PPG Architectural Coatings
400 Bertha Lamme Drive
Cranberry Township, PA, 16066

Environmental Product Declaration – Top Gun® Sealants

Top Gun® is a family of architectural sealants from PPG suitable for interior or exterior use on many different building surfaces. Each *Top Gun* product delivers high-level performance for a wide range of applications. Visit ppgpaints.com for more information.

The product image to the right is an example of one of the formulas covered by the EPD. A list of all Top Gun formulas covered by this EPD is shown in Table 1.

Declaration Holder	PPG Architectural Finishes, Inc. (email: PPGACProductStewardship@ppg.com); website: www.ppgac.com for additional information)
Declaration Number	EPD10137
Declared Product	*Top Gun* Sealants
Product Category and Subcategory	Architectural Sealants – Acrylic/Acrylic copolymers – Water-based latex
Program Operator	NSF International (ncss@nsf.org)
PCR	Product Category Rules for Building-Related Products and Services, From the range of Environmental Product Declarations of UL Environment and Institute Construction and Environment e.V. (IBU): “Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report,” v2, June 2017. Product Category Rules Guidance-Texts for Building-Related Products and Services, From the range of Environmental Product Declarations of Institute of Construction and Environment e.V. (IBU), “Part B: Requirements for the EPD for Building Sealants,” v1.6, July 2014.
Date of Issue	January 5, 2018 (Revised October 8, 2018)
Period of Validity	5 years from date of issue
Contents of the declaration	Product definition and information about building application Information about basic material and the material’s origin Description of the product’s manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by	Dr. Lindita Bushi (lindita.bushi@athenasmi.org); Francois Charron-Doucet (francois.charron@groupeageco.ca); David H. Nicastro, F. ASTM, P.E. (dnicastro@buildingdx.com)	
This declaration was independently verified in accordance with ISO 14025 by NSF International. The UL Environment Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project report, based on CEN Norm EN 15804, serves as the core PCR.	Jenny Oorbeck joorbeck@nsf.org	☐ Internal ☒ External
This life cycle assessment was conducted in accordance with ISO 14040/14044 and the reference PCR by	PPG Architectural Finishes, Inc. PPGACProductStewardship@ppg.com	
This life cycle assessment was independently verified in accordance with ISO 14040/14044 and the reference PCR by	Jack Geibig – EcoForm jgeibig@ecoform.com	☐ Internal ☒ External

Environmental declarations from different programs may not be comparable. Many factors affect the comparability of EPDs. End users should be extremely cautious when comparing or evaluating EPD data of different EPD publishers. Such comparison or evaluation is only possible if all conditions for comparability listed in ISO 14025 (Section 6.7.2) are met. Comparison of the overall environmental performance of sealants using EPD information shall be based on the product’s use and impacts at the building level, and therefore EPDs based on this PCR may not be used for comparability purposes. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.

Product Definition, Characteristics and Specifications

Product Classification and Description

Products included in this study comprise 15 products from PPG's *Top Gun* line of sealants. *Top Gun* sealants are a family of acrylic sealants suitable for interior or exterior use on most building surfaces. According to the PCR, *Top Gun* sealants fall into the water-based and solvent-based evaporative chemistry type acrylic/acrylic copolymers, sub-group water-based latex. Included in this report are *Top Gun* 200XI (Siliconized Acrylic Sealant, 10 colors covered in this report), *Top Gun* 300 (Elastomeric Siliconized Acrylic Sealant, white color only covered in this report) and *Top Gun* 400 (Elastomeric Acrylic Urethane Sealant, 4 colors covered in this report). The 15 products are listed in Table 1 along with their crucial technical properties.

Table 1 – List of *Top Gun* formulas covered by this EPD with declared unit and key properties

Product	**Declared Unit**	**Density**	**Yield in joint of dimensions 12mm x 6mm**
Units->	**kg**	**g/cm3**	**m/kg**
TOP GUN 200XI Siliconized acrylic sealant - White (1414X)	1	1.61	31
TOP GUN 200XI Siliconized acrylic sealant - Almond (1414A)	1	1.67	29
TOP GUN 200XI Siliconized acrylic sealant - Brown (1414B)	1	1.34	37
TOP GUN 200XI Siliconized acrylic sealant - Clear (1414C)	1	1.35	37
TOP GUN 200XI Siliconized acrylic sealant - Bronze (1414D)	1	1.68	29
TOP GUN 200XI Siliconized acrylic sealant - Gray (1414G)	1	1.67	29
TOP GUN 200XI Siliconized acrylic sealant - Bisque (1414Q)	1	1.68	29
TOP GUN 200XI Siliconized acrylic sealant - Terra Beige (1414R)	1	1.67	30
TOP GUN 200XI Siliconized acrylic sealant - Shell White (1414S)	1	1.68	29
TOP GUN 200XI Siliconized acrylic sealant - Cedar Tan (1414T)	1	1.67	30
TOP GUN 300 Elastomeric siliconized acrylic sealant - White (1416)	1	1.44	35
TOP GUN 400 Elastomeric acrylic urethane sealant - White (1418)	1	1.16	43
TOP GUN 400 Elastomeric acrylic urethane sealant - Clear (1418C)	1	1.04	48
TOP GUN 400 Elastomeric acrylic urethane sealant - Bronze (1418D)	1	1.13	45
TOP GUN 400 Elastomeric acrylic urethane sealant - Stone (1418S)	1	1.16	43

Application

Top Gun sealants are ideal for a variety of interior and exterior applications. *Top Gun* 200XI series products are recommended for doorjambs, crown and other moldings, base-boards, window frames, pipe openings and roof flashing. *Top Gun* 300 series products are additionally recommended for siding, sinks and counters, hardboard, stucco and exterior insulation finishing systems (EIFS). *Top Gun* 400 products are additionally recommended for expansion and control joints up to 1½" x ½". In accordance with the PCR, the yield for each product is calculated in m/kg for a joint with dimensions of 12mm x 6mm (1/2" x ¼") in Table 1.

Technical data

Technical data sheets for *Top Gun* sealants are available at https://www.ppgpaints.com/products/paints-stains-data-sheets# .

Application rules

Top Gun products covered by this EPD meet or exceed the specifications of ASTM C834-14 – Standard Specification for Latex Joint Sealants.

Properties of declared product as delivered

Top Gun products covered by this EPD are shipped in cartons containing 12 10.3-oz tubes each.

Base materials/ancillary materials

The compositional range of the *Top Gun* products covered by this EPD is shown by % weight in Table 2. Safety data sheets are available at https://www.ppgpaints.com/products/paints-stains-data-sheets#.

Table 2 – Compositional range of *Top Gun* formulas covered by this EPD

Ingredient category	Additives	Biocides	Binders	Fillers	Glycols, esters, ethers	Pigments	Solvents	Titanium dioxide	Water
% of product by weight	1-10%	0-1%	15-60%	0-60%	0-2%	0-1%	0-2%	0-2%	14-38%

Manufacturing:

The manufacturing process for architectural sealants primarily involves the mixing and dispersing of raw materials into a homogeneous mixture. Raw materials include *pigments and fillers*, which provide color, hiding, and gloss control; *resins/binders*, which dry to form a solid bead and adhere the sealant to the substrate; *water*, which acts as a thinner and carrier; and *additives*, which assist with various sealant properties. The product is then packaged for distribution to the customer. A simplified version of this process is shown in Figure 1.

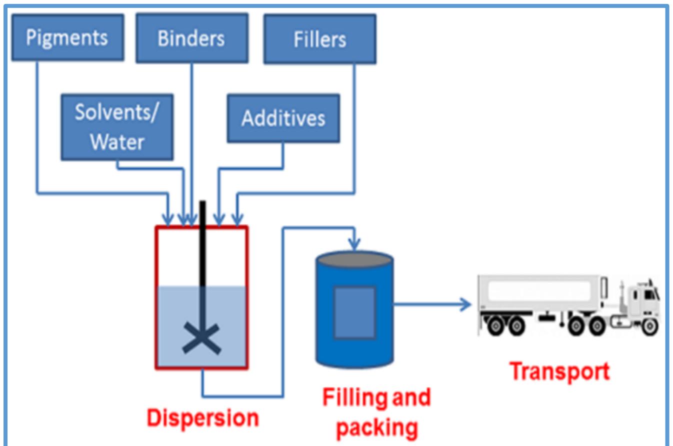

Figure 1 - Simplified process diagram for sealant manufacturing

Environment and health during manufacturing

Products are manufactured in the United States in facilities that comply with all applicable regulations.

Product processing/installation

Information regarding industrial and environmental protection related to installation of *Top Gun* products is contained on the Safety Data Sheets located at https://www.ppgpaints.com/products/paints-stains-data-sheets#.

Packaging

Cardboard cartons for shipping tubes may be recycled in accordance with local guidelines for corrugated cardboard. Individual product tubes are made of high density polyethylene (HDPE) but are not generally expected to be recyclable and should be disposed of in accordance with local guidelines.

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Life Cycle Assessment Methodology and Calculation Rules:

Declared unit:

The declared unit is 1 kg for each *Top Gun* product covered by this EPD.

System Boundary

The EPD is declared as cradle-to-gate, and hence only modules A1 to A3 are declared. In the case of use of secondary materials the impact of the life-cycle of these materials is considered to occur in the module in which they enter the PPG process. Likewise losses and disposal of waste are accounted for in the module in which they occur. Infrastructure processes (e.g. industrial plants, roads and vehicles) are included in all modules. Module A1 includes all processes necessary for the manufacture of the raw materials for the sealant products. Module A2 includes the transportation of the raw materials to the PPG plant. Module A3 includes all processing at the PPG plant, as well as the manufacture and transportation of the packaging for the finished products and disposal of all waste. The manufacture and transportation for packaging of the raw materials and primary packaging is not included in the system boundary. Table 3 shows the modules included in the life cycle assessment underpinning this EPD.

Table 3 – System boundaries and modules included

	PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE					END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY	
	A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**C1**	**C2**	**C3**	**C4**	**D**	
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential	Reference Service Life
						B6 Operational Energy Use of Building Integrated System During Product Use										
						B7 Operational Water Use of Building Integrated System During Product Use										
Cradle to grave	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

MND = Module Not Declared

According to the PCR, “when a product EPD only includes Module A”, additional information is required, as addressed below:

- No products other than those included in the assessment are needed for TOP GUN adhesives to serve their intended function in a building.
- The anticipated replacement cycle is 50 years, consistent with the warranty on TOP GUN 200XI. Other TOP GUN formulations have longer warranties.
- Information on the intended use is discussed above in *Application*.

- Disposal: End of life disposal for TOP GUN products is anticipated to be landfilling in a municipal or construction and demolition waste landfill. No recycling of the products is anticipated. Organic compounds in the cured products, including acrylic resins, pigments and other polymer additives, are not anticipated to decompose or release carbon dioxide or other greenhouse gases after disposal.

Estimates and assumptions

In addition to processes outside the system boundary, the following key assumptions were made:

- All raw materials were assumed to travel a distance of 1200 miles from the site of their manufacture to the PPG plant, consistent with the assumptions documented in the ACA PCR for Architectural Coatings, which was referenced for consistency with other PPG Architectural Coatings EPDs.
- Packaging materials were also assumed to travel the distances used in the PCR for Architectural Coatings.

Cut-off criteria

For processes included in the system boundary, no known flows are deliberately excluded from this EPD.

Background data

Primary data on the content of products is collected from the declaration of raw material composition from PPG raw materials suppliers. Primary data on resource use, emissions and waste from PPG plants were taken from PPG's environmental reporting system. The regional U.S. electric power grid generation mix for each plant was used in the LCA model according to the percentage of product made at that plant. For life cycle modeling of all processes, SimaPro V.8.04 was used. All relevant background datasets were taken from Ecoinvent V3.1 database and are documented in supporting Ecoinvent documentation.

Data quality

To assess the input quality of the specific product data used in the LCA modeling, the pedigree matrix developed by Weidema and Wesnaes (1996) was used. The pedigree matrix rates data on a scale of 1 to 5 (1-poor, 2-fair, 3-good, 4-very good, 5-excellent) for each of 5 rating criteria: reliability of source, completeness, temporal correlation, geographical correlation, and technological correlation. The primary data is considered to be of excellent quality and ecoinvent very good. Because the transportation, application and disposal stages contained several estimates based on industry characteristics, these stages received a minimum score of good. Considering that the majority of environmental impact is in the stages for which the data was of higher quality, the overall data quality rating was assessed as Very Good.

Period under review

All time-averaged primary data is calculated using the annual average from the year 2015.

Allocation:

In the LCA model, the only allocation used was a mass-based allocation during the manufacturing process, to assign PPG manufacturing plant inputs and outputs across multiple products produced at the same plant. VOC emissions from PPG plants were allocated to each product by the ratio of (mass fraction of VOC in product * total mass of product produced at plant) / (total mass of VOC in all products from plant).

LCA: Additional environmental information:

Additional environmental information required by the PCR (VOC content) is shown in Table 4.

Table 4 – Required additional environmental information

Product	Sealant category per SCAQMD Rule 1168	Calculated VOC content (Note 1)	Category limit per Rule 1168 category
Units->		g/L	g/L
TOP GUN 200XI Siliconized acrylic sealant - White (1414X)	Architectural Sealants	43.71	250
TOP GUN 200XI Siliconized acrylic sealant - Almond (1414A)	Architectural Sealants	25.1	250
TOP GUN 200XI Siliconized acrylic sealant - Brown (1414B)	Architectural Sealants	20.1	250
TOP GUN 200XI Siliconized acrylic sealant - Clear (1414C)	Architectural Sealants	20.2	250
TOP GUN 200XI Siliconized acrylic sealant - Bronze (1414D)	Architectural Sealants	25.2	250
TOP GUN 200XI Siliconized acrylic sealant - Gray (1414G)	Architectural Sealants	25.1	250
TOP GUN 200XI Siliconized acrylic sealant - Bisque (1414Q)	Architectural Sealants	25.5	250
TOP GUN 200XI Siliconized acrylic sealant - Terra Beige (1414R)	Architectural Sealants	18.4	250
TOP GUN 200XI Siliconized acrylic sealant - Shell White (1414S)	Architectural Sealants	25.3	250
TOP GUN 200XI Siliconized acrylic sealant - Cedar Tan (1414T)	Architectural Sealants	21.3	250
TOP GUN 300 Elastomeric siliconized acrylic sealant - White (1416)	Architectural Sealants	21.6	250
TOP GUN 400 Elastomeric acrylic urethane sealant - White (1418)	Architectural Sealants	17.4	250
TOP GUN 400 Elastomeric acrylic urethane sealant - Clear (1418C)	Architectural Sealants	15.6	250
TOP GUN 400 Elastomeric acrylic urethane sealant - Bronze (1418D)	Architectural Sealants	16.5	250
TOP GUN 400 Elastomeric acrylic urethane sealant - Stone (1418S)	Architectural Sealants	17.4	250

Note 1: VOC content calculated using USEPA Reference Method 24, as directed by SCAQMD Rule 1168

Life cycle inventory and impact assessment results:

Table 5 reports Life Cycle Impact Assessment (LCIA) results using characterization factors from the current version of U.S. EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI - http://www.epa.gov/nrmrl/std/traci/traci.html) for a North American context. LCIA results in Table 6 are reported to achieve conformance with EN 15804 and the mutual recognition program with UL Environment and the German Institute for Construction & Environment's (IBU) Part A PCR, CML v 4.7. Results derived from the product Life Cycle Inventory (LCI) in accordance with EN15804 requirements are included for resource use in Table 7 and waste generation in Table 8. No use of secondary materials, secondary fuels, or generation of components, materials or energy for re-use is reported, resulting in a conservative estimation of other impacts based on the assumed use and disposal of waste generated from, primary fuels and materials.

In interpreting these tables, it should be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

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Life cycle impact assessment results for 1 kg of *Top Gun* Sealants

Table 5 – North American LCIA results

TRACI Impact Categories	Units	Formulations														
		TOP GUN 200XI Siliconized acrylic sealant - White (1414X)	*TOP GUN* 200XI Siliconized acrylic sealant - Almond (1414A)	*TOP GUN* 200XI Siliconized acrylic sealant - Brown (1414B)	*TOP GUN* 200XI Siliconized acrylic sealant - Clear (1414C)	*TOP GUN* 200XI Siliconized acrylic sealant - Bronze (1414D)	*TOP GUN* 200XI Siliconized acrylic sealant - Gray (1414G)	*TOP GUN* 200XI Siliconized acrylic sealant - Bisque (1414Q)	*TOP GUN* 200XI Siliconized acrylic sealant - Terra Beige (1414R)	*TOP GUN* 200XI Siliconized acrylic sealant - Shell White (1414S)	*TOP GUN* 200XI Siliconized acrylic sealant - Cedar Tan (1414T)	*TOP GUN* 300 Elastomeric siliconized acrylic sealant - White (1416)	*TOP GUN* 400 Elastomeric acrylic urethane sealant - White (1418)	*TOP GUN* 400 Elastomeric acrylic urethane sealant - Clear (1418C)	*TOP GUN* 400 Elastomeric acrylic urethane sealant - Bronze (1418D)	*TOP GUN* 400 Elastomeric acrylic urethane sealant - Stone (1418S)
Ozone depletion	kg CFC-11 eq	1.95E-07	2.38E-07	2.34E-07	3.42E-07	2.27E-07	2.25E-07	2.26E-07	2.50E-07	2.26E-07	2.54E-07	2.80E-07	3.82E-07	4.70E-07	4.40E-07	3.91E-07
Global warming	kg CO2 eq	1.70E+00	1.52E+00	1.56E+00	3.48E+00	1.47E+00	1.50E+00	1.50E+00	1.52E+00	1.50E+00	1.51E+00	1.97E+00	3.24E+00	3.30E+00	3.01E+00	3.25E+00
Smog	kg O3 eq	9.84E-02	8.81E-02	8.52E-02	1.71E-01	8.01E-02	8.37E-02	8.49E-02	8.58E-02	8.49E-02	8.48E-02	1.10E-01	1.66E-01	1.68E-01	1.54E-01	1.66E-01
Acidification	kg SO2 eq	8.84E-03	7.89E-03	7.99E-03	1.77E-02	7.55E-03	7.72E-03	7.71E-03	7.93E-03	7.72E-03	7.89E-03	1.01E-02	1.57E-02	1.73E-02	1.57E-02	1.58E-02
Eutrophication	kg N eq	5.55E-03	5.66E-03	5.41E-03	7.73E-03	5.23E-03	5.46E-03	5.50E-03	5.54E-03	5.50E-03	5.49E-03	7.39E-03	1.14E-02	7.54E-03	6.93E-03	1.14E-02
Fossil fuel depletion	MJ surplus	4.51E+00	4.26E+00	4.50E+00	9.49E+00	4.20E+00	4.18E+00	4.16E+00	4.40E+00	4.16E+00	4.44E+00	5.35E+00	8.12E+00	9.48E+00	8.89E+00	8.20E+00

Table 6 – European and rest of world LCIA results

CML Impact Categories	Units	Formulations														
		TOP GUN 200XI Siliconized acrylic sealant - White (1414X)	*TOP GUN* 200XI Siliconized acrylic sealant - Almond (1414A)	*TOP GUN* 200XI Siliconized acrylic sealant - Brown (1414B)	*TOP GUN* 200XI Siliconized acrylic sealant - Clear (1414C)	*TOP GUN* 200XI Siliconized acrylic sealant - Bronze (1414D)	*TOP GUN* 200XI Siliconized acrylic sealant - Gray (1414G)	*TOP GUN* 200XI Siliconized acrylic sealant - Bisque (1414Q)	*TOP GUN* 200XI Siliconized acrylic sealant - Terra Beige (1414R)	*TOP GUN* 200XI Siliconized acrylic sealant - Shell White (1414S)	*TOP GUN* 200XI Siliconized acrylic sealant - Cedar Tan (1414T)	*TOP GUN* 300 Elastomeric siliconized acrylic sealant - White (1416)	*TOP GUN* 400 Elastomeric acrylic urethane sealant - White (1418)	*TOP GUN* 400 Elastomeric acrylic urethane sealant - Clear (1418C)	*TOP GUN* 400 Elastomeric acrylic urethane sealant - Bronze (1418D)	*TOP GUN* 400 Elastomeric acrylic urethane sealant - Stone (1418S)
Abiotic depletion	kg Sb eq	5.00E-06	5.84E-06	5.78E-06	1.22E-05	5.71E-06	5.90E-06	5.79E-06	5.87E-06	5.78E-06	5.82E-06	7.26E-06	1.11E-05	1.42E-05	1.22E-05	1.11E-05
Abiotic depletion (fossil fuels)	MJ	3.61E+01	3.33E+01	3.48E+01	7.47E+01	3.26E+01	3.26E+01	3.25E+01	3.42E+01	3.25E+01	3.44E+01	4.21E+01	6.39E+01	7.41E+01	6.93E+01	6.45E+01
Global warming (GWP100a)	kg CO2 eq	1.70E+00	1.52E+00	1.56E+00	3.48E+00	1.47E+00	1.50E+00	1.50E+00	1.52E+00	1.50E+00	1.51E+00	1.97E+00	3.24E+00	3.30E+00	3.01E+00	3.25E+00
Ozone layer depletion (ODP)	kg CFC-11 eq	1.60E-07	2.02E-07	1.98E-07	2.79E-07	1.93E-07	1.92E-07	1.93E-07	2.11E-07	1.93E-07	2.13E-07	2.41E-07	3.15E-07	3.95E-07	3.63E-07	3.22E-07
Photochemical oxidation	kg C2H4 eq	7.08E-04	6.70E-04	6.51E-04	1.48E-03	6.23E-04	6.45E-04	6.51E-04	6.65E-04	6.51E-04	6.53E-04	8.38E-04	1.43E-03	1.39E-03	1.26E-03	1.43E-03
Acidification	kg SO2 eq	9.11E-03	8.16E-03	8.26E-03	1.85E-02	7.82E-03	7.99E-03	7.98E-03	8.21E-03	7.98E-03	8.17E-03	1.05E-02	1.63E-02	1.81E-02	1.64E-02	1.64E-02
Eutrophication	kg PO4--- eq	2.49E-03	2.36E-03	2.28E-03	3.97E-03	2.18E-03	2.28E-03	2.29E-03	2.32E-03	2.29E-03	2.30E-03	3.04E-03	5.48E-03	3.86E-03	3.54E-03	5.49E-03

Life cycle inventory results for 1 kg of *Top Gun* Sealants

Table 7 – LCI results for resource use

Additional Life Cycle Inventory Categories - Resource Use	Units	Formulations														
		TOP GUN 200XI Siliconized acrylic sealant - White (1414X)	*TOP GUN 200XI* Siliconized acrylic sealant - Almond (1414A)	*TOP GUN 200XI* Siliconized acrylic sealant - Brown (1414B)	*TOP GUN 200XI* Siliconized acrylic sealant - Clear (1414C)	*TOP GUN 200XI* Siliconized acrylic sealant - Bronze (1414D)	*TOP GUN 200XI* Siliconized acrylic sealant - Gray (1414G)	*TOP GUN 200XI* Siliconized acrylic sealant - Bisque (1414Q)	*TOP GUN 200XI* Siliconized acrylic sealant - Terra Beige (1414R)	*TOP GUN 200XI* Siliconized acrylic sealant - Shell White (1414S)	*TOP GUN 200XI* Siliconized acrylic sealant - Cedar Tan (1414T)	*TOP GUN 300* Elastomeric siliconized acrylic sealant - White	*TOP GUN 400* Elastomeric acrylic urethane sealant - White (1418)	*TOP GUN 400* Elastomeric acrylic urethane sealant - Clear (1418C)	*TOP GUN 400* Elastomeric acrylic urethane sealant - Bronze (1418D)	*TOP GUN 400* Elastomeric acrylic urethane sealant - Stone (1418S)
PERE	MJ, net CV	1.52E+00	1.33E+00	1.41E+00	2.71E+00	1.28E+00	1.30E+00	1.31E+00	1.32E+00	1.31E+00	1.31E+00	1.77E+00	7.84E+00	2.71E+00	2.57E+00	7.84E+00
PERM	MJ, net CV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ, net CV	1.52E+00	1.33E+00	1.41E+00	2.71E+00	1.28E+00	1.30E+00	1.31E+00	1.32E+00	1.31E+00	1.31E+00	1.77E+00	7.84E+00	2.71E+00	2.57E+00	7.84E+00
PENRE	MJ, net CV	3.10E+01	2.85E+01	2.92E+01	6.08E+01	2.77E+01	2.78E+01	2.77E+01	2.92E+01	2.78E+01	2.95E+01	3.62E+01	5.37E+01	6.08E+01	5.70E+01	5.42E+01
PENRM	MJ, net CV	8.66E+00	7.41E+00	8.30E+00	1.93E+01	7.41E+00	7.41E+00	7.39E+00	7.58E+00	7.39E+00	7.44E+00	9.40E+00	1.56E+01	1.85E+01	1.67E+01	1.56E+01
PENRT	MJ, net CV	3.96E+01	3.59E+01	3.75E+01	8.01E+01	3.51E+01	3.52E+01	3.51E+01	3.67E+01	3.51E+01	3.69E+01	4.56E+01	6.93E+01	7.92E+01	7.38E+01	6.98E+01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ, net CV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ, net CV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	4.39E-02	3.54E-02	3.47E-02	1.03E-01	3.42E-02	3.48E-02	3.48E-02	3.62E-02	3.48E-02	3.65E-02	4.90E-02	8.89E-02	9.10E-02	8.10E-02	8.90E-02

Abbreviations: 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; LHV = lower heating value

Table 8 – LCI results for output flows and waste categories

Additional Life Cycle Inventory Categories - Resource Use	Units	Formulations														
		TOP GUN 200XI Siliconized acrylic sealant - White (1414X)	*TOP GUN 200XI* Siliconized acrylic sealant - Almond (1414A)	*TOP GUN 200XI* Siliconized acrylic sealant - Brown (1414B)	*TOP GUN 200XI* Siliconized acrylic sealant - Clear (1414C)	*TOP GUN 200XI* Siliconized acrylic sealant - Bronze (1414D)	*TOP GUN 200XI* Siliconized acrylic sealant - Gray (1414G)	*TOP GUN 200XI* Siliconized acrylic sealant - Bisque (1414Q)	*TOP GUN 200XI* Siliconized acrylic sealant - Terra Beige (1414R)	*TOP GUN 200XI* Siliconized acrylic sealant - Shell White (1414S)	*TOP GUN 200XI* Siliconized acrylic sealant - Cedar Tan (1414T)	*TOP GUN 300* Elastomeric siliconized acrylic sealant - White	*TOP GUN 400* Elastomeric acrylic urethane sealant - White (1418)	*TOP GUN 400* Elastomeric acrylic urethane sealant - Clear (1418C)	*TOP GUN 400* Elastomeric acrylic urethane sealant - Bronze (1418D)	*TOP GUN 400* Elastomeric acrylic urethane sealant - Stone (1418S)
HWD	kg	5.73E-02	5.97E-02	3.71E-02	6.15E-02	3.56E-02	4.78E-02	5.19E-02	4.77E-02	5.19E-02	4.48E-02	6.70E-02	1.02E-01	5.56E-02	5.18E-02	1.02E-01
NHWD	kg	7.50E-01	6.41E-01	6.39E-01	1.29E+00	6.14E-01	6.29E-01	6.30E-01	6.41E-01	6.30E-01	6.44E-01	7.97E-01	1.14E+00	1.23E+00	1.13E+00	1.14E+00
RWD	kg	6.82E-05	6.31E-05	6.38E-05	1.13E-04	6.09E-05	5.89E-05	5.88E-05	6.96E-05	5.88E-05	7.14E-05	7.11E-05	1.18E-04	1.35E-04	1.37E-04	1.22E-04
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Abbreviations: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; EE = Exported energy

Example LCA results by stage for a typical product

Table 9 shows the breakdown of LCIA and LCI results by life cycle stage for one specific product covered by this EPD, *TOP GUN* 200XI Siliconized acrylic sealant – White (1414X). The results for other products are similar with respect to the distribution of impacts by stage.

Table 9 - LCIA results by module for *TOP GUN* 200XI Siliconized acrylic sealant - White (1414X)

Impact Categories	Units	Modules			
		A1	A2	A3	Total
TRACI Impact Categories					
Stratospheric ozone layer depletion potential (ODP)	kg CFC-11 eq	1.38E-07	2.55E-08	3.14E-08	1.95E-07
Global warming potential based on IPCC (2013 AR5), 100 years, excluding biogenic CO2 (GWP)	kg CO2 eq	1.16E+00	1.01E-01	4.42E-01	1.70E+00
Photochemical ozone creation potential (POCP)	kg O3 eq	6.30E-02	1.07E-02	2.47E-02	9.84E-02
Acidification potential (AP)	kg SO2 eq	6.06E-03	4.68E-04	2.31E-03	8.84E-03
Eutrophication potential (EP)	kg N eq	4.37E-03	1.35E-04	1.05E-03	5.55E-03
Abiotic resource depletion potential - fossil fuels (ADP)	MJ surplus	3.06E+00	2.27E-01	1.22E+00	4.51E+00
CML Impact Categories					
Abiotic depletion potential for non-fossil resources (ADP elements)	kg Sb eq	4.47E-06	1.91E-07	3.36E-07	5.00E-06
Abiotic depletion potential for fossil resources (ADP fossil fuels)	MJ	2.45E+01	1.66E+00	9.95E+00	3.61E+01
Global warming potential (GWP)	kg CO2 eq	1.16E+00	1.01E-01	4.42E-01	1.70E+00
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq	1.16E-07	1.92E-08	2.41E-08	1.60E-07
Formation potential of tropospheric ozone (POCP)	kg C2H4 eq	5.54E-04	1.73E-05	1.37E-04	7.08E-04
Acidifiation potential for air emissions (AP Air)	kg SO2 eq	6.33E-03	4.12E-04	2.37E-03	9.11E-03
Eutrophication potential (EP)	kg PO4--- eq	1.84E-03	9.94E-05	5.51E-04	2.49E-03
Additional Life Cycle Inventory Categories - Resource Use					
Renewable primary energy as energy carrier (PERE)	MJ, net CV	9.07E-01	2.44E-02	5.93E-01	1.52E+00
Renewable primary energy as material utilization (PERM)	MJ, net CV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	MJ, net CV	9.07E-01	2.44E-02	5.93E-01	1.52E+00
Non-renewable primary energy as energy carrier (PENRE)	MJ, net CV	2.16E+01	1.62E+00	7.74E+00	3.10E+01
Non-renewable primary energy as material utilization (PENRM)	MJ, net CV	4.91E+00	0.00E+00	3.74E+00	8.66E+00
Total use of non-renewable primary energy resources (PENRT)	MJ, net CV	2.65E+01	1.62E+00	1.15E+01	3.96E+01
Use of secondary material (SM)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	MJ, net CV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	MJ, net CV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	m3	4.08E-02	3.47E-04	2.81E-03	4.39E-02
Additional Life Cycle Inventory Categories - Output Flows and Waste Categories					
Hazardous waste disposed (HWD)	kg	4.98E-02	1.13E-03	6.37E-03	5.73E-02
Non-hazardous waste disposed (NHWD)	kg	4.17E-01	1.55E-01	1.78E-01	7.50E-01
Radioactive waste disposed (RWD)	kg	4.16E-05	1.09E-05	1.57E-05	6.82E-05
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

PPG Architectural Coatings
400 Bertha Lamme Drive
Cranberry Township, PA, 16066

LCA Interpretation

The LCA results show that the raw materials (Stage I, Module 1) tend to contribute highly to the impact of many indicators. This high contribution of raw materials to the impact indicators is not unexpected. As latex sealants are primarily mixtures of pre-processed ingredients, much of the expenditure of energy, raw materials, processing, waste processing, etc. in bringing the product to existence has occurred prior to the entry of the raw materials onto the PPG production site. The majority of the impact of the raw materials comes from the titanium dioxide (where present) and the binder. This is typical for latex sealant products since these two raw materials are often present in high proportions and have a relatively high processing energy demand.

References:

Sustainability reporting standards

EN 15804: 2012-04 - Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction product.

ISO 14025: 2006 - Environmental labels and declarations — Type III environmental declarations — Principles and procedures

ISO 14040: 2006 - Environmental management – Life cycle assessment – Principles and framework

ISO 14044:2006 - Environmental management – Life cycle assessment – Requirements and guidelines

ISO 14046:2013 - Environmental management- Water footprint- Principles, requirements and guidelines

ISO 15392:2008 - Sustainability in building construction- General principles

ISO 15686-1:2011 - Buildings and constructed assets- Service life planning- Part 1: General principles

ISO 15686-2:2008 - Buildings and constructed assets- Service life planning Part 2: Service life prediction procedures

ISO 15686-7:2008 - Buildings and constructed assets- Service life planning Part 7: Performance evaluation for feedback of service life data from practice

ISO 15686-8:2008 - Buildings and constructed assets- Service life planning Part 8: Reference service life and service life estimation

ISO 21930: 2007 - Sustainability in building construction -- Environmental declaration of building products

Testing and classification references

ASTM C834 - Standard Specification for Latex Joint Sealants

ASTM C920 - Standard Specification for Elastomeric Joint Sealants

ASTM C1184 - Standard Specification for Structural Silicone Sealants

ASTM C1311 - Standard Specification for Solvent Release Sealants

ASTM C1193 - Standard Guide for Use of Joint Sealants

National Institute of Building Sciences Whole Building Design Guide, Section 07920

South Coast Air Quality Management District (SCAQMD) Rule #1168. Adhesive and Sealant Applications. January 2005. (http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1168.pdf?sfvrsn=4)

Relevant federal standards and SOPs

Competition Bureau Canada Environmental Claims: A Guide for Industry and Advertisers (http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/02701.html)

Environment Canada, National Pollutant Release Inventory (http://www.ec.gc.ca/inrp-npri/)

EPCRA 313 Toxic Release Inventory Reporting (U.S.) (http://www2.epa.gov/toxics-release-inventory-tri-program)

US EPA, ORD/NRMRL/Sustainable Technology Division, Systems Analysis Branch, SOP No. S-10637-OP-1-0- Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI), Software Name and Version Number: TRACI version 2.1, User's Manual, July 2012.

US: Resource Conservation and Recovery Act (RCRA), Clause C (http://www.epa.gov/region6/rcra/)

Federal Trade Commission. Green Guides, 16 CFR Part 260. October 2012. (https://www.gpo.gov/fdsys/pkg/FR-2012-10-11/pdf/2012-24713.pdf)

Relevant product category rules

Weidema, B.P., M.S. Wesnaes, Data quality management for life cycle inventories – an example of using data quality indicators. Journal of Cleaner Production, 1996, Vol 4, p. 167.

Product Category Rules for Building-Related Products and Services, From the range of Environmental Product Declarations of UL Environment and Institute Construction and Environment e.V. (IBU): "Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report," v2, June 2017.

Product Category Rules Guidance-Texts for Building-Related Products and Services, From the range of Environmental Product Declarations of Institute of Construction and Environment e.V. (IBU), "Part B: Requirements for the EPD for Building Sealants," v1.6, July 2014.

Product Category Rules for Architectural Coatings. NSF Sustainability, June 2015.

Glossary:

- ASTM – A standards development organization formerly known as the American Society for Testing and Materials (ASTM). ASTM serves as an open forum for the development of international technical standards for a wide range of materials, products, systems, and services.
- CML – An Institute of Environmental Sciences at Leiden University.
- EPD – Environmental Product Declaration. a Type III environmental declaration under ISO 14025, which provides a standardized way of reporting the environmental impacts of a product or system. Life Cycle Assessment is the method used to assess the impacts that are reported in an EPD.
- LCA – Life Cycle Assessment. A scientific method to assess the environmental impacts associated with all stages of a product life cycle from cradle to grave (i.e., raw material extraction, pre-processing, transport, manufacturing, distribution, installation, use, and disposal), or a portion of that cycle, such as cradle to gate.
- LCIA – Life Cycle Impact Assessment. The phase of a Life Cycle Assessment that evaluates the significance of potential environmental impacts based on the LCI flow results.
- LCI – Life Cycle Inventory. The quantified inputs and outputs of a product system to and from nature, i.e. its material, water, and energy inputs and releases to air, land, and water. To develop an inventory, a flow model of the technical system is constructed using data on system inputs and outputs.
- Multi-Component Sealant – A user-mixed product consisting of a base component, an activator component, and/or a tinting component. The activator component is typically added to the base component and mixed for a set period of time before application. Multi-component sealants typically require bulk guns and mixing equipment to prepare and apply the sealant, and are typically packaged in separate containers.
- Part A PCR – Product Category Rule, Part A. Available for use by any program operator, UL Environment's "Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report" is the core, general document to be used alongside a product specific PCR Part B. The general Part A document, coupled with a specific Part B, conforms to the EN 15804 and ISO 21930 sustainability standards for EPD reporting.

- Part B PCR – Product Category Rule, Part B. Outlines product-specific calculation and reporting requirements when creating an EPD. A Part B document, coupled with the Part A, conforms to the EN 15804 and ISO 21930 sustainability standards for EPD reporting.
- Reactive Sealant Chemistry Type – Creates bond through a chemical reaction involving a one-part or two-part reaction. One-part sealants are pre-mixed and typically need UV light, heat or moisture to cure. Two-part sealants require mixing and include a base resin plus a hardener/curing agent that transforms into a thermoset polymer via a cross linking process.
- Sealant – Materials with adhesive properties that are formulated primarily to fill or seal gaps or joints between two surfaces. The main purpose of sealants is to prevent air, water, and other environmental elements from entering or exiting a structure while permitting limited movement of the substrates. Sealants have a suitable viscosity to extrude through a nozzle and then be tooled to a desired profile, or to flow sufficiently for gravitational self-levelling. Sealants are used for a variety of commercial and residential applications and are a critical component for building design and construction. Common sealants include silicone, acrylic, urethane, butyl and other polymeric types.
- TRACI – Tool for Reduction and Assessment of Chemicals and other environmental Impacts. A tool developed by the US Environmental Protection Agency that includes sustainability metrics, life cycle impact assessment, industrial ecology, and process design impact assessment for developing increasingly sustainable products, processes, facilities, companies, and communities. TRACI allows the quantification of stressors that have potential effects, including ozone depletion, global warming, acidification, eutrophication, tropospheric ozone (smog) formation, human health criteria-related effects, human health cancer, human health noncancer, ecotoxicity, and fossil fuel depletion.
- Water-Based Evaporative Chemistry – Sealant products formulated with polymer particles dispersed in water. When the sealant is applied, the water evaporates and the polymer particles move closer together. As the evaporation of water continues, the polymer particles begin to deform and fuse together, eventually forming a continuous seal.
- Single-Component Sealant – A sealant product packaged in a single container. No special equipment is required to mix one-component sealants.
- Solvent-Based Evaporative Chemistry – Sealant products formulated with a continuous polymer and solvent solution. When the sealant is applied, the solvent evaporates, and the polymer chains are drawn closer together and eventually entangle.
- Yield – The expected sealant output of 1kg (declared unit) expressed as m/kg using the product's uncured density in a rectangular joint configuration (without concave surfaces) of dimensions 12mm x 6mm.

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