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3M EHS Laboratory & 3M Industrial Mineral Products Division

Environmental Product Declaration

3M™ Premium and 3M™ Standard Cool Roofing Granules



3M™ Premium Cool Roofing Granules and 3M™ Standard Cool Roofing Granules are two different color classes of ceramic-coated minerals used as surfacing material in asphalt roofing products. These granules are colored with durable pigments, bonded in a ceramic matrix and treated to promote adhesion to asphalt.

1 Program Related Information

EPD Programme Holder	The International EPD® System (www.environdec.com) Operated by EPD® International AB. Valhallavägen 81, 114 27 Stockholm, Sweden
Product Category Rules (PCRs)	EN 15804:2012+A1:2013 - Sustainability of construction works - Environmental Product Declarations - Core rules for the product category of construction products PCR 2012:01 v2.2 - Construction Products and Construction Services (Multiple UN CPC codes, valid until: 2019-03-03)
PCR review conducted by	The Technical Committee of the International EPD® System. Chair: Massimo Marino (info@environdec.com)
EPD Registration Number	S-P-01074
Publication Date (Version)	2017-11-02 (Ver. 1)
Valid Until	2022-11-01
Geographical Validity	Europe (CML midpoints) and United States of America (TRACI midpoints)
Independent Verification	<input type="checkbox"/> Internal <input type="checkbox"/> External <input checked="" type="checkbox"/> EPD® Process Certification
Verified and approved by	Rita Schenck with The Institute for Environmental Research and Education (IERE)
Manufacturer	3M; 3M Center, St. Paul, MN 55144-1000
EPD Prepared by	John Furney, 3M Life Cycle Assessment Analyst
Calculation Procedure	thinkstep GaBi™ 7.3 Software with DB version 6.115 and service pack 30
System Boundaries	<input checked="" type="checkbox"/> Cradle-to-Gate <input type="checkbox"/> Cradle-to-Grave <input type="checkbox"/> Cradle-to-Gate with Options
Data Sources	Specific data collected by the 3M Industrial Mineral Products Division (3M IMPD), representative of 2015 production. Generic data sources as available in the GaBi™ software and databases.
Disclaimer	Environmental product declarations within the same product category but from different programs may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804. All values provided in this Environmental Product Declaration are a direct result from the use of characterization factors and calculation rules as defined in the GaBi™ software. The environmental indicators used for these calculations are based on CML2001 and TRACI 2.1.
Manufacturer Contact Information	For more information about this Environmental Product Declaration or its contents, contact Frank Klink with 3M IMPD at fwklink@mmm.com ; or Carrie Pearson, 3M EPD® process owner, at cpearson2@mmm.com .

2 Product Related Information

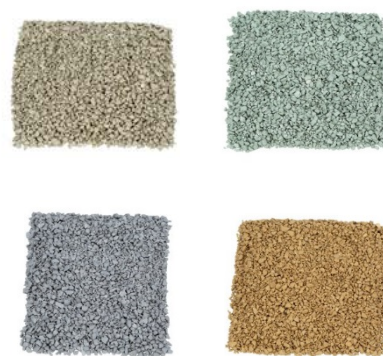
2.1 Manufacturing company

With operations employing nearly 90 000 people globally in more than 70 countries, and products sold through 5 business groups in nearly 200 countries, 3M is a diversified technology company with global sales of \$30.1 billion (year-end 2016). 3M's commitment to innovation is reflected in the continued investment of nearly 6 percent of sales back into R&D (nearly \$1.7 billion in 2016), an investment that has helped produce more than 109 000 patents in company history. 3M is one of 30 companies in the Dow Jones Industrial Average and is a component of the Standard & Poor's 500 Index.

The products covered by this Environmental Product Declaration are manufactured by 3M Industrial Mineral Products Division, for the purpose of asphalt roofing applications. The manufacturing site is located in Corona, CA, US. This site holds an ISO 14001 certificate for their environmental management systems. Two cradle-to-gate Life Cycle Assessments (LCAs) were completed as a part of this evaluation for the 3M™ Premium and 3M™ Standard Cool Roofing Granules and these LCAs were used as a reference for this EPD.

2.2 Specification of the product

3M™ Premium and 3M™ Standard Cool Roofing Granules are two different color categories of ceramic-coated minerals used as surfacing material to provide weathering resistance and durable color in asphalt roofing products. The 3M™ Premium and 3M™ Standard Cool Roofing Granules reflect more of the infrared portion of the solar spectrum than 3M™ Classic Roofing Granules by using a patented¹ multi-layer design incorporating colored durable infrared pigments which are bound in a ceramic matrix. The granules are also surface treated to reduce dust, to reduce asphaltic staining, and to promote adhesion to asphalt.



2.2.1 Classification

- 3M™ Premium and 3M™ Standard Cool Roofing Granules are classified under CPC code 153 "Sand, pebbles, gravel, broken or crushed stone, natural bitumen and asphalt" in the United Nations Central Product Classification (CPC) System.

Given that these granules are used as a construction product, PCR 2012:01 v2.2 and EN 15804:2012+A1:2013 apply.

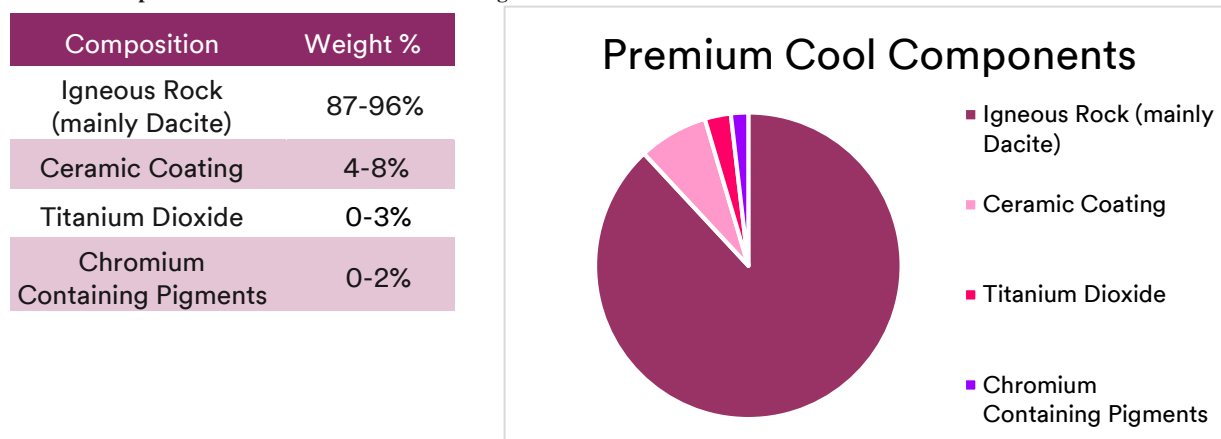
2.3 Declared unit

The declared unit in this Environmental Product Declaration is 1 kg of 3M™ Premium Cool or 3M™ Standard Cool Roofing Granules. Since the amount of 3M™ Premium Cool or 3M™ Standard Cool Roofing Granules used in any given application is unavailable, the precise function of the product or scenarios at the building level is unknown. The reference flow used for this study is 1kg of 3M™ Premium Cool or 3M™ Standard Cool Roofing Granules.

2.4 Content of material and chemical substances

The composition of 3M™ Premium Cool Roofing Granules (as sold) is shown in Table 1. 3M™ Premium Cool Roofing Granules covered by this Environmental Product Declaration do not contain Substances of Very High Concern (SVHC) included in the REACH candidate list² at a concentration at or above 0.1% in weight.

Table 1: Composition of 3M™ Premium Cool Roofing Granules.

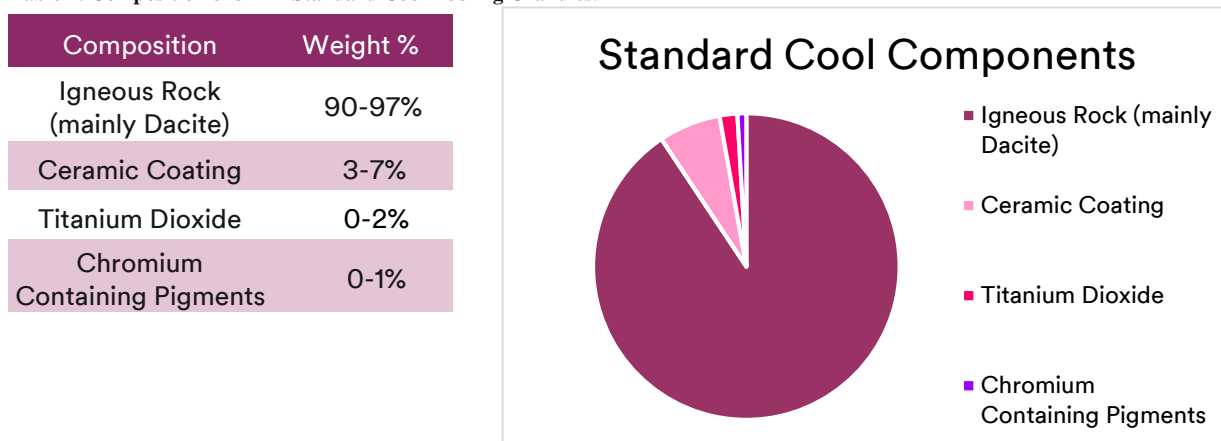


The composition of 3M™ Standard Cool Roofing Granules (as sold) is shown in Table 2. 3M™ Standard Cool Roofing Granules covered by this Environmental Product Declaration do not contain Substances of Very High Concern (SVHC) included in the REACH candidate list at a concentration at or above 0.1% in weight.

¹ US 7,455,899 B2; US 7,648,755 B2

² Candidate list according to article 59 (10) of Regulation (EC) No 1907/2006 (REACH) dated 2016-08-03.

Table 2: Composition of 3M™ Standard Cool Roofing Granules.



2.5 Units and Quantities

This Environmental Product Declaration uses the International System of Units with a maximum of 3 significant figures to report all results. Throughout the report, the SI English style for displaying values that need either a thousands separator or a decimal separator is used. The SI English style uses a space for the thousands separator and a period for the decimal separator (Example: 1 234.56).

3 Environmental Performance Related Information

3.1 Life cycle stages

The LCA studies supporting this Environmental Product Declaration are cradle-to-gate analyses, including the life cycle stages listed in Table 3. Due to the exclusion of the use phase in this cradle-to-gate analysis, the reference service life (RSL) is not specified.

Table 3: Modules of the product life cycle included in the EPD.

Product stage			Construction process stage	Use Stage									End-of-life stage				Resource recovery stage
Raw materials	Transport	Manufacturing	Transport	Construction instillation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/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	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	

(X = declared module; MND = module not declared)

A1 = Upstream module; A2-A3 = Core module; A4-C4 = Downstream module; D = Other environmental information

3.1.1 Upstream module (A1)

Raw material supply includes the acquisition of raw materials from nature to create usable intermediates, as well as the packaging used to ship the raw materials.

3.1.2 Core module (A2, A3)

All raw materials are transported from the source to the 3M manufacturing site by truck, rail, and/or boat. Most of the time, raw materials need to be packed for transportation; however, loading and unloading of raw materials are not included in the study.

Manufacturing includes all steps carried out at 3M manufacturing sites to produce the finished product, including utilities used and waste produced. The environmental profile of these energy carriers is modeled for local conditions. Machines and facilities (capital goods) required for and during production are excluded, as is transportation of employees. All materials and energy used in the production of 3M™ Premium Cool or 3M™ Standard Cool Roofing Granules were included in the studies (no cut-off rule was applied). Proxy data sets were used in the LCA models when specific information was not available. The proxy data sets account for <14.2% in the 3M™ Premium Cool Roofing Granule LCA and <1.28% in the 3M™ Standard Cool Roofing Granule LCA for all reported potential environmental impacts.

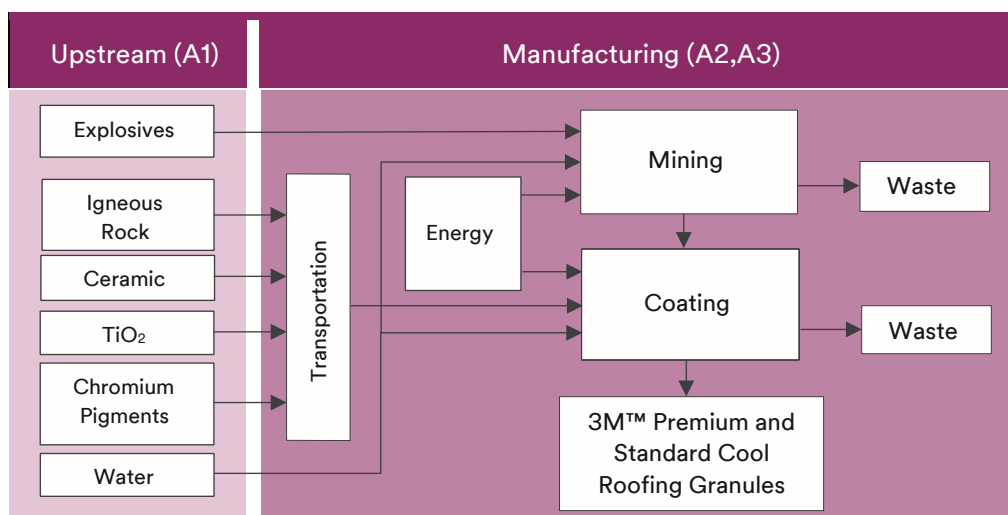


Figure 1: Process flow for the cradle-to-gate life cycle of 3M™ Premium and 3M™ Cool Roofing Granules.

3.2 Environmental performance-related information

The environmental parameters are declared for upstream and core processes. The overall impact of the product is divided into potential environmental impacts, use of resources, and other indicators. All environmental impacts are reported per declared unit.

3.2.1 Potential environmental impact

The reported environmental impacts result from characterization models applied to the life cycle stages considered in the study. Total pollutant emissions from the operations included in the system boundaries are reported as potential environmental impacts, using the 2016-01 version of CML 2001 (Table 4 and Table 5) and TRACI 2.1 (Table 6 and Table 7) characterization factors as implemented in GaBi. At this time TRACI 2.1 methodology does not include a midpoint for abiotic depletion potential for non fossil resources. Data are presented per declared unit. The span between potential environmental impacts for individual granule colors within each product group may be greater than 10% for some impact categories but is expected to be within the uncertainty ranges reported in Section 4.1 of this EPD.

Table 4: Environmental impact of 1 kg of 3M™ Premium Cool Roofing Granules using CML 2001.

	Upstream	Core		Total
	A1	A2	A3	
Abiotic depletion potential for non fossil resources [kg Sb eq.]	8.14E-06	4.76E-09	4.86E-08	8.20E-06
Abiotic depletion potential for fossil resources [MJ]	3.91	0.459	1.73	6.09
Acidification potential [kg SO ₂ eq.]	2.47E-03	1.40E-04	1.09E-04	2.72E-03
Eutrophication potential [kg PO ₄ ³⁻ eq.]	1.84E-04	3.28E-05	1.67E-05	2.34E-04
Global warming potential [kg CO ₂ eq.]	0.273	0.0334	0.132	0.439
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	3.23E-09	2.65E-13	9.51E-12	3.24E-09
Formation potential of tropospheric ozone [kg ethene eq.]	1.55E-04	1.38E-05	2.22E-05	1.91E-04

Table 5: Environmental impact of 1 kg of 3M™ Standard Cool Roofing Granules using CML 2001.

	Upstream	Core		Total
	A1	A2	A3	
Abiotic depletion potential for non fossil resources [kg Sb eq.]	2.71E-06	2.50E-09	2.79E-08	2.74E-06
Abiotic depletion potential for fossil resources [MJ]	1.82	0.244	0.992	3.06
Acidification potential [kg SO ₂ eq.]	1.42E-03	7.74E-05	6.24E-05	1.56E-03
Eutrophication potential [kg PO ₄ ³⁻ eq.]	8.54E-05	1.77E-05	9.57E-06	1.13E-04
Global warming potential [kg CO ₂ eq.]	0.122	0.0178	0.0758	0.215
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	1.43E-09	1.41E-13	5.46E-12	1.43E-09
Formation potential of tropospheric ozone [kg ethene eq.]	8.40E-05	6.69E-06	1.27E-05	1.03E-04

Table 6: Environmental impact of 1 kg of 3M™ Premium Cool Roofing Granules using TRACI 2.1.

	Upstream	Core		Total
	A1	A2	A3	
Abiotic depletion potential for fossil resources [MJ surplus energy]	0.398	0.0622	0.245	0.705
Acidification potential [kg SO ₂ eq.]	2.28E-03	1.79E-04	1.31E-04	2.59E-03
Eutrophication potential [kg N eq.]	2.32E-04	1.52E-05	7.90E-06	2.55E-04
Global warming potential [kg CO ₂ eq.]	0.272	0.0333	0.131	0.436
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	4.05E-09	2.82E-13	1.01E-11	4.06E-09
Formation potential of tropospheric ozone [kg O ₃ eq.]	0.0170	5.33E-03	2.96E-03	0.0253

Table 7: Environmental impact of 1 kg of 3M™ Standard Cool Roofing Granules using TRACI 2.1.

	Upstream	Core		Total
	A1	A2	A3	
Abiotic depletion potential for fossil resources [MJ surplus energy]	0.196	0.0332	0.140	0.369
Acidification potential [kg SO ₂ eq.]	1.29E-03	9.80E-05	7.50E-05	1.46E-03
Eutrophication potential [kg N eq.]	1.07E-04	8.18E-06	4.50E-06	1.20E-04
Global warming potential [kg CO ₂ eq.]	0.121	0.0177	0.0753	0.214
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	1.76E-09	1.50E-13	5.81E-12	1.77E-09
Formation potential of tropospheric ozone [kg O ₃ eq.]	8.00E-03	2.86E-03	1.70E-03	0.0126

3.2.2 Use of resources

The main resource consumption sources for 3M™ Premium and 3M™ Standard Cool Roofing Granules are reported in the tables below. Use of resources without energy content is expressed in kg or m³ per declared unit. Energy data are expressed in MJ per declared unit and as net calorific value. The net calorific value or lower heating value is calculated by subtracting the heat of vaporization of water from the higher heating value. The results from the tables should be interpreted over the different modules and as they are calculated by the GaBi™ software. It is important to note that the renewable energy reported under A3 is not generated by 3M, but is part of the energy mix data sets used in the LCA model. The values are presented as calculated in the GaBi™ software.

Table 8: Resource use for 1 kg of 3M™ Premium Cool Roofing Granules.

	Upstream	Core		Total
	A1	A2	A3	
Use of renewable primary energy as energy carrier [MJ]	0.508	7.92E-03	0.108	0.624
Use of renewable primary energy as raw materials [MJ]	0	0	0	0
Total use of renewable primary energy [MJ]	0.508	7.92E-03	0.108	0.624
Use of non-renewable primary energy as energy carrier [MJ]	9.67	0.462	1.81	11.9
Use of non-renewable primary energy as raw materials [MJ]	0	0	0	0
Total use of non-renewable primary energy [MJ]	9.67	0.462	1.81	11.9
Use of secondary material [kg]	0	0	0	0
Use of renewable secondary fuels [MJ]	0	0	0	0
Use of non-renewable secondary fuels [MJ]	0	0	0	0
Use of net fresh water [m ³]	1.78E-03	9.12E-05	3.03E-04	2.17E-03

Table 9: Resource use for 1 kg of 3M™ Standard Cool Roofing Granules.

	Upstream	Core		Total
	A1	A2	A3	
Use of renewable primary energy as energy carrier [MJ]	0.190	4.43E-03	0.0620	0.257
Use of renewable primary energy as raw materials [MJ]	0	0	0	0
Total use of renewable primary energy [MJ]	0.190	4.43E-03	0.0620	0.257
Use of non-renewable primary energy as energy carrier [MJ]	1.99	0.246	1.04	3.28
Use of non-renewable primary energy as raw materials [MJ]	0	0	0	0
Total use of non-renewable primary energy [MJ]	1.99	0.246	1.04	3.28
Use of secondary material [kg]	0	0	0	0
Use of renewable secondary fuels [MJ]	0	0	0	0
Use of non-renewable secondary fuels [MJ]	0	0	0	0
Use of net fresh water [m ³]	1.00E-03	4.80E-05	1.74E-04	1.23E-03

3.2.3 Output flows and waste categories

The important output flows and waste categories for 3M™ Premium and 3M™ Standard Cool Roofing Granules are reported in the tables below. All material flows are expressed in kg per declared unit while the exported energy data is expressed in MJ per declared unit and as net calorific value. Components for re-use, materials for recycling, materials for energy recovery, exported electrical energy, and exported thermal energy are required to be reported following EN 15804. It should be noted that the applicable 3M processes do not produce radioactive waste and the values are presented as calculated in the GaBi™ software based on background data sets.

No information is provided for the release of dangerous substances to indoor air, soil, and water during the use stage according to standards on measurement of release of regulated dangerous substances as the granules are a passive product.

Table 10: Output flows and waste categories for 1 kg of 3M™ Premium Cool Roofing Granules.

	Upstream	Core		Total
	A1	A2	A3	
Hazardous waste disposed [kg]	1.04E-05	1.32E-09	7.14E-10	1.04E-05
Non-hazardous waste disposed [kg]	0.100	1.65E-05	9.83E-04	0.101
Radioactive waste disposed [kg]	9.96E-05	9.63E-07	3.31E-05	1.34E-04
Components for re-use [kg]	0	0	0	0
Materials for recycling [kg]	0	0	0	0
Materials for energy recovery [kg]	0	0	0	0
Exported electrical energy [MJ]	0	0	0	0
Exported thermal energy [MJ]	0	0	0	0

Table 11: Output flows and waste categories for 1 kg of 3M™ Standard Cool Roofing Granules.

	Upstream	Core		Total
	A1	A2	A3	
Hazardous waste disposed [kg]	6.22E-05	5.12E-07	1.90E-05	8.17E-05
Non-hazardous waste disposed [kg]	7.82E-06	1.10E-09	4.10E-10	7.82E-06
Radioactive waste disposed [kg]	0.0413	9.02E-06	5.32E-04	0.0419
Components for re-use [kg]	0	0	0	0
Materials for recycling [kg]	0	0	0	0
Materials for energy recovery [kg]	0	0	0	0
Exported electrical energy [MJ]	0	0	0	0
Exported thermal energy [MJ]	0	0	0	0

3.3 Other environmental information

3.3.1 LCA results interpretation for 3M™ Premium and 3M™ Standard Cool Roofing Granules

The most significant impact of the product's life cycle on the environment, energy use, water, and waste use is related to the raw material supply (A1), as this stage has the greatest impact for each CML2001 and TRACI 2.1 midpoint, the greatest renewable and non-renewable energy use, the greatest net fresh water use, and the greatest waste generation.

4 Additional Information

4.1 Uncertainty on the environmental indicators

Data quality and uncertainty are mutually dependent. The precision of the data depends on measuring tolerance, assumptions, completion, comprehensiveness of the considered system, and the representativeness of the data. Uncertainty is also introduced in the impact assessment phase of the study, and will vary according to the impact categories considered.

To get an idea of the uncertainty of an LCIA, it is calculated for each reference and midpoint based on a pedigree matrix, using six different data quality indicators, and Monte Carlo analysis. The uncertainty results are presented below in Table 12-15 with a 95% confidence and are calculated for the totals of the different modules.

Table 12: Uncertainty results for 1 kg of 3M™ Premium Cool Roofing Granules for CML 2001.

	Min	Max	Base	Δ%
Abiotic depletion potential for non fossil resources [kg Sb eq.]	6.74E-06	9.91E-06	8.20E-06	21%
Abiotic depletion potential for fossil resources [MJ]	5.42	6.84	6.09	12%
Acidification potential [kg SO ₂ eq.]	2.27E-03	3.23E-03	2.72E-03	19%
Eutrophication potential [kg PO ₄ ³⁻ eq.]	2.00E-04	2.76E-04	2.34E-04	18%
Global warming potential [kg CO ₂ eq.]	0.388	0.498	0.439	13%
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	2.39E-09	4.39E-09	3.24E-09	35%
Formation potential of tropospheric ozone [kg ethene eq.]	1.66E-04	2.18E-04	1.91E-04	14%

Table 13: Uncertainty results for 1 kg of 3M™ Standard Cool Roofing Granules for CML 2001.

	Min	Max	Base	Δ%
Abiotic depletion potential for non fossil resources [kg Sb eq.]	2.23E-06	3.45E-06	2.74E-06	26%
Abiotic depletion potential for fossil resources [MJ]	2.59	3.62	3.06	18%
Acidification potential [kg SO ₂ eq.]	1.27E-03	1.89E-03	1.56E-03	21%
Eutrophication potential [kg PO ₄ ³⁻ eq.]	9.06E-05	1.36E-04	1.13E-04	20%
Global warming potential [kg CO ₂ eq.]	0.184	0.255	0.215	19%
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	1.03E-09	2.06E-09	1.43E-09	44%
Formation potential of tropospheric ozone [kg ethene eq.]	8.76E-05	1.23E-04	1.03E-04	19%

Table 14: Uncertainty results for 1 kg of 3M™ Premium Cool Roofing Granules for TRACI 2.1.

	Min	Max	Base	Δ%
Abiotic depletion potential for fossil resources [MJ surplus energy]	0.622	0.792	0.705	12%
Acidification potential [kg SO ₂ eq.]	2.17E-03	3.08E-03	2.59E-03	19%
Eutrophication potential [kg N eq.]	2.02E-04	3.20E-04	2.55E-04	25%
Global warming potential [kg CO ₂ eq.]	0.382	0.489	0.436	12%
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	3.02E-09	5.39E-09	4.06E-09	33%
Formation potential of tropospheric ozone [kg O ₃ eq.]	0.0222	0.0289	0.0253	14%

Table 15: Uncertainty results for 1 kg of 3M™ Standard Cool Roofing Granules for TRACI 2.1.

	Min	Max	Base	Δ%
Abiotic depletion potential for fossil resources [MJ surplus energy]	0.314	0.430	0.369	17%
Acidification potential [kg SO ₂ eq.]	1.20E-03	1.76E-03	1.46E-03	21%
Eutrophication potential [kg N eq.]	8.89E-05	1.63E-04	1.20E-04	36%
Global warming potential [kg CO ₂ eq.]	0.182	0.250	0.214	17%
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	1.24E-09	2.45E-09	1.77E-09	38%
Formation potential of tropospheric ozone [kg O ₃ eq.]	0.0106	0.0150	0.0126	19%

4.2 Use of EPD® Results in Cradle-to-Grave evaluation

If the contents of this EPD are to be used in a cradle-to-grave evaluation, please contact your shingle manufacturer for more information on the solar reflectance of their product incorporating 3M™ Roofing Granules and the potential impact on building energy use as well as urban heat island reduction. Contact Frank Klink with 3M IMPD at fwklink@mmm.com for inquiries specific to 3M™ Premium and 3M™ Standard Cool Roofing Granules.

4.3 Comparisons of EPD® within this Product Category

Environmental product declarations within the same product category but from different programs may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804. This Environmental Product Declaration is based PCR 2012:01 v2.2 - Construction Products and Construction Services (Multiple UN CPC codes) from the International EPD® System which is in accordance with ISO 14025 and EN 15804.

4.4 Validity of the EPD® and changes versus previous version

This Environmental Product Declaration is the first version for this product. If changes in the products' life cycle result in worsening of the environmental impacts by more than ±10.0% from the numbers reported above, the Environmental Product Declaration shall be adjusted. Regardless, the Environmental Product Declaration shall be reviewed every five years. The next review is planned for 2022.

4.5 References

European Standard, Sustainability of construction works - Environmental Product Declarations - Core rules for the product category of construction products (EN 15804:2012+A1:2013), La Plaine Saint-Denis: Afnor, 2013.

GaBi Software-System and Database for Life Cycle Engineering, copyright 1992-2016 thinkstep AG. (Compilation 7.2.2.28, DB version 6.115).

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The International EPD® System, Construction Products and Construction Services for multiple UN CPC codes (PCR 2012:01, version 2.2), The International EPD® System, 2016.

For more information on sustainability at 3M,
visit our website: www.3M.com/sustainability

