Environmental Product Declaration – ARMORSEAL 8100[1]

Certified Environmental Product Declaration
www.nsf.org

ARMORSEAL® 8100 is the next generation in water-based epoxy floor coatings; a two-component polyamine epoxy with excellent chemical and abrasion resistance that is breathable. A LEED 4.1 compliant material that offers improved performance while maintaining ease of application.

The product image to the right is an example of one of the formulas covered by the EPD. A list of all relevant ARMORSEAL 8100 formulas is shown in Table 1 on page 2-3 of the EPD.

Program Operator	NSF International
Declaration Holder	The Sherwin-Williams Company
Declaration Prepared by	April Morris (april.morris@sherwin.com)
Declaration Number	EPD10272
Product Category and Subcategory	Resinous Floor Coatings – Thin-mil
Program Operator	NSF International ncss@nsf.org
Reference PCR	PCR for Resinous Floor Coatings -12 /2018

Date of Issue	10/11/2019
Period of Validity	5 Years

Contents of the Declaration	– Product definition and material characteristics – Overview of manufacturing process – Information about in-use conditions – Life cycle assessment results – Testing verifications

The PCR review was conducted by	Thomas P. Gloria, Ph. D. t.gloria@industrial-ecology.com

This EPD was independently verified by NSF International in accordance with ISO 21930:2017 and ISO 14025. ☐ **Internal** ☒ **External**	Jenny Oorbeck joorbeck@nsf.org
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by	Jack Geibig - EcoForm jgeibig@ecoform.com

Functional Unit:	1m² of covered and protected substrate for a period of 60 years (the assumed average lifetime of a building)
Market-Based Lifetime Used in Assessment	10 years
Design Lifetime Used in Assessment	15 years
Test Methods Used to Calculate Design Life	ASTM D2805-11, ASTM D2486-06, ASTM D6736-08, ASTM D4828-94
Estimated Amount of Colorant	Varies (see Table 2)
Data Quality Assessment Score	Very Good
Manufacturing Location(s)	Various Plants Throughout the United States and Europe

[1] *In order to support comparative assertions, this EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers or programs, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the construction works level per ISO 21930:2017 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis.*

ISO21930:2017 – serves as the core PCR PCR for Resinous Floor Coatings PCR review was conducted by: Thomas P. Gloria, Ph. D., Mr. Bill Stough, Mr. Jack Geibig PCR for Resinous Floor Coatings review was conducted by: Thomas P. Gloria, Ph. D., Mr. Bill Stough, Mr. Jack Geibig NSF International – National Center for Sustainability Standards, ncss@nsf.org
Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ internal X external
Jack Geibig - EcoForm

Product Definition:

ARMOSEAL 8100 is a family of resinous floor coatings manufactured by The Sherwin-Williams Company, headquartered in Cleveland, Ohio. ARMORSEAL 8100 is manufactured in a number of Sherwin-Williams facilities across the United States and Europe and the data used by the LCA were representative of all Sherwin-Williams facilities in which ARMORSEAL 8100 was produced. These Sherwin-Williams resinous floor coatings are field applied and designed to cover and protect floors from foot traffic in commercial spaces. For information about specific products, please visit www.sherwin.com.

Product Classification and Description:

The ARMORSEAL 8100 formulas listed below are included in this assessment. ARMORSEAL 8100 is a 2 part epoxy system comprised of a Part A and a Part B. The primary differences between the Part A formulas are base and sheen. Part B is the hardener. For information on other attributes of each of the specific formulations, please visit www.sherwin.com.

Table 1. List of ARMORSEAL 8100 Formulas Assessed by LCA Model and Report.

Product System	System Type		Parts	Base	Sheen	Formula
ArmorSeal 8100	Thin-mil	Tintable	Part A	Extra White	Gloss	B70W8111
			Part A	Deep Base	Gloss	B70W8113
			Part A	Ultradeep Base	Gloss	B70T8104
		Package Colors	Part A	Deck Gray	Gloss	B70A08101
			Part A	Haze Gray	Gloss	B70A8100
			Part A	Tile Red	Gloss	B70R08100
			Part A	Black	Gloss	B70B8100
			Part A	Safety Red	Gloss	B70R8101
			Part A	Safety Yellow	Gloss	B70Y8100
			Part A	Extra White	Satin	B70W8161

		Tintable	Part A	Deep Base	Satin	B70W8163
			Part A	Ultra Deep Base	Satin	B70T8164
		Package Colors	Part A	Haze Gray	Satin	B70A8160
			Part A	Deck Gray	Satin	B70A08161
			Part A	Tile Red	Satin	B70R08160
		-	Part B	Hardener	-	B70V08100

Under the Product Category Rule (PCR) for Resinous Floor Coatings, ARMORSEAL 8100 falls under the following heading:

- "a fluid-applied and poured/formed in place and cured material coating used to protect and enhance horizontal substrates such as concrete, metal, and wood from foot traffic."

Resinous Floor Coatings are manufactured in a way similar to other paint and coating products. Raw materials are manually added in appropriate quantities into a high-speed disperser which are mixed. The product is then moved via compressed air or gravity and filled into containers and transported to the distribution center and finally to the point of sale. A customer travels to the store to purchase the product and transports the coating to the site where it is applied. The applied coating adheres to the substrate where it remains until the substrate is disposed by the user. Any unused coating will be disposed by the purchaser as well. Because the functional unit mandates a 60 year product life, multiple recoats were necessary and were accounted for in the LCA models in Module B4.

The typical composition of a Resinous Floor Coating is shown below.

Solvent (20%-60%)
Resin (30%-60%)
Extender Pigments (5%-25%)
Titanium Dioxide (0-15%)
Additives (5%-20%)

Table 2. List of Hazardous ingredients in ARMORSEAL 8100 Formulas.

Ingredient	Percentage	CAS #
Epoxy Resin	0 - 50	69761-19-9
Titanium Dioxide	0 - 25	13463-67-7
Polypropylene glycol alkyl phenyl ether	0 - 1	9064-13-5
Poly(oxypropylene)diamine	0 - 3	9046-10-0
3,6,9-triazaundecamethylenediamine	0 - 1	100-51-6
Carbon Black	0 – 0.3	1333-86-4
Iron Oxide	0 - 10	1309-37-1

Note that these ingredients may only appear in as little as a single formula to a few formulas within the entire ARMORSEAL 8100 flooring line.

Aside from the ingredients present in the table above, there are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting. For additional information about product hazards, please refer to the Safety Data Sheet for the specific ARMORSEAL 8100 formula available on www.sherwin.com.

Table 3. Typical Physical Properties for ARMOSEAL 8100 flooring system.

Test Name	Test Method	Results
Abrasion Resistance	ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load	150 mg loss
Adhesion	ASTM D4541	550 psi concrete
Finish	Satin Gloss	15-25 units@ 85° 90+ units @ 60°
Flexibility	ASTM D 522	180° bend 1/8" mandrel
Impact Resistance	ASTM D2794	Direct 100 in.lb. Indirect 80 in.lb.
Pencil Hardness	ASTM D3363	H
WVP Perms (US)	Grains(hr ft2 in Hg)	Gloss – 2.0 Satin – 5.0

ARMORSEAL 8100 requires 2 coats to achieve proper coverage. The typical thickness of the ARMORSEAL 8100 floor coating system (2 coats) is 2-4 mils. Additional technical information can be found on the product data sheet.

About Sherwin-Williams:

For 150 years, Sherwin-Williams has provided contractors, builders, property managers, architects and designers with the trusted products they need to build their business and satisfy customers. ARMORSEAL 8100 is just one more way we bring you industry-leading paint technology — innovation you can pass on to your customers. Plus, with more than 4,000 stores and 2,400 sales representatives across North America, personal service and expert advice is always available near jobsites. Find out more about ARMORSEAL 8100 at your nearest Sherwin-Williams store or to have a sales representative contact you, call 800-524-5979.

Definitions:

Acronyms & Abbreviated Terms:

ACA: American Coatings Association
ASTM: ASTM International, a standards development organization that serves as an open forum for the development of international standards. ASTM methods are industry-recognized and approved test methodologies for demonstrating the durability of a various coating types in the United States.
ecoinvent: A life cycle database that contains international industrial life cycle inventory data on energy supply, resource extraction, material supply, chemicals, metals, agriculture, waste management services, and transport services.
EPA WARM model: United States Environmental Protection Agency Waste Reduction Model.
EPD: Environmental Product Declaration. EPDs are form of as Type III environmental declarations under ISO 14025:2006. They are the summary document of data collected in the LCA as specified by a relevant PCR. EPDs can enable comparison between products if the underlying studies and assumptions are similar.
GaBi: Created by thinkstep, GaBi Databases are LCA databases that contain ready-to-use Life Cycle Inventory profiles.
LCA: Life Cycle Assessment. A technique to assess environmental impacts associated with all the stages of a product's life from cradle to grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling), as defined in ISO 14040:2006.
NCSS: NSF International's National Center for Sustainability Standards
$NRPR_E$: non-renewable primary resources used as an energy carrier (fuel)
$NRPR_M$: non-renewable primary resources with energy content used as materials
PCR: Product Category Rule. A PCR defines the rules and requirements for creating EPDs of a certain product category, as described in ISO 14025:2006.
RPR_E: renewable primary resources used as an energy carrier (fuel)
RPR_M: renewable primary energy resources with energy content used as material
RSF: renewable secondary fuels
SM: secondary material

Terminology:

Adhesion: the degree of attachment between two surfaces held together by interfacial forces.
Basecoats: coatings applied to the surface after preparation and before the application of a finish coat.
Commercial Project: Projects not used for residential, manufacturing, processing, or assembly purposes. Common commercial project types include education, healthcare, hospitality, entertainment, retain, and construction.
Generic data: Defined by the ILCD handbook as "a generic data set has been developed using at least partly other information then those measured for the specific process. This other information can be stoichiometric or other calculation models, patents and other plans for processes or products, expert judgment etc. Generic processes can aim at representing a specific process or system or an average situation. Both specifically measured data and generic data can hence be used for the same purpose of representing specific or average processes or systems."
Failure: The physical degradation of the floor surfacing material which would require substantial or complete removal in order to return the floor to serviceable condition.

Industrial Project: Any project where the primary activity includes the manufacture, production, processing, assembly, or handling of goods or materials. This could include use conditions such as heavy wheeled traffic or the use of fixed of moving machinery. For example, in a maintenance facility or as an automotive shop.

Intermediate processing: the conversion of raw materials to intermediates (e.g. titanium dioxide ore into titanium dioxide pigment, etc.).

Market Service Lifetime: The estimated lifetime of a resinous floor coating based off the predicted use pattern of the product type.

Pigment: The material(s) that give a coating its color.

Primary materials: Resources made from materials initially extracted from nature. Examples include titanium dioxide ore, petroleum, etc. that are used to create basic materials used in the production of coatings (e.g., pigment, solvents)

Primers: materials applied to a surface to promote adhesion between the substrate and subsequent coats.

Resin / Binder: Acts as the glue or adhesive to adhere the coating to the substrate.

Secondary materials: Materials that contain recovered, reclaimed, or recycled content that is used to create basic materials for the production of coatings (e.g. aluminum scrap).

Technical Service Lifetime: The estimated lifetime of a coating based solely on its hiding and performance characteristics determined by industry consensus values.

Topcoat: the final layer of coating put onto a surface over another layer(s).

Underlying Life Cycle Assessment Methodology:

Functional Unit:

Per the reference PCR, the functional unit for the study was covering and protecting 1m^2 of substrate for a period of 60 years (the assumed lifetime of a building). The product has no additional functionalities beyond what is stated by the functional unit.

In the reference PCR, product life for resinous floor coatings was calculated both in terms of a typical market life and a technical life depending on its type and application setting.

Based on the guidance provided by the PCR, the appropriate quality levels and coating quantities were derived for each ARMORSEAL 8100 formula.

Table 4. Formula Lifetimes and Quantity of Product (Part A+Part B) Needed to Satisfy Functional Unit[2]

Product Formula	ArmorSeal 8100 GLOSS	ArmorSeal 8100 SATIN
Application Setting	Commercial	Commercial
Product Type	Thin-mil	Thin-mil
Technical Lifetime (years)	15	15
Market Lifetime (years)	10	10
Total Quantity Needed using Design-Based Life (kg)[3]	1.42-1.60	1.44-1.62
Total Quantity Needed using Market-Based Life (kg)[4]	2.13-2.40	2.16-2.43

Tinting:

As stated in the reference PCR, the tint/colorant inventory was taken from thinkstep carbon black pigment data.

Allocation Rules:

In accordance with the reference PCR, allocation was avoided whenever possible, however if allocation could not be avoided, the following hierarchy of allocation methods was utilized:

- Mass, or other biophysical relationship; and
- Economic value.

In the LCA models, mass allocation was ONLY used during packaging and end of life-stages.

[2] Values represent total product (Part A + Part B). Ranges are provided to include all Part A + Part B pairings.
[3] Value includes 2% over-purchase stipulated by reference PCR.
[4] Value includes 2% over-purchase stipulated by reference PCR.

Treatment of Biogenic Carbon:

In accordance with the reference PCR, biogenic carbon was not disclosed as there were no significant sources or impacts from the product system.

CO2 from calcination and carbonation, as well as, CO2 from combustion of waste from non-renewable sources used in product process are indicators listed in the PCR. These values were not recorded as they did not contribute to the Global Warming Potential due to the fact that bio materials are not present and waste was specifically taken to landfill and not combusted.

System Boundary:

This LCA included all relevant steps in the coating manufacturing process as described by the reference PCR. The system boundary began with the extraction of raw materials to be used in the ARMORSEAL 8100 coating and its formulas are manufactured in a way similar to other architectural paint and coating products. The raw materials are manually added in appropriate quantities into a high-speed disperser which are mixed. The product is then moved via compressed air or gravity and filled into containers and shipped to a distribution center and then to the point of sale. A customer travels to the store to purchase the product and transports the coating to the site where it is applied. The applied coating adheres to the substrate where it remains until the substrate is disposed. Any unused coating will be disposed by the customer as well. Because the functional unit mandates a 60 year product life, multiple repaints were necessary and were accounted for by the LCA models. The system boundary ends with *the end-of-life stage. This can be seen in Figure 1, below.*

As described in the reference PCR, the following items were excluded from the assessment and they were expected to not substantially affect the results.

- personnel impacts;
- research and development activities;
- business travel;
- any secondary packaging (pallets, for example);
- all point of sale infrastructure; and
- the coating applicator.

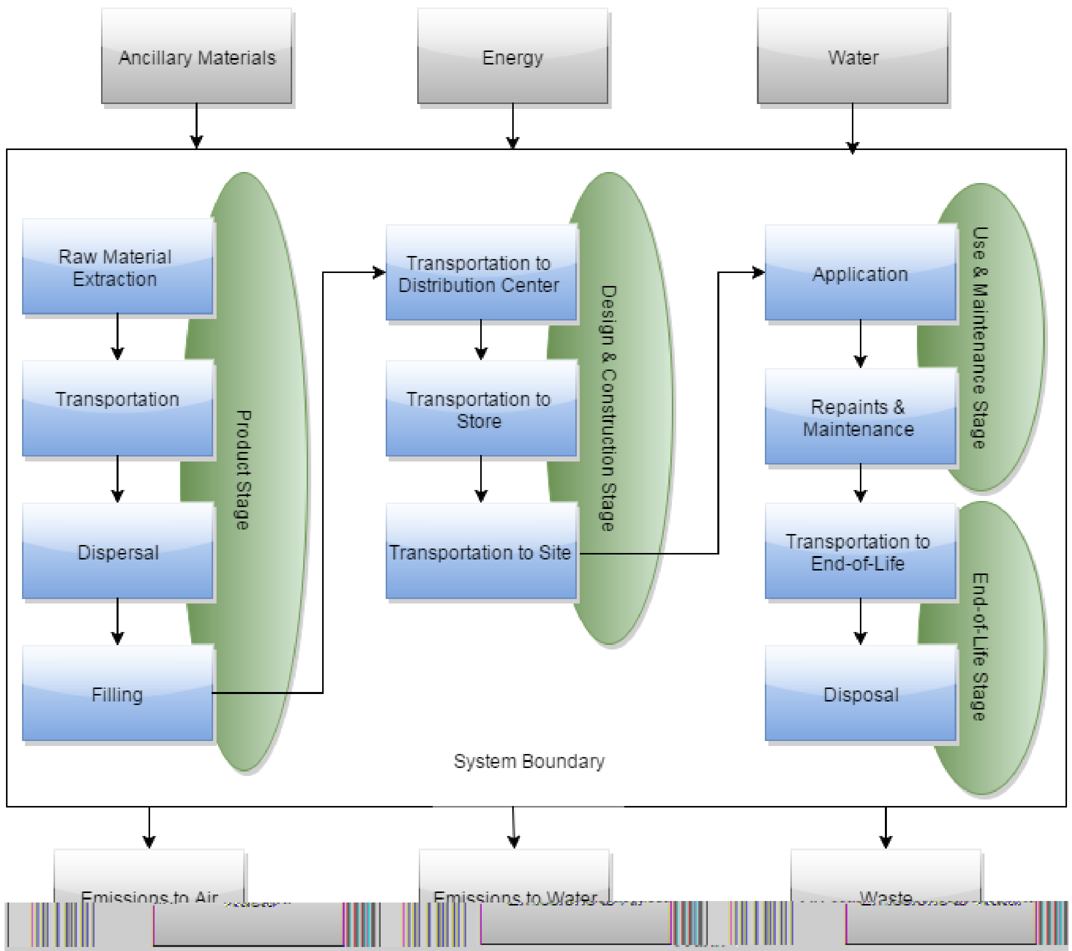


Figure 1. Diagram of System Boundary for the EPD.

Cut-Off Rules:

The cut-off rules prescribed by the reference PCR required a minimum of 95% of the total mass, energy, and environmental relevance be captured by the LCA models. Any unit process shall use a maximum 1% cut-off of renewable primary resource usage, nonrenewable primary resource usage, total mass or environmental impact. All formulas that use this tool shall be modeled to at least 98% of their material content by weight in order to be eligible for verification through this tool. The formulas that were included for testing were all modeled to at least 99.5% of their material content by weight. No significant flows were excluded from the LCA models and the 5% total maximum threshold prescribed by the PCR and ISO 21930:2017 was not exceeded.

Data Sources & Quality:

When primary data was unavailable, data was taken from either thinkstep, ecoinvent, or CEPE's coating industry life cycle inventory. The data from thinkstep and ecoinvent are widely accepted by the LCA community and the CEPE database has been built using those databases as a foundation. A brief description of these databases is below:

Table 5. Overview of Databases used in LCA Models.

Database	Comments
Sherwin-Williams	Primary source data taken as an average monthly value over a 12-month average of 2017 relevant facilities operation metrics.
thinkstep/GaBi	DB Version 8.6.20
ecoinvent	Version 3.3 – Most recent version available in GaBi.
CEPE LCI	Most recent version of industry LCI. Last revised August 26, 2016. Made up of refined data from thinkstep and ecoinvent to make it more representative to coatings manufacturing. Primarily limited to EU data, although some processes are global.

Precision and Completeness:

Annual averages from the 2018 calendar year of primary data was used for all gate-gate processes and the most representative inventories were selected for all processes outside of Sherwin-Williams' direct operational control. Secondary data was primarily drawn from the most recent GaBi and ecoinvent databases and CEPE's 2016 coating life cycle inventory. All of these databases were assessed in terms of overall completeness.

Assumptions relating to application and disposal were conformant with the reference PCR. All data used in the LCA models was less than five years old. Pigment and resin data were taken from both ecoinvent v3.3 and GaBi databases.

Consistency and Reproducibility:

In order to ensure consistency, primary source data was used for all gate-to-gate processes in coating manufacturing. All other secondary data were applied consistently and any modifications to the databases were documented in the LCA Report.

This assessment was completed using an EPD calculator tool that has been externally verified by NSF Certification, LLC. This tool was not altered in any way from its original and verified form to generate the LCA results described in this EPD, and the results from the calculator were translated into the EPD by hand. Reproducibility is possible using the verified EPD Calculator tool or by reproducing the LCIs documented in the LCA Report.

Temporal Coverage:

Primary data was collected from the manufacturing facilities from the 2018 calendar year. Secondary data reflected the most up-do-date versions of the LCA databases mentioned above.

Geographic Coverage:

ARMORSEAL 8100 is manufactured by the Sherwin-Williams Company primarily within the United States, with some products being produced in Europe. Given that the facilities making ARMORSEAL 8100 are spread across the United States and Europe, the average US grid mix was used in the LCA models as a conservative estimate. ARMORSEAL products are purchased, used, and the unused portions are disposed by the customer throughout the US, Europe, and the Middle East.

Cleaning Events:

During product application, it was assumed that the products are brush or roller applied and no impacts occurred other than the use of water for cleaning and emissions associated with the coating drying. The amount of cleaning water needed was conservatively estimated at 10% of the amount of coating applied. The amount of cleaning solution used was determined by parameters set forth in the PCR. Impacts of all cleaning events were calculated in B2. Ancillary materials were not considered as they were considered outside the system boundary by the reference PCR.

Table 6. Cleaning Water and Solution Values and Data Sources Used.[5]

Production Step	Assumption	Data Source
Machinery Cleaning (water)	5% of product manufactured by weight	Estimate
Consumer Application Cleaning (water)	10% of product manufactured by weight	Estimate
Cleaning Solution	22,000 cleaning events	Ecoinvent 3.3

[5] Information regarding cleaning events can be found in reference PCR. One cleaning event covers 100m^2 and in order to satisfy the 60 year time frame 22,000 cleaning events will occur. This corresponds to 220 cleaning events for the 1m^2 surface area described by the functional unit.

Life Cycle Impact Assessment:

The purpose of the Life Cycle Impact Assessment (LCIA) is to show the link between the life cycle inventory results and potential environmental impacts. As such, these results are classified and characterized into several impact categories which are listed and described below. The TRACI 2.1 method was used and the LCIA results are formatted to be conformant with the PCR, which was based on ISO 21930:2017. The TRACI method is widely accepted for use in North America and is developed by the US EPA. This method is also listed in the reference PCR.

***Table 7. Overview of Impact Categories*[6]**

Overview of LCA Impact Categories	
Impact Category Name	***Description of Impact Category***
Global Warming Potential 	*"Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities" (US Environmental Protection Agency 2008b).* *Biogenic carbon was both included and excluded in the analysis as stipulated by the PCR.*
Ozone Depletion Potential 	*Ozone within the stratosphere provides protection from radiation, which can lead to increased frequency of skin cancers and cataracts in the human populations. Additionally, ozone has been documented to have effects on crops, other plants, marine life, and human-built materials. Substances which have been reported and linked to decreasing S-10637-OP-1-0 REVISION: 0 DATE: 6/22/2012 Page 13 | 24 Document ID: S-10637-OP-1-0 Date: 7/24/2012 the stratospheric ozone level are chlorofluorocarbons (CFCs) which are used as refrigerants, foam blowing agents, solvents, and halons which are used as fire extinguishing agents (US Environmental Protection Agency 2008j).*
Acidification Potential 	*Acidification is the increasing concentration of hydrogen ion (H+) within a local environment. This can be the result of the addition of acids (e.g., nitric acid and sulfuric acid) into the environment, or by the addition of other substances (e.g., ammonia) which increase the acidity of the environment due to various chemical reactions and/or biological activity, or by natural circumstances such as the change in soil concentrations because of the growth of local plant species n (US Environmental Protection Agency 2008q).*
Smog Formation Potential 	*Ground level ozone is created by various chemical reactions, which occur between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in sunlight. Human health effects can result in a variety of respiratory issues including increasing symptoms of bronchitis, asthma, and emphysema. Permanent lung damage may result from prolonged exposure to ozone. Ecological impacts include damage to various ecosystems and crop damage. The primary sources of ozone precursors are motor vehicles, electric power utilities and industrial facilities (US Environmental Protection Agency 2008e).*
Eutrophication Potential 	*Eutrophication is the "enrichment of an aquatic ecosystem with nutrients (nitrates, phosphates) that accelerate biological productivity (growth of algae and weeds) and an undesirable accumulation of algal biomass" (US Environmental Protection Agency 2008d).*

[6] See EPA TRACI References for Additional Detail

The LCA results are documented and grouped separately below into the following stages as defined by ISO 21930.

- *Total Impact (across the entire cradle-grave lifecycle including tinting)*
- *Product Stage (Modules A1-A3)*
- *Construction Stage (Modules A4-A5)*
- *Use Stage (Modules B1-B5)*
- *End-Of-Life Stage (Modules C1-C4)*

No weighting or normalization was done to the results. At this time it is not recommended to weight the results of the LCA or the subsequent EPD. It is important to remember that LCA results show potential and expected impacts and these should not be used as firm thresholds/indicators of safety and/or risk. As with all scientific processes, there is uncertainty within the calculation and measurement of all impact categories and care should be taken when interpreting the results.

Results:

The results of the LCA are shown in the tables below.

ARMORSEAL 8100 has options with regards to Part A and a single choice for Part B which are listed in Table 1. The results of the impact categories for all Part A options and Part B were calculated. Each combination of Part A and Part B were used to calculate the Total LCIA results for the entire system. The results for each possible pairing are presented in Table 8 and Table 9.

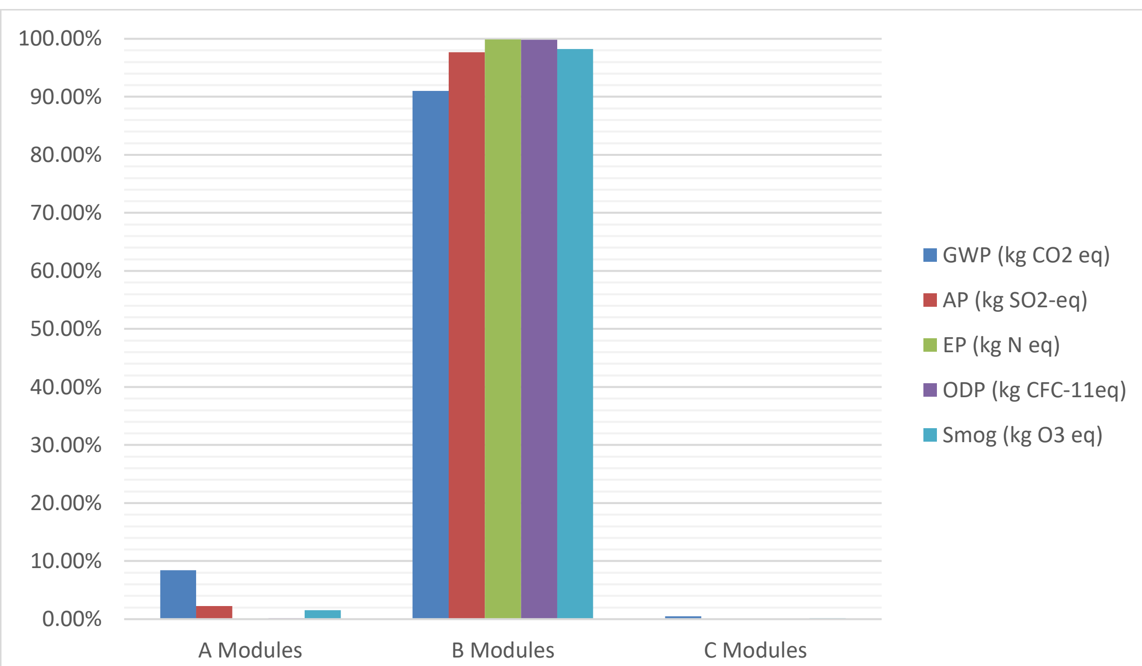
Table 8. Total LCIA Results for Technical Life Scenario (Part A & B)

GLOSS									
	B70W8111 & B70V08100	B70W8113 & B70V08100	B70T8104 & B70V08100	B70A08101 & B70V08100	B70A8100 & B70V08100	B70R08100 & B70V08100	B70B8100 & B70V08100	B70R8101 & B70V08100	B70Y8100 & B70V08100
GWP Inc Bio Carb (kg CO2e)	17.9	17.3	16.9	16.0	16.1	15.5	15.7	15.8	16.2
Acidification (kg SO2e)	0.602	0.578	0.562	0.569	0.576	0.560	0.559	0.562	0.573
Eutrophication (kg N e)	0.954	0.954	0.954	0.953	0.953	0.953	0.953	0.953	0.953
Ozone Depletion (kg CFC-11e)	8.42E-06	8.41E-06	8.42E-06	8.42E-06	8.42E-06	8.41E-06	8.42E-06	8.42E-06	8.43E-06
Smog Formation (kg o3e)	5.34	5.26	5.25	5.21	5.22	5.19	5.19	5.20	5.22
SATIN									
	B70W8161 & B70V08100	B70W8163 & B70V08100	B70T8164 & B70V08100	B70A8160 & B70V08100	B70A08161 & B70V08100	B70R08160 & B70V08100			
GWP Inc Bio Carb (kg CO2e)	18.1	18.0	17.8	16.4	16.3	16.3			
Acidification (kg SO2e)	0.602	0.582	0.565	0.555	0.553	0.563			
Eutrophication (kg N e)	0.954	0.955	0.955	0.952	0.952	0.955			
Ozone Depletion (kg CFC-11e)	8.45E-06	8.47E-06	8.47E-06	8.40E-06	8.41E-06	8.46E-06			
Smog Formation (kg o3e)	5.30	5.30	5.32	5.07	5.07	5.22			

Table 9. Total LCIA Results for Market Life Scenario (Part A & B)

GLOSS									
	B70W8111 & B70V08100	B70W8113 & B70V08100	B70T8104 & B70V08100	B70A08101 & B70V08100	B70A8100 & B70V08100	B70R08100 & B70V08100	B70B8100 & B70V08100	B70R8101 & B70V08100	B70Y8100 & B70V08100
GWP Inc Bio Carb (kg CO2e)	22.3	21.3	20.8	18.6	18.8	17.9	18.1	18.3	18.9
Acidification (kg SO2e)	0.632	0.597	0.560	0.581	0.591	0.568	0.556	0.570	0.586
Eutrophication (kg N e)	0.956	0.955	0.953	0.955	0.955	0.954	0.954	0.955	0.955
Ozone Depletion (kg CFC-11e)	8.43E-06	8.43E-06	8.41E-06	8.43E-06	8.43E-06	8.42E-06	8.42E-06	8.44E-06	8.45E-06
Smog Formation (kg o3e)	5.55	5.44	5.20	5.32	5.33	5.29	5.19	5.31	5.33
SATIN									
	B70W8161 & B70V08100	B70W8163 & B70V08100	B70T8164 & B70V08100	B70A8160 & B70V08100	B70A08161 & B70V08100	B70R08160 & B70V08100			
GWP Inc Bio Carb (kg CO2e)	22.5	21.7	21.5	19.1	18.9	19.0			
Acidification (kg SO2e)	0.633	0.599	0.575	0.592	0.582	0.571			
Eutrophication (kg N e)	0.956	0.956	0.956	0.955	0.956	0.956			
Ozone Depletion (kg CFC-11e)	8.49E-06	8.50E-06	8.50E-06	8.50E-06	8.51E-06	8.50E-06			
Smog Formation (kg o3e)	5.49	5.45	5.49	5.35	5.34	5.33			

Figure 2. Averaged Floor Coating LCIA Impact Distribution by ISO 21930 Module



Resource Metrics:

The resource metrics presented in Table 10 are representative of a worst-case scenario pairing for the ARMORSEAL 8100 product studied in this EPD. Resinous floor coatings are often comprised of multiple components, Part As and Part Bs. ARMORSEAL 8100 is a thin-mil system consisting of 2 components, each listed in Table 1. Within the ARMORSEAL 8100 system, there are multiple options for Part A and one choice for Part B. Variations within Part A options often depended on base and/or color choice. Once the appropriate combination was determined calculations were run for the worst-case Part A + Part B pairing assuming 2 coats applied. For ARMORSEAL 8100 the following systems were used for the resource metrics calculations-

Gloss: Part A (B70W8111) + PART B (B70V08100)
Satin: Part A (B70W8161) + PART B (B70V08100)

Table 10. Resource Metrics for Worst Case- Gloss ARMORSEAL 8100 System

Tech Life	Total	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
$NRPR_E$ (MJ)	714.75	19.29	2.08	0.69	2.44	3.27 E-01	0.00	614	0.00	74.52	0.00	0.00	1.92 E-01	0.00	1.19	-1.02
$NRPR_M$ (kg)	19.15	0.45	5.94 E-02	1.63 E-02	6.97 E-02	8.57 E-03	0.00	16.7	0.00	1.81	0.00	0.00	5.48 E-03	0.00	3.10 E-02	-4.15 E-02
RPR_E (MJ)	1196.62	1.37	5.83 E-02	8.90 E-02	9.45 E-02	2.05E-02	0.00	1.19 E+03	0.00	4.90	0.00	0.00	5.35 E-03	0.00	8.25 E-02	6.80 E-02
RPR_M (KG)	66.48	2.10 E-02	0.00	0.00	0.00	0.00	0.00	66.4	0.00	6.29 E-02	0.00	0.00	0.00	0.00	0.00	0.00
Recovered Energy from disposal of waste in previous systems (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic Depletion Potential for Fossil Resources Used as Energy (MJ)	135.13	16.63	1.93	5.09 E-01	2.27	3.13 E-01	0.00	47.3	0.00	64.93	0.00	0.00	1.78 E-01	0.00	1.07	-8.04 E-01
Abiotic Depletion Potential for Fossil Resources Used as Materials (kg)	5.25 E-03	3.56 E-06	2.62 E-08	9.73 E-09	3.10 E-08	7.93 E-09	0.00	5.24 E-03	0.00	1.09 E-05	0.00	0.00	2.40 E-09	0.00	2.86 E-08	-1.69 E-01
Consumption of Freshwater (m^3)	175.67	1.60E-01	1.39 E-03	9.15E-04	2.20 E-03	9.74E-04	0.00	175	0.00	4.97E-01	0.00	0.00	1.27 E-04	0.00	3.73 E-03	-1.26 E-02
SM (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recycled Material (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuels (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hazardous waste (kg)	0.017	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.00	0.012	0.00	0.00	0.00	0.00	0.00	0.00
Non-hazardous waste (kg)	0.076	0.00	0.00	0.00	0.00	0.009	0.00	0.00	0.00	0.028	0.00	0.00	0.00	0.00	0.038	0.00
High-level radioactive waste (kg)	1.40 E-03	1.50 E-04	2.88 E-06	1.61 E-04	7.87 E-06	3.29 E-06	0.00	9.13 E-05	0.00	9.74 E-04	0.00	0.00	2.65 E-07	0.00	9.15 E-06	2.84 E-08

Market Life	Total	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
$NRPR_E$ (MJ)	765.12	19.29	2.08	6.93 E-01	2.44	3.27 E-01	0.00	614	0.00	124.20	0.00	0.00	0.29	0.00	1.79	-1.53
$NRPR_M$ (kg)	20.37	0.45	0.06	1.63 E-02	0.07	8.57 E-03	0.00	16.7	0.00	3.01	0.00	0.00	8.22 E-03	0.00	4.66 E-02	-6.23 E-02
RPR_E (MJ)	1199.93	1.37	0.06	8.90 E-02	0.09	2.05 E-02	0.00	1.19 E+03	0.00	8.16	0.00	0.00	8.03 E-03	0.00	1.24 E-01	1.02 E-01
RPR_M (KG)	66.53	2.10 E-02	0.00	0.00	0.00	0.00	0.00	66.4	0.00	1.05 E-01	0.00	0.00	0.00	0.00	0.00	0.00
Recovered Energy from disposal of waste in previous systems (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic Depletion Potential for Fossil Resources Used as Energy (MJ)	179.05	16.63	1.93	5.09E-01	2.27	3.13E-01	0.00	47.3	0.00	108.22	0.00	0.00	0.27	0.00	1.61	-1.21
Abiotic Depletion Potential for Fossil Resources Used as Materials (kg)	5.26E-03	3.56E-06	2.62E-08	9.73E-09	3.10 E-08	7.93 E-09	0.00	5.24 E-03	0.00	1.82 E-05	0.00	0.00	3.60 E-09	0.00	4.29 E-08	-0.25
Consumption of Freshwater (m^3)	176.00	1.60E-01	1.39E-03	9.15E-04	2.20 E-03	9.74 E-04	0.00	175	0.00	0.83	0.00	0.00	1.90 E-04	0.00	5.59 E-03	-1.90 E-02
SM (kg)	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recycled Material (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuels (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hazardous waste (kg)	0.037	0.00	0.00	0.006	0.00	0.00	0.00	0.00	0.00	0.031	0.00	0.00	0.00	0.00	0.00	0.00
Non-hazardous waste (kg)	0.170	0.00	0.00	0.00	0.00	0.014	0.00	0.00	0.00	0.071	0.00	0.00	0.00	0.00	0.085	0.00
High-level radioactive waste (kg)	2.05 E-03	1.50 E-04	2.88 E-06	1.61 E-04	7.87 E-06	3.29 E-06	0.00	9.13 E-05	0.00	1.62 E-03	0.00	0.00	3.97 E-07	0.00	1.36 E-05	4.25 E-08

Table 11. Resource Metrics for Worst Case- Satin ARMORSEAL 8100 System

Tech Life	Total	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
$NRPR_E$ (MJ)	721.11	20.82	2.11	0.70	2.47	3.31 E-01	0.00	614	0.00	79.29	0.00	0.00	1.94 E-01	0.00	1.20	-1.03
$NRPR_M$ (kg)	19.29	4.82 E-01	6.00 E-02	1.65 E-02	7.04 E-02	8.66 E-03	0.00	16.70	0.00	1.91	0.00	0.00	5.54 E-03	0.00	3.14 E-02	-4.19 E-02
RPR_E (MJ)	1196.73	1.40	5.89 E-02	9.00 E-02	9.54 E-02	2.08 E-02	0.00	1.19 E+03	0.00	4.98	0.00	0.00	5.41 E-03	0.00	8.34 E-02	6.87 E-02
RPR_M (KG)	66.49	2.15 E-02	0.00	0.00	0.00	0.00	0.00	66.40	0.00	6.44 E-02	0.00	0.00	0.00	0.00	0.00	0.00
Recovered Energy from disposal of waste in previous systems (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic Depletion Potential for Fossil Resources Used as Energy (MJ)	140.64	17.97	1.95	5.15 E-01	2.29	3.02 E-01	0.00	47.30	0.00	69.05	0.00	0.00	1.80 E-01	0.00	1.09	-8.15 E-01
Abiotic Depletion Potential for Fossil Resources Used as Materials (kg)	5.26 E-03	3.73 E-06	2.64 E-08	9.84 E-09	3.13 E-08	8.01 E-09	0.00	5.24 E-03	0.00	1.14 E-05	0.00	0.00	2.43 E-09	0.00	2.89 E-08	-1.69 E-01
Consumption of Freshwater (m^3)	176.02	2.48 E-01	1.41 E-03	9.25 E-04	2.22 E-03	9.84 E-04	0.00	175	0.00	7.59 E-01	0.00	0.00	1.28 E-04	0.00	3.77 E-03	-1.28 E-02
SM (kg)	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recycled Material (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuels (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hazardous waste (kg)	0.017	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.00	0.013	0.00	0.00	0.00	0.00	0.00	0.00
Non-hazardous waste (kg)	0.076	0.00	0.00	0.00	0.00	0.010	0.00	0.00	0.00	0.029	0.00	0.00	0.00	0.00	0.038	0.00
High-level radioactive waste (kg)	1.41 E-03	1.51 E-04	2.91 E-06	1.61 E-04	7.92 E-06	3.32 E-06	0.00	9.13 E-05	0.00	9.78 E-04	0.00	0.00	2.68 E-07	0.00	9.26 E-06	2.87 E-08

Market Life	Total	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
$NRPR_E$ (MJ)	774.67	20.82	2.11	7.01 E-01	2.47	3.31 E-01	0.00	614	0.00	132.14	0.00	0.00	2.91 E-01	0.00	1.81	-1.54
$NRPR_M$ (kg)	20.58	4.82 E-01	6.00 E-02	1.65 E-02	7.04 E-02	8.66 E-03	0.00	16.70	0.00	3.19	0.00	0.00	8.31 E-03	0.00	4.70 E-02	-6.29 E-02
RPR_E (MJ)	1200.10	1.40	5.89E-02	9.00 E-02	9.54 E-02	2.08 E-02	0.00	1.19 E+03	0.00	8.31	0.00	0.00	8.11 E-03	0.00	1.25 E-01	1.03 E-01
RPR_M (KG)	66.53	2.15 E-02	0.00	0.00	0.00	0.00	0.00	66.40	0.00	1.07 E-01	0.00	0.00	0.00	0.00	0.00	0.00
Recovered Energy from disposal of waste in previous systems (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic Depletion Potential for Fossil Resources Used as Energy (MJ)	187.31	17.97	1.95	5.15 E-01	2.29	3.02 E-01	0.00	47.30	0.00	115.09	0.00	0.00	2.70 E-01	0.00	1.63	-1.22
Abiotic Depletion Potential for Fossil Resources Used as Materials (kg)	5.26 E-03	3.73 E-06	2.64 E-08	9.84 E-09	3.13 E-08	8.01 E-09	0.00	5.24 E-03	0.00	1.90 E-05	0.00	0.00	3.64 E-09	0.00	4.33 E-08	-0.25
Consumption of Freshwater (m^3)	176.52	2.48 E-01	1.41 E-03	9.25 E-04	2.22 E-03	9.84 E-04	0.00	175	0.00	1.27	0.00	0.00	1.92 E-04	0.00	5.65 E-03	-1.92 E-02
SM (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recycled Material (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuels (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hazardous waste (kg)	0.038	0.00	0.00	0.006	0.00	0.00	0.00	0.00	0.00	0.013	0.00	0.00	0.00	0.00	0.00	0.00
Non-hazardous waste (kg)	0.172	0.00	0.00	0.00	0.00	0.014	0.00	0.00	0.00	0.072	0.00	0.00	0.00	0.00	0.068	0.00
High-level radioactive waste (kg)	2.06 E-03	1.51 E-04	2.91 E-06	1.61 E-04	7.92 E-06	3.32 E-06	0.00	9.13 E-05	0.00	1.63 E-03	0.00	0.00	4.02 E-07	0.00	1.38 E-05	4.31 E-08

Specific resource metrics for an ARMOSEAL 8100 formula are available upon requested. These results were not reported in the EPD to maintain simplicity. Please contact sustainability@sherwin.com for the specific resource results for an individual ARMORSEAL 8100 formula.

Table 12. A5 Product Packaging Waste

Module	Parameter	Unit (per functional unit)	Value
A5 Installation of the product	Mass of steel can waste	kg	0.032-0.049 kg
A5 Installation of the product	GWP in biogenic carbon of steel can	kg CO2e	0.0048- 0.0073 kg CO2e

Table 13. Waste Generation Values and GWP of Packaging Waste and Data Sources

Waste Generation		
Non-Hazardous Waste	.0059 kg/kg of product	Primary Data taken from average waste creation during Resinous Floor Coating manufacturing Plants in 2017.
Hazardous Waste	.0026 kg/kg of product	Primary Data taken from average waste creation during Resinous Floor Coating manufacturing Plants in 2017.
Mass of Packaging Waste – A5	.020kg/kg of product – tinplated steel	Primary data taken from products assessed and considered for this EPD tool.
GWP of Packaging Waste Biogenic Carbon – A5	.003 kg CO2e per kg of product	Calculated from Packaging Waste Values

Table 14. Assignments of Output Flows at the Construction Product's End of Life

Type of Flow	Fate	Material Specifications	Unit	C1	C3	C4
Material Flows Reached Boundary Between Systems	Components for Reuse	Type 1	Kg	0	0	
		Type n	Kg	0	0	
	Materials for Recycling Used in Next Product System	Type 1	Kg	0	0.04	
		Type n	Kg	0	0	
	Materials for Energy Recovery as Secondary Fuel	Secondary Fuel 1 w/NCV	kg		0	
		Type n, with NCV	Kg		0	
Material Flows have not reached boundary between systems	Exported Energy from Waste with >60% Energy Recovery Efficiency	Energy Type 1	MJ		0	
		Energy Type n	MJ		0	
	Incineration from Waste with <60% Energy Recovery Efficiency	Waste Disposed	Kg			0
		Waste Disposed	Kg			0
		Energy Type 1	MJ			0
		Energy Type n	MJ			0
	Wastes Disposed in Landfill Where Energy is Recovered from Landfill Gas	Waste Disposed	Kg			0
		Waste Disposed	Kg			0
		Energy Type 1	MJ			0
		Energy Type n	MJ			0

Interpretation:

The majority of the environmental impact was from the raw materials used to make the coatings (Module A1) and the cleaning process (Module B2). The raw materials with the largest impacts were the resins and primary pigment (often titanium dioxide). This was not surprising given the amount of resources needed to manufacture these intermediate products and also that they typically represent a substantial portion of the formulation (typically >35%).

The cleaning process was a major contributor to all indicators. This was not surprising given that the PCR prescribed daily cleaning events for a 60 year time horizon (i.e. over 20,000 cleanings). This cleaning would occur to all floor coating systems (and all flooring in general) and is not an area of possible differentiation between floor coatings or something Sherwin-Williams could necessarily affect as it is up to the customer. It should be noted that this impact was accounted for only within the topcoat of each system as that is technically the only layer being cleaned.

Since the raw materials were responsible for the largest portion of the impact that the manufacturer could potentially optimize, product performance and durability were important. Within the flooring system, there was a range of ~1 kg of coating being needed to satisfy the functional unit to ~3 kg of coating depending on the market and technical life. This means that close fifty percent more material was needed when using the latter lifetime.

Generally speaking, the longer a coating lasts, the better its environmental performance will be. Ultimately, the end-user should decide which lifetime is more appropriate for their decision-making.

Study Completeness:

Completeness estimates are somewhat subjective, as it is impossible for any LCA or inventory to be 100% complete. However, based on expert judgment, it is believed that given the overall data quality that the study is at least 95% complete. As such, at least 95% of system mass, energy, and environmental relevance were covered.

Uncertainty:

Because a large number of data sets are linked together in the LCA models, it is unknown how much of the data sets have goals that are dissimilar to this LCA. As such, it is difficult to estimate overall uncertainty of the LCA models. However, primary source data was used whenever possible and the most appropriate secondary data sources were used throughout the models. The thinkstep and ecoinvent databases are widely accepted by the LCA community and CEPE's LCI Database is based off thinkstep and ecoinvent data, just being optimized/corrected for coating manufacturing processes.

Since the reference PCR stipulated the majority of the crucial LCA assumptions, Sherwin-Williams is comfortable with the methodology of the LCA and feel they reflect current best-practices.

Limitations:

LCA is not a perfect tool for comparisons and impact values are constantly changing due to shifts in the grid mix, transportation, fuels, etc. Because of this, care should be taken when applying or interpreting these results. This being said, the relative impacts between products should be more reliable and less sensitive versus the specific impact category and metric values.

As stated in the Treatment of Missing Data section of the LCA report (page 12), there were cases where analogue chemicals had to be used in the LCA models. This occurred when no LCI data was available for an intermediate chemical/material. This was typically limited to additives representing a very small amount of the overall formula (less than a percent), but may still impact the results. Likewise, there were cases where data had to be used from a different region or technology. These instances were uncommon and noted in the Data Quality section of the report and were not expected to have a serious effect on the results, but still may limit the study.

Emissions to Water, Soil, and to Indoor Air:

Many of Sherwin-Williams' products are considered low or no-VOC including many floor coating systems under consideration for EPDs. ARMORSEAL 8100 is GreenGuard certified and is available at the link found on page 23.

VOC determination was done using the federally-accepted methods outlined by the EPA in the Federal Register. Additional information on VOCs and GreenGuard certification can be found on the environmental data sheets for ARMORSEAL 8100 on www.sherwin.com.

Critical Review:

Since the goal of the LCA was to generate an EPD, it was submitted for review by NSF Certification, LLC. NSF has commissioned Mr. Jack Geibig of EcoForm to conduct the formal review of the LCA report.

Additional Environmental Information:

Emissions Testing Standard	
	GREENGUARD
	https://spot.ul.com/main-app/products/detail/5ad1eed855b0e82d946aaae0?page_type=Products%20Catalog

VOC Content[7]			
Part A	*B70W8111*	<50g/L	Determined by *EPA* VOC Regulatory Calculation
	B70W8113	<50g/L	
	B70T8104	<50g/L	
	B70A08101	<50g/L	
	B70A8100	<50g/L	
	B70R08100	<50g/L	
	B70B8100	<50g/L	
	B70R8101	<50g/L	
	B70Y8100	<50g/L	
	B70W8161	<50g/L	
	B70W8163	<50g/L	
	B70T8164	<50g/L	
	B70A8160	<50g/L	
	B70A08161	<50g/L	
	B70R08160	<50g/L	
Part B	*B70V08100*	<50g/L	

[7] Calculated per Method 24.

Preferred End-of Life Options for ARMOSEAL 8100:

Please visit www.paintcare.org/ *for information about disposing leftover latex paint. If possible, unused paint should be taken to an appropriate recycling/take-back center. Additional information can also be found on the Sherwin-Williams website at:* www.sherwin-williams.com/homeowners/ask-sherwin-williams/painting/interior-painting-how-tos/interior-cleaning-up/.

References:

American Coating Association Product Category Rule for Resinous Floor Coatings. Available at via NSF International. Published December 2018.

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 21930:2017 *Sustainability in building construction – Environmental declaration of building products.*

PaintCare - http://www.paintcare.org/

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Appendix A: LCIA Results by ISO Module.[8]

B70W8111 & B70V08100 GLOSS Market Life	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
GWP Inc Bio Carb (kg CO2e)	1.53	1.30 E-01	3.84 E-02	1.55 E-01	9.05 E-03	0.00	10.9	0.00	9.37	0.00	0.00	1.79 E-02	0.00	9.81 E-02	-1.50 E-01
Acidification (kg SO2e)	1.33 E-02	3.65 E-04	1.09 E-04	3.52 E-04	4.17 E-05	0.00	0.546	0.00	7.12 E-02	0.00	0.00	5.18 E-05	0.00	4.52 E-04	-2.94 E-04
Eutrophication (kg N e)	6.85 E-04	3.49 E-05	4.56 E-06	4.18 E-05	2.21 E-06	0.00	0.951	0.00	3.85 E-03	0.00	0.00	4.93 E-06	0.00	2.31 E-05	-1.20 E-05
Ozone Depletion (kg CFC-11e)	9.14 E-09	0.00	0.00	0.00	0.00	0.00	8.38 E-06	0.00	4.57 E-08	0.00	0.00	0.00	0.00	0.00	1.06 E-09
Smog Formation (kg o3e)	6.67 E-02	1.16 E-02	9.02 E-04	1.10 E-02	8.67 E-04	0.00	4.99	0.00	4.59 E-01	0.00	0.00	1.16 E-03	0.00	9.04 E-03	-4.18 E-03

B70W8111 & B70V08100 GLOSS Technical Life	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
GWP Inc Bio Carb (kg CO2e)	1.39	1.30 E-01	3.84 E-02	1.55 E-01	9.05 E-03	0.00	10.9	0.00	5.18	0.00	0.00	1.19 E-02	0.00	6.54 E-02	-1.00 E-01
Acidification (kg SO2e)	1.29 E-02	3.65 E-04	1.09 E-04	3.52 E-04	4.17 E-05	0.00	0.546	0.00	4.15 E-02	0.00	0.00	3.45 E-05	0.00	3.01 E-04	-1.96 E-04
Eutrophication (kg N e)	6.38 E-04	3.49 E-05	4.56 E-06	4.18 E-05	2.21 E-06	0.00	0.951	0.00	2.17 E-03	0.00	0.00	3.29 E-06	0.00	1.54 E-05	-7.99 E-06
Ozone Depletion (kg CFC-11e)	9.14 E-09	0.00	0.00	0.00	0.00	0.00	8.38 E-06	0.00	2.74 E-08	0.00	0.00	0.00	0.00	0.00	7.09 E-10
Smog Formation (kg o3e)	6.06 E-02	1.16 E-02	9.02 E-04	1.10 E-02	8.67 E-04	0.00	4.99	0.00	2.57 E-01	0.00	0.00	7.71 E-04	0.00	6.03 E-03	-2.78 E-03

B70W8161 & B70V08100 SATIN Market Life	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
GWP Inc Bio Carb (kg CO2e)	1.58	1.31 E-01	3.88 E-02	1.57 E-01	1.83 E-02	0.00	10.9	0.00	9.61	0.00	0.00	1.81 E-02	0.00	9.92 E-02	-2.53 E-02
Acidification (kg SO2e)	1.35 E-02	3.69 E-04	1.10 E-04	3.56 E-04	8.42 E-05	0.00	0.546	0.00	7.19 E-02	0.00	0.00	5.24 E-05	0.00	4.57 E-04	-4.96 E-05
Eutrophication (kg N e)	7.75 E-04	3.53 E-05	4.61 E-06	4.23 E-05	4.46 E-06	0.00	0.951	0.00	4.31 E-03	0.00	0.00	4.98 E-06	0.00	2.33 E-05	-2.02 E-06
Ozone Depletion (kg CFC-11e)	1.82 E-08	0.00	0.00	0.00	0.00	0.00	8.38 E-06	0.00	9.12 E-08	0.00	0.00	0.00	0.00	0.00	1.79 E-10
Smog Formation (kg o3e)	5.68 E-02	1.17 E-02	9.11 E-04	1.11 E-02	1.75 E-03	0.00	4.99	0.00	4.11 E-01	0.00	0.00	1.17 E-03	0.00	9.14 E-03	-7.04 E-04

B70W8161 & B70V08100 SATIN Technical Life	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
GWP Inc Bio Carb (kg CO2e)	1.43	1.31 E-01	3.88 E-02	1.57 E-01	1.83 E-02	0.00	10.9	0.00	5.32	0.00	0.00	1.70 E-02	0.00	9.35 E-02	-3.84 E-02
Acidification (kg SO2e)	1.30 E-02	3.69 E-04	1.10 E-04	3.56 E-04	8.42 E-05	0.00	0.546	0.00	4.19 E-02	0.00	0.00	4.94 E-05	0.00	4.31 E-04	-7.52 E-05
Eutrophication (kg N e)	7.27 E-04	3.53 E-05	4.61 E-06	4.23 E-05	4.46 E-06	0.00	0.951	0.00	2.44 E-03	0.00	0.00	4.70 E-06	0.00	2.20 E-05	-3.06 E-06
Ozone Depletion (kg CFC-11e)	1.82 E-08	0.00	0.00	0.00	0.00	0.00	8.38 E-06	0.00	5.47 E-08	0.00	0.00	0.00	0.00	0.00	2.72 E-10
Smog Formation (kg o3e)	5.07 E-02	1.17 E-02	9.11 E-04	1.11 E-02	1.75 E-03	0.00	4.99	0.00	2.28 E-01	0.00	0.00	1.10 E-03	0.00	8.61 E-03	-1.07 E-03

[8] Due to the options available for Part A, values were based on a worst case scenario pairing.

Appendix B: LCIA Results by ISO Stage.[9]

B70W8111 & B70V08100 GLOSS Market Life	Production Stage A1-A3	Construction Stage A4-A5	Use Stage B1-B5	End-of-Life Stage C1-C4	Potential Net Benefits D
GWP Inc Bio Carb (kg CO2e)	1.70	1.64E-01	20.27	1.16E-01	-1.50E-01
Acidification (kg SO2e)	1.38E-02	3.94E-04	6.17E-01	5.04E-04	-2.94E-04
Eutrophication (kg N e)	7.25E-04	4.40E-05	9.55E-01	2.80E-05	-1.20E-05
Ozone Depletion (kg CFC-11e)	9.14E-09	0.00	8.43E-06	0.00	1.06E-09
Smog Formation (kg o3e)	7.92E-02	1.18E-02	5.45	1.02E-02	-4.18E-03
B70W8111 & B70V08100 GLOSS Technical Life	**Production Stage A1-A3**	**Construction Stage A4-A5**	**Use Stage B1-B5**	**End-of-Life Stage C1-C4**	**Potential Net Benefits D**
GWP Inc Bio Carb (kg CO2e)	1.55	1.64E-01	16.08	7.73E-02	-1.00E-01
Acidification (kg SO2e)	1.34E-02	3.94E-04	5.87E-01	3.36E-04	-1.96E-04
Eutrophication (kg N e)	6.77E-04	4.40E-05	9.53E-01	1.87E-05	-7.99E-06
Ozone Depletion (kg CFC-11e)	9.14E-09	0.00	8.41E-06	0.00	7.09E-10
Smog Formation (kg o3e)	7.30E-02	1.18E-02	5.25	6.80E-03	-2.78E-03
B70W8161 & B70V08100 SATIN Market Life	**Production Stage A1-A3**	**Construction Stage A4-A5**	**Use Stage B1-B5**	**End-of-Life Stage C1-C4**	**Potential Net Benefits D**
GWP Inc Bio Carb (kg CO2e)	1.75	1.75E-01	20.51	1.17E-01	-2.53E-02
Acidification (kg SO2e)	1.39E-02	4.40E-04	6.18E-01	5.09E-04	-4.96E-05
Eutrophication (kg N e)	8.15E-04	4.68E-05	9.55E-01	2.83E-05	-2.02E-06
Ozone Depletion (kg CFC-11e)	1.82E-08	0.00	8.47E-06	0.00	1.79E-10
Smog Formation (kg o3e)	6.94E-02	1.28E-02	5.40	1.03E-02	-7.04E-04
B70W8161 & B70V08100 SATIN Technical Life	**Production Stage A1-A3**	**Construction Stage A4-A5**	**Use Stage B1-B5**	**End-of-Life Stage C1-C4**	**Potential Net Benefits D**
GWP Inc Bio Carb (kg CO2e)	1.60	1.75E-01	16.22	1.11E-01	-3.84E-02
Acidification (kg SO2e)	1.35E-02	4.40E-04	5.88E-01	4.80E-04	-7.52E-05
Eutrophication (kg N e)	7.67E-04	4.68E-05	9.53E-01	2.67E-05	-3.06E-06
Ozone Depletion (kg CFC-11e)	1.82E-08	0.00	8.43E-06	0.00	2.72E-10
Smog Formation (kg o3e)	6.33E-02	1.28E-02	5.22	9.72E-03	-1.07E-03

[9] Due to the options available for Part A, values were based on a worst case scenario pairing.