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Geographical scope: Europe, USA

3M Sustainability & 3M Industrial Mineral Products Division

Environmental Product Declaration

In accordance with ISO 14025 and EN 15804+A1 for:

3M™ Smog-reducing Roofing Granules

3M Smog-reducing Roofing Granules are ceramic-coated minerals used as a surfacing material in asphalt roofing products and are designed specifically to be able to photocatalytically oxidize air pollutants such as NO_x. These granules are colored with durable pigments, bonded in a ceramic matrix, and treated to promote adhesion to asphalt.

1. Program Related Information

EPD Program Holder	The International EPD® System (www.environdec.com) Operated by EPD® International AB. Box 210 60; SE-100 31 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 version 2.3 - Construction Products and Construction Services (Multiple UN CPC codes, valid until 2020-03-03)		
PCR review conducted by	The Technical Committee of the International EPD® System. Chair: Massimo Marino (info@environdec.com)		
EPD Registration Number	S-P-01746		
Publication Date (Version)	2020-07-28 (Version 1)		
Valid Until	2025-07-27		
Geographical Validity	Europe (CML midpoints) and United States of America (TRACI midpoints)		
Independent Verification	<input checked="" type="checkbox"/> EPD® Process Certification (Internal)	<input type="checkbox"/> EPD® Verification (External)	
Third Party Verifier	The Epsten Group, Inc.; Accreditation Number 1003 www.epstengroup.com 		
Accredited by	A2LA; Certificate #3142.03 		
Manufacturer	3M; 3M Center St. Paul, MN 55144-1000		
EPD Prepared by	John Furney, LCACP; 3M Product Support Engineer		
Calculation Procedure	thinkstep GaBi™ ts Software Program Version 8.7.0.18 Software with DB version 8.7 and service pack 36		
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 2017. Generic data sources as available in the GaBi™ software and databases.		
Disclaimer	The EPD owner has the sole ownership, liability, and responsibility for the EPD. 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 Lara Ughetta with 3M IMPD at lughetta@mmm.com; or Carrie Pearson, 3M EPD process owner, at cpearson2@mmm.com.		

2. Product Related Information

2.1. Manufacturing company

With operations employing 96 000 people globally in more than 70 countries, and products sold through four business groups in nearly 200 countries, 3M is a diversified technology company with global sales of \$32 billion USD (year-end 2019). 3M's commitment to innovation is reflected in the continued investment of nearly 6 percent of sales back into R&D, an investment that has helped produce more than 115 000 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 product covered by this Environmental Product Declaration is manufactured by the 3M Industrial Mineral Products Division, for photocatalytic capabilities on asphalt roof coverings. The manufacturing location is in Corona, California, US. This site holds an ISO 14001 certificate for its environmental management system. A cradle-to-gate Life Cycle Assessment (LCA) was completed as a part of this evaluation for the 3M™ Smog-reducing Roofing Granules and this LCA was used as a reference for this EPD.

2.2. Specification of the product

3M Smog-reducing Roofing Granules are ceramic-coated minerals used as a surfacing material in asphalt roofing products that contain a photocatalytic layer as part of the ceramic coating matrix. These granules can be integrated into asphalt shingles as part of the shingle blend design or used in granule surfaced roofing membranes for low slope roofs. The photocatalytic layer generates oxygen (O₂) and hydroxyl (-OH) radicals when activated by the sun. The radicals react with the nitrogen oxides (NO and NO₂, or NO_x) in smog to form NO₃ which is a plant usable form of nitrogen. The NO₃ ion deposits wash away with the rainwater over time. The catalyst activity is constant when exposed to UV, so the smog-reduction activity is a continuous process.



2.2.1. Classification

The 3M Smog-reducing Roofing Granule is 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 version 2.3 and EN 15804:2012+A1:2013 apply.

2.2.2. Additional technical information

Additional information relevant to the product performance, certifications, or other technical data may be found on the 3M product page for 3M Smog-reducing Roofing Granules ([Link](#)). Alternatively, contact Lara Ughetta with 3M IMPD at lughetta@mmm.com.

2.3. Declared unit

The declared unit in this Environmental Product Declaration is 1 kg of 3M Smog-reducing Roofing Granules. Since the amount of 3M Smog-reducing 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 1 kg of 3M Smog-reducing Roofing Granules.

2.4. Content of material and chemical substances

The composition of 3M Smog-reducing Roofing Granules (as sold) is shown in Table 1. 3M Smog-reducing Roofing Granules covered by this Environmental Product Declaration do not contain Substances of Very High Concern (SVHC) included in the REACH candidate list¹ at a concentration at or above 0.1% in weight.

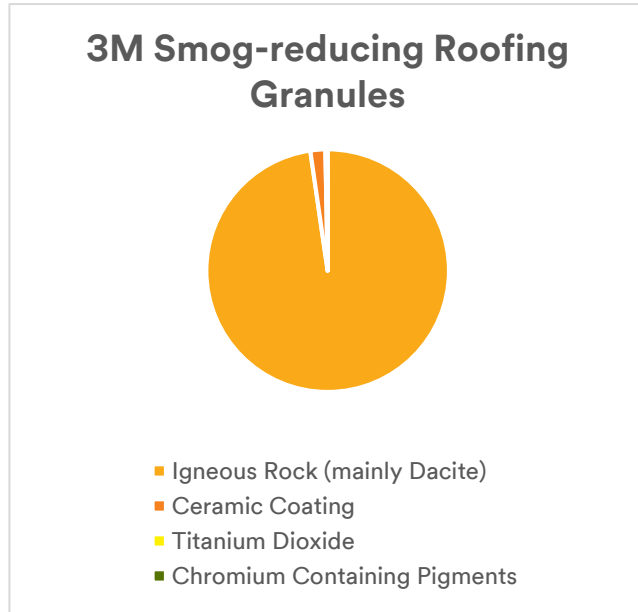
¹ Candidate list according to article 59 (10) of Regulation (EC) No 1907/2006 (REACH) dated 2020-01-16.

Table 1: Composition of 3M™ Smog-reducing Roofing Granules

Composition	Weight %
Igneous Rock (mainly Dacite)	95-98%
Ceramic Coating	0.5-2%
Titanium Dioxide	<0.2%
Chromium Containing Pigments	<0.1%

2.5. Units and Quantities

This Environmental Product Declaration uses the International System of Units with a maximum of three 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 study supporting this Environmental Product Declaration is a cradle-to-gate analysis, including the life cycle stages listed in Table 2. Due to the exclusion of the use phase in this cradle-to-gate analysis, the reference service life (RSL) is not specified.

Table 2: Modules of the product life cycle included in the EPD

Product stage			Construction process stage		Use Stage								End-of-life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Construction installation process	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. Raw Material Supply 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. Transport module (A2)

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.

3.1.3. Manufacturing module (A3)

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™ Smog-reducing Roofing Granules were included in the study (no cut-off rule was applied). Proxy data sets were used in the LCA model when specific information was not available and accounted for <0.531% for all reported potential environmental impacts.

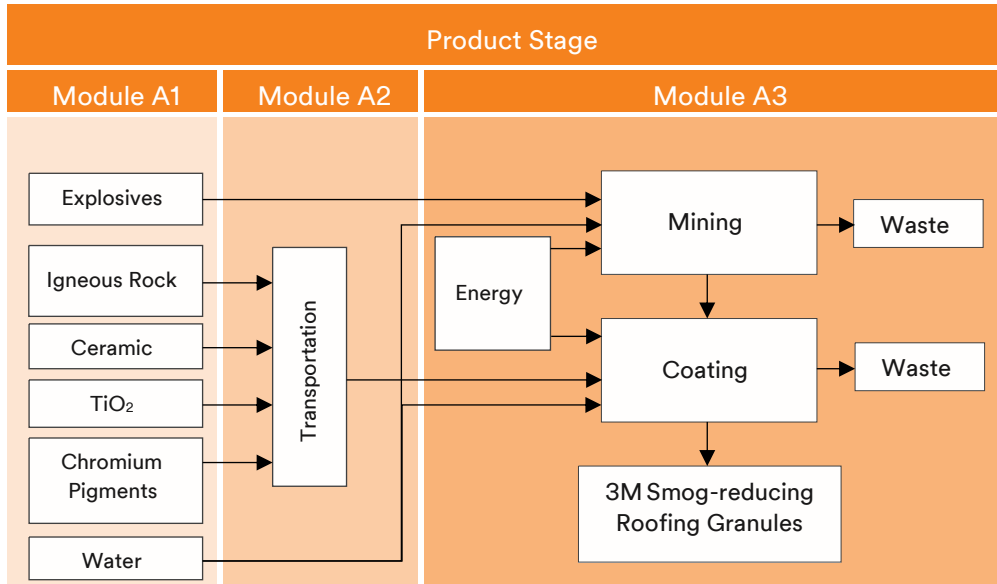


Figure 1: Process flow for the cradle-to-gate life cycle of 3M™ Smog-reducing Roofing Granules for modules A1 (Raw material supply), A2 (Transport), and A3 (Manufacturing).

3.2. Environmental performance-related information

The environmental parameters are declared for the product stage (A1-A3 modules). 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 3) and TRACI 2.1 (Table 4) characterization factors as implemented in GaBi™. Currently, TRACI 2.1 methodology does not include a midpoint for abiotic depletion potential for non-fossil resources. Data are presented per declared unit.

Table 3: Environmental impact of 1 kg of 3M™ Smog-reducing Roofing Granules using CML 2001.

	Raw	Transport	Manufacturing	Product
	Material			Stage
	Supply			Total
	A1	A2	A3	A1-A3
Abiotic depletion potential for non-fossil resources [kg Sb eq.]	9.55E-07	1.13E-09	4.48E-08	1.00E-06
Abiotic depletion potential for fossil resources [MJ, net calorific value]	0.392	0.0964	1.36	1.85
Acidification potential [kg SO ₂ eq.]	1.07E-04	4.43E-05	9.29E-05	2.45E-04
Eutrophication potential [kg PO ₄ ³⁻ eq.]	2.32E-05	8.01E-06	1.78E-05	4.90E-05
Global warming potential [kg CO ₂ eq.]	0.0265	6.95E-03	0.0849	0.118
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	3.24E-10	2.28E-16	1.46E-14	3.24E-10
Formation potential of tropospheric ozone [kg ethene eq.]	8.63E-06	3.22E-06	1.45E-05	2.63E-05

Table 4: Environmental impact of 1 kg of 3M™ Smog-reducing Roofing Granules using TRACI 2.1.

	Raw Material Supply	Transport	Manufacturing	Product Stage Total
	A1	A2	A3	A1-A3
Abiotic depletion potential for fossil resources [MJ surplus energy]	0.0443	0.0130	0.197	0.254
Acidification potential [kg SO ₂ eq.]	1.06E-04	5.28E-05	1.16E-04	2.75E-04
Eutrophication potential [kg N eq.]	2.51E-05	3.12E-06	8.10E-06	3.64E-05
Global warming potential [kg CO ₂ eq.]	0.0264	6.94E-03	0.0840	0.117
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	4.06E-10	2.28E-16	1.47E-14	4.06E-10
Formation potential of tropospheric ozone [kg O ₃ eq.]	1.13E-03	1.38E-03	2.62E-03	5.14E-03

3.2.2. Use of resources

The main resource consumption sources for 3M Smog-reducing Roofing Granules are reported in Table 5 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. It is important to note that the renewable energy reported under A3 is not generated by 3M and the values presented are as calculated in the GaBi™ software based on background data sets.

Table 5: Resource use for 1 kg of 3M™ Smog-reducing Roofing Granules.

	Raw Material Supply	Transport	Manufacturing	Product Stage Total
	A1	A2	A3	A1-A3
Use of renewable primary energy as energy carrier [MJ]	0.0424	2.24E-03	0.111	0.155
Use of renewable primary energy as raw materials [MJ]	0	0	0	0
Total use of renewable primary energy [MJ]	0.0424	2.24E-03	0.111	0.155
Use of non-renewable primary energy as energy carrier [MJ]	0.412	0.0969	1.40	1.91
Use of non-renewable primary energy as raw materials [MJ]	0	0	0	0
Total use of non-renewable primary energy [MJ]	0.412	0.0969	1.40	1.91
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]	2.88E-04	6.65E-05	9.41E-04	1.30E-03

3.2.3. Output flows and waste categories

The important output flows and waste categories for 3M Smog-reducing Roofing Granules are reported in Table 6 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 presented are as calculated in the GaBi™ software based on background data sets.

During use, 3M Smog-reducing Roofing Granules are designed to produce radicals when activated by sunlight. The radicals generated from the granules transform nitrogen oxides, common smog pollutants, into water soluble nitrate ions which are deposited on the roof. These ions are washed off the roof by rainwater refreshing the granule surface. Both the amount of nitrogen oxides transformed and the amount of nitrate ions produced will be dependent upon the percentage of 3M Smog-reducing Granules in the roofing material and on the local conditions (concentration of nitrogen oxides present at roof level, weather, etc.). While variable, the concentration of nitrate ions in roof runoff is expected to be small even when used as a 100% blend on the roofing material ([Link](#)). For more information contact Lara Ughetta with 3M IMPD at lughetta@mmm.com.

Table 6: Output flows and waste categories for 1 kg of 3M™ Smog-reducing Roofing Granules.

	Raw Material Supply	Transport	Manufacturing	Product Stage Total
	A1	A2	A3	A1-A3
Hazardous waste disposed [kg]	5.71E-09	7.71E-10	5.38E-10	7.02E-09
Non-hazardous waste disposed [kg]	4.71E-03	3.43E-06	1.18E-03	5.89E-03
Radioactive waste disposed [kg]	6.88E-06	2.02E-07	1.31E-05	2.02E-05
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™ Smog-reducing 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 Manufacturing stage (A3), as this stage has the greatest impact for the majority of the CML2001 and TRACI 2.1 midpoints, the greatest renewable and non-renewable energy use, 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 the LCIA, it is calculated for each midpoint based on a pedigree matrix, using five different data quality indicators, and Monte Carlo analysis. The uncertainty analysis results are presented below in Table 7 (CML 2001) and Table 8 (TRACI 2.1) with 95% confidence and are calculated for the product stage total (A1-A3).

Table 7: Uncertainty analysis results for 1 kg of 3M™ Smog-reducing Roofing Granules for CML 2001 (A1-A3).

	Min	Max	Base	Δ%
Abiotic depletion potential for non-fossil resources [kg Sb eq.]	7.93E-07	1.24E-06	1.00E-06	24%
Abiotic depletion potential for fossil resources [MJ]	1.59	2.15	1.85	16%
Acidification potential [kg SO ₂ eq.]	2.20E-04	2.72E-04	2.45E-04	11%
Eutrophication potential [kg PO ₄ ³⁻ eq.]	4.35E-05	5.63E-05	4.90E-05	15%
Global warming potential [kg CO ₂ eq.]	0.102	0.137	0.118	16%
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	2.24E-10	4.57E-10	3.24E-10	41%
Formation potential of tropospheric ozone [kg ethene eq.]	2.42E-05	2.86E-05	2.63E-05	10%

Table 8: Uncertainty analysis results for 1 kg of 3M™ Smog-reducing Roofing Granules for TRACI 2.1 (A1-A3).

	Min	Max	Base	Δ%
Abiotic depletion potential for fossil resources [MJ surplus energy]	0.219	0.302	0.254	19%
Acidification potential [kg SO ₂ eq.]	2.48E-04	3.04E-04	2.75E-04	11%
Eutrophication potential [kg N eq.]	2.98E-05	4.45E-05	3.64E-05	22%
Global warming potential [kg CO ₂ eq.]	0.102	0.134	0.117	15%
Depletion potential of stratospheric ozone layer [kg CFC-11 eq.]	2.87E-10	5.77E-10	4.06E-10	42%
Formation potential of tropospheric ozone [kg O ₃ eq.]	4.56E-03	5.85E-03	5.14E-03	14%

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 or for inquiries specific to 3M Smog-reducing Roofing Granules, please contact Lara Ughetta (lughetta@mmm.com).

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 on PCR 2012:01 version 2.3 - 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

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 2025.

4.5. References

EPD International (2015) General Program Instructions of the International EPD® System. Version 2.5, dated 2015-05-11.

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For more information on Sustainability at 3M, visit our website:

www.3M.com/sustainability

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