

ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804+A1

Owner of the Declaration	Milliken Industrials Ltd.
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-MIL-20210300-CBC1-EN
Issue date	26/11/2021
Valid to	25/11/2026

Tufted carpet tiles

polyamide 6 pile material made of Aquafil PA6 granulate with 40% recycled content, max. total pile weight 915 g/m², print design, Comfort Lite[®]/Comfort Plus[®] recycled cushion back

Milliken

www.ibu-epd.com | <https://epd-online.com>



Milliken



General Information

Milliken

Programme holder

IBU – Institut Bauen und Umwelt e.V.
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10178 Berlin
Germany

Declaration number

EPD-MIL-20210300-CBC1-EN

This declaration is based on the product category rules:

Floor coverings, 02/2018
(PCR checked and approved by the SVR)

Issue date

26/11/2021

Valid to

25/11/2026

Dipl. Ing. Hans Peters
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Tufted carpet tiles

PA 6 pile material made of Aquafil PA6 granulate with 40% recycled content, max. total pile weight 915 g/m², print design, Comfort Lite®/Comfort Plus® recycled cushion back

Owner of the declaration

Milliken Industrials Ltd.
Beech Hill Plant, Gidlow Lane
Wigan WN6 8RN
United Kingdom

Declared product / declared unit

1 m² tufted carpet tiles having a pile material of polyamide 6 with 40% recycled content and a Comfort Lite® or Comfort Plus® recycled cushion back.

Scope:

The manufacturer declaration applies to a group of similar products with a maximum total pile weight of 915 g/m².

The carpet is manufactured at the Milliken production site in Wigan, United Kingdom.

LCA results for products with a maximum total pile weight of 655 g/m² can be taken from the corresponding tables of the annexe. Specific data for every product within the declared group of products in relation to its total pile weight can be calculated by using equation 1 given in the annexe (see annexe chapter: 'General Information on the annexe').

The declaration is only valid in conjunction with a valid GUT-PRODIS license of the product.

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.

The EPD was created according to the specifications of EN 15804+A1. In the following, the standard will be simplified as EN 15804.

Verification

The standard EN 15804 serves as the core PCR

Independent verification of the declaration and data according to ISO 14025:2010

internally externally

Angela Schindler
(Independent verifier)

Product

Product description/Product definition

Tufted carpet tiles having a polyamide 6 pile material made of Aquafil PA 6 granulate with 40% recycled content and a Comfort Lite® or Comfort Plus® recycled cushion back.

The injection printing system Millitron® allows the creation of various designs.

Comfort Lite® or Comfort Plus® recycled cushion back: The bitumen based heavy backing with recycled filler includes a glass fibre reinforcement, a 90% recycled polyurethane cushion and it is covered by a felt backing.

The recycled content based on the total weight of the product amounts to minimum 59%.

The declaration applies to a group of products with a maximum total pile weight of 915 g/m².

LCA results for products with a maximum total pile weight of 655 g/m² can be taken from the corresponding tables of the annexe.

Results for specific products with any other total pile weight can be calculated by using equation 1 given in the annexe (see annexe chapter: 'General Information on the annexe').

For the placing on the market of the product in the European Union/European Free Trade Association (EU/EFTA) (with the exception of Switzerland) *Regulation (EU) No. 305/2011 Construction Product Regulation (CPR)* applies. The product needs a Declaration of Performance (DoP) taking into consideration *EN 14041-2018-05, Resilient, textile and laminate floor coverings - Essential characteristics and the CE-marking*. The DoP of the product can be found on the manufacturer's technical information section. For the application and use of the product the respective national provisions apply.

Application

According to the use class as defined in *EN 1307* the products can be used in all professional areas which require class 33 or less.



Technical Data

The performance data listed in the DoP apply.

Constructional data

Name	Value	Unit
Product Form	Tiles or modules, several dimensions	-
Type of manufacture	Tufted carpet	-
Yarn type	Polyamide 6 made of Aquafil PA6 granulate with 40% recycled content	-
Colouration	print design	-
Primary backing	Polyester	-
Secondary backing	Comfort Lite®/Comfort Plus® recycled cushion back	-
Total pile weight	max. 915	g/m ²
Total carpet weight	max. 4700	g/m ²

Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to *EN 14041: 2018-05, Resilient, textile and laminate floor coverings*

- Essential characteristics. Additional product properties in accordance with *EN 1307* can be found on the Product Information System *PRODIS* using the *PRODIS* registration number of the product (www.pro-dis.info) or on the manufacturer's technical information section (www.millikencarpet.com).

Base materials/Ancillary materials

Name	Value	Unit
Polyamide 6	19.5	%
Polyester	4.6	%
Polypropylene	1.1	%
Limestone	37.3	%
Bitumen	10.8	%
Aluminum hydroxide	8.7	%
Vinyl acetate-ethylene	3.5	%
Glass fibre	1.0	%
Polyurethane	13.2	%
Additives	0.5	%

This product contains substances listed in the *ECHA candidate list* (16.01.2020) or other carcinogenic, mutagenic or reprotoxic (CMR) substances in categories 1A or 1B which are not on the candidate list exceeding 0.1 percentage by mass: no

The products are registered in the *GUT-PRODIS* Information System. The *PRODIS* system ensures the compliance with limitations of various chemicals and Volatile Organic Compound (VOC)-emissions and a ban on the use of all substances that are listed as 'Substances of Very High Concern' (SVHC) under *REACH*.

Reference service life

A calculation of the reference service life according to *ISO 15686* is not possible.

The service life of textile floor coverings strongly depends on the correct installation taking into account the declared use classification and the adherence to cleaning and maintenance instructions.

A minimum service life of 10 years can be assumed, technical service life can be considerably longer.

LCA: Calculation rules

Declared Unit

Name	Value	Unit
Declared unit	1	m ²
conversion factor [Mass/Declared Unit]	4.7	-
Gross density	440	kg/m ³

The declared unit refers to 1 m² produced textile floor covering. The output of module A5 'Assembly' is 1 m² installed textile floor covering.

System boundary

Type of EPD: Cradle-to-grave

System boundaries of modules A, B, C, D:

Modules C3, C4 and D are indicated separately for three end-of-life scenarios:

- 1 landfill disposal
- 2 municipal waste incineration
- 3 recovery in a cement plant

A1-A3 Production:

Energy supply and production of the basic material, processing of secondary material, auxiliary material, transport of the material to the manufacturing site,

emissions, waste water treatment, packaging material and waste processing up to the landfill disposal of residual waste (except radioactive waste). Benefits for generated electricity and steam due to the incineration of production waste are aggregated. Biogenic carbon that is stored in renewable material (packaging paper) is taken into account as well as the associated carbon dioxide uptake from the air from which this biogenic carbon comes.

A4 Transport:

Transport of the packed textile floor covering from factory gate to the place of installation.

A5 Installation:

Installation of the textile floor covering, processing of installation waste and packaging waste up to the landfill disposal of residual waste (except radioactive waste), the production of the amount of carpet that occurs as installation waste including its transport to the place of installation. Generated electricity and steam due to the incineration of waste are listed in the result table as exported energy. Biogenic carbon that is stored in renewable materials in packaging paper is released as carbon dioxide emissions into the air at the end of life in module A5. Preparation of the floor and auxiliary materials (adhesives, fixing agents, PET connectors) are beyond the system boundaries and not taken into account.

B1 Use:

Indoor emissions during the use stage. After the first year, no product-related Volatile Organic Compound (VOC) emissions are relevant due to known VOC decay curves of the product.

B2 Maintenance:

Cleaning of the textile floor covering for a period of 1 year:
 Vacuum cleaning – electricity supply
 Wet cleaning – electricity, water consumption, production of the cleaning agent, waste water treatment.

The declared values in this module have to be multiplied by the assumed service life of the floor covering in the building in question.

B3 - B7:

The modules are not relevant and therefore not declared.

C1 De-construction:

The floor covering is de-constructed manually and no additional environmental impact is caused.

C2 Transport:

Transport of the carpet waste to a landfill, to the municipal waste incineration plant (MWI) or to the waste collection facility for recycling.

C3 Waste processing:

C3-1: Landfill disposal needs no waste processing.
 C3-2: The impact from waste incineration (plant with $R1 > 0.6$), generated electricity and steam are listed in the result table as exported energy.
 C3-3: Collection of the carpet waste for recovery in the cement industry, waste processing (granulating), transport to the cement plant, emissions from the incineration. The biogenic carbon that is stored in the renewable materials of the floor covering is released into the air as carbon dioxide emissions.

C4 Disposal

C4-1: Impact from landfill disposal.
 C4-2: The carpet waste leaves the system in module C3-2.
 C4-3: The pre-processed carpet waste leaves the system in module C3-3.

D Recycling potential:

Calculated benefits result from materials exclusive secondary materials (net materials).
 D-A5: Benefits for generated energy due to incineration of packaging and installation waste (incineration plant with $R1 > 0.6$),
 D-1: Benefits for generated energy due to landfill disposal of carpet waste at the end-of-life,
 D-2: Benefits for generated energy due to incineration of carpet waste at the end-of-life (incineration plant with $R1 > 0.6$),
 D-3: Benefits for saved fossil energy and saved inorganic material due to recovery of the carpet in a cement plant.

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.

Background data are taken from the *GaBi database 2021-2*. Remaining data gaps are covered by the *ecoinvent 3.7 database 2020*.

LCA: Scenarios and additional technical information

The following information refer to the declared modules and are the basis for calculations or can be used for further calculations. The indicated values refer to the declared functional unit of all products with a max. total pile weight of 915 g/m².

Transport to the construction site (A4)

Name	Value	Unit
Litres of fuel (truck, EURO 0-6 mix)	0.011	l/100km
Transport distance	700	km
Capacity utilisation (incl. empty runs)	55	%

Installation in the building (A5)

Name	Value	Unit
Material loss	0.14	kg

Polyethylene packaging waste and installation waste are considered to be incinerated in a municipal waste incineration plant. Cardboard packaging waste is going to be recycled.

Preparation of the floor and auxiliaries (adhesives, fixing agents, PET connectors, etc.) are not taken into account.

Maintenance (B2)

The values for cleaning refer to 1 m² floor covering used in commercial areas per year. Depending on the application based on *ISO 10874*, the technical service life recommended by the manufacturer and the anticipated strain on the floor by customers, the case-specific useful life can be established. Based on this useful life the effects of Module B2 need to be calculated in order to obtain the overall environmental impacts.

Name	Value	Unit
Maintenance cycle (wet cleaning)	1.5	1/year
Maintenance cycle (vacuum cleaning)	208	1/year
Water consumption (wet cleaning)	0.004	m ³
Cleaning agent (wet cleaning)	0.09	kg
Electricity consumption	0.314	kWh

Further information on cleaning and maintenance see www.millikencarpet.com

End of Life (C1-C4)

Three different end-of-life scenarios are declared and the results are indicated separately in module C.

Each scenario is calculated as a 100% scenario.

Scenario 1: 100% landfill disposal

Scenario 2: 100% municipal waste incineration (MWI) with R1>0.6

Scenario 3: 100% recycling in the cement industry

If combinations of these scenarios have to be calculated this should be done according to the following scheme:

$$\begin{aligned} \text{EOL-impact} &= x\% \text{ impact (Scenario 1)} \\ &+ y\% \text{ impact (Scenario 2)} \\ &+ z\% \text{ impact (Scenario 3)} \\ &\text{with } x\% + y\% + z\% = 100\% \end{aligned}$$

Name	Value	Unit
Collected as mixed construction waste (scenario 1 and 2)	4.7	kg
Collected separately (scenario 3)	4.7	kg
Landfilling (scenario 1)	4.7	kg
Energy recovery (scenario 2)	4.7	kg
Energy recovery (scenario 3)	2.49	kg
Recycling (scenario 3)	2.21	kg

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Recovery or recycling potentials due to the three end-of-life scenarios (module C) are indicated separately.

Recycling in the cement industry (scenario 3)

VDZ e.V.

The organic material of the carpet is used as an alternative fuel in a cement kiln. It mainly substitutes for lignite (65.2%), hard coal (26.2%) and petrol coke (8.6%).

The inorganic material is substantially integrated into the cement clinker and substitutes for original material input.

LCA: Results

The LCA results refer to all declared products with a maximum total pile weight of 915 g/m². LCA results for products with a maximum total pile weight of 655 g/m² can be taken from the corresponding tables of the annexe. Results for specific products with any other total pile weight can be calculated by using equation 1 given in the annexe (see annexe chapter: 'General Information on the annexe'). The declared result figures in module B2 have to be multiplied by the assumed service life (in years) of the floor covering in the building under consideration. Information on non-relevant modules: Modules B3 - B7 are not relevant during the service life of the carpet. Modules C1, C3/1, C4/2 and C4/3 cause no additional impact (see chapter "LCA: Calculation rules" in this document). All these modules are declared and marked as 'modules not relevant/declared'. Module C2 represents the transport for scenarios 1, 2 and 3. Column D represents module D/A5. The calculations are based on the *CML characterization factors* (version August 2016).

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

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	X	X	MNR	MNR	MNR	MND	MND	MND	X	X	X	X	

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A1: 1 m² floorcovering

Parameter	Unit	A1-A3	A4	A5	B1	B2	C2	C3/2	C3/3	C4/1	D	D/1	D/2	D/3
GWP	[kg CO ₂ -Eq.]	9.59E+0	2.85E-1	7.98E-1	0.00E+0	2.92E-1	1.56E-2	5.86E+0	5.93E+0	3.19E-1	-3.83E-2	0.00E+0	-1.02E+0	-4.33E-1
ODP	[kg CFC11-Eq.]	8.02E-9	4.97E-17	2.41E-10	0.00E+0	1.08E-8	2.72E-18	2.20E-15	3.03E-15	1.08E-15	-5.89E-16	0.00E+0	-1.57E-14	-2.34E-15
AP	[kg SO ₂ -Eq.]	1.66E-2	1.18E-3	6.49E-4	0.00E+0	1.08E-3	6.45E-5	3.74E-3	3.95E-3	8.28E-4	-4.45E-5	0.00E+0	-1.19E-3	-1.40E-3
EP	[kg (PO ₄) ³ -Eq.]	3.38E-3	3.00E-4	1.39E-4	0.00E+0	3.02E-4	1.64E-5	9.34E-4	9.81E-4	8.99E-4	-6.11E-6	0.00E+0	-1.63E-4	-1.94E-4
POCP	[kg ethene-Eq.]	2.06E-3	-5.04E-4	5.23E-5	6.29E-5	1.45E-4	-2.76E-5	2.30E-4	1.65E-4	7.46E-5	-4.08E-6	0.00E+0	-1.09E-4	-1.48E-4
ADPE	[kg Sb-Eq.]	1.17E-5	2.53E-8	3.59E-7	0.00E+0	2.74E-6	1.38E-9	1.89E-7	2.01E-7	6.13E-8	-7.21E-9	0.00E+0	-1.92E-7	-2.43E-7
ADPF	[MJ]	1.98E+2	3.88E+0	6.15E+0	0.00E+0	6.76E+0	2.13E-1	3.11E+0	3.93E+0	4.77E+0	-5.49E-1	0.00E+0	-1.47E+1	-4.76E+1

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 - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A1: 1 m² floorcovering

Parameter	Unit	A1-A3	A4	A5	B1	B2	C2	C3/2	C3/3	C4/1	D	D/1	D/2	D/3
PERE	[MJ]	7.69E+1	2.17E-1	2.90E+0	0.00E+0	1.23E+0	1.19E-2	5.16E-1	7.58E-1	3.57E-1	-1.52E-1	0.00E+0	-4.04E+0	-5.56E-1
PERM	[MJ]	5.52E-1	0.00E+0	-5.52E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	7.74E+1	2.17E-1	2.35E+0	0.00E+0	1.23E+0	1.19E-2	5.16E-1	7.58E-1	3.57E-1	-1.52E-1	0.00E+0	-4.04E+0	-5.56E-1
PENRE	[MJ]	1.54E+2	3.89E+0	6.61E+0	0.00E+0	7.85E+0	2.13E-1	5.50E+1	5.60E+1	4.91E+0	-6.72E-1	0.00E+0	-1.80E+1	-4.79E+1
PENRM	[MJ]	5.18E+1	0.00E+0	-2.15E-1	0.00E+0	0.00E+0	0.00E+0	-5.16E+1	-5.16E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PENRT	[MJ]	2.06E+2	3.89E+0	6.40E+0	0.00E+0	7.85E+0	2.13E-1	3.41E+0	4.41E+0	4.91E+0	-6.72E-1	0.00E+0	-1.80E+1	-4.79E+1
SM	[kg]	2.98E+0	0.00E+0	8.94E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.10E-1
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m ³]	8.38E-2	2.48E-4	3.11E-3	0.00E+0	4.13E-3	1.36E-5	1.84E-2	1.87E-2	4.53E-5	-1.48E-4	0.00E+0	-3.95E-3	-4.21E-3

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 – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A1: 1 m² floorcovering

Parameter	Unit	A1-A3	A4	A5	B1	B2	C2	C3/2	C3/3	C4/1	D	D/1	D/2	D/3
HWD	[kg]	1.56E-3	1.96E-10	4.67E-5	0.00E+0	5.90E-10	1.07E-11	6.70E-10	8.19E-10	8.84E-10	-1.51E-10	0.00E+0	-4.03E-9	-5.27E-10
NHWD	[kg]	4.87E-1	5.78E-4	4.87E-2	0.00E+0	5.62E-3	3.17E-5	1.13E+0	1.13E+0	4.68E+0	-3.15E-4	0.00E+0	-8.41E-3	-1.96E-1
RWD	[kg]	3.04E-3	4.71E-6	9.51E-5	0.00E+0	3.32E-4	2.58E-7	1.19E-4	1.89E-4	5.71E-5	-4.88E-5	0.00E+0	-1.30E-3	-1.37E-4
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	1.97E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.29E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	0.00E+0	2.72E-1	0.00E+0	0.00E+0	0.00E+0	7.97E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	0.00E+0	5.02E-1	0.00E+0	0.00E+0	0.00E+0	1.48E+1	8.01E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

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; EET = Exported thermal energy

Not all of the life cycle inventories applied in this study support the methodological approach for the waste and water indicators. The data are based on publications of industry. The indicators for waste and water of the system are evaluated but contain a higher degree of uncertainty.

References

EN 1307

DIN EN 1307: 2014+A1:2016+A2:2018-05: Textile floor coverings - Classification

EN 13501-1

DIN EN 13501-1:2019-05: Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests

EN 14041

DIN EN 14041: 2018-05: Resilient, textile and laminate floor coverings - Essential characteristics

EN 15804

EN 15804:2012-04+A1 2013/, Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

EN 16810

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ISO 10874

DIN EN ISO 10874: 2012+A1:2021-04: Resilient, textile and laminate floor coverings - Classification

ISO 14025

DIN EN /ISO 14025:2011-10/, Environmental labels and declarations — Type III environmental declarations — Principles and procedures

ISO 14040

DIN EN ISO 14040:2006+A1:2020 Environmental management - Life cycle assessment - Principles and framework

ISO 14044

DIN EN ISO 14044:2006+A1:2018+A2:2020 Environmental management - Life cycle assessment - Requirements and guidelines

ISO 15686

ISO 15686: Buildings and constructed assets - Service life planning

ISO 15686-1: 2011-05: Part 1: General principles and framework

ISO 15686-2: 2012-05: Part 2: Service life prediction procedures

ISO 15686-7: 2017-04: Part 7: Performance evaluation for feedback of service life data from practice

ISO 15686-8: 2008-06: Part 8: Reference service life and service-life estimation

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CML characterization factors

Impact assessment characterization factors, version 4.7, August 2016, Institute of Environmental Sciences - 'Centrum voor Milieuwetenschappen in Leiden' (CML), Leiden, The Netherlands

ECHA candidate list

Candidate List of substances of very high concern (SVHCs) for authorisation, 16.01.2020, European Chemicals Agency (ECHA), Helsinki, Finland

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IBU 2021

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PCR Part A

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