is at 10 ng/m³.

7.3 Formaldehyde
Emission tests on PU boards with 50 µm aluminium facings only detected very small quantities of formaldehydes (< 3 µg/m3 (/PU Europe Technical Dossier/)). This is significantly below the threshold value of 120 µg/m3 (Class E1).

7.4 Leaching
Measuring the leaching behaviour (eluate analysis) while indicating the measuring process (provided that it is relevant to the area of application) can be performed e.g. based on DIN EN 12457/1-4 or DIN/CEN TS 14405 in connection with the European Council's decision dated 19.12.2002 (2002/33/EC).

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900 Threshold values for workplaces, 2014

WKI
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