



# Environmental Product Declaration

According to ISO 14025 and ISO 21930

Carlisle Sure-Flex™ Single-ply PVC Roofing Membrane with a finished nominal thickness of 50 mils, 60 mils and 80 mils.

Sponsored by the Carlisle SynTec Systems

**Sure-Flex™ PVC**  
Membrane






## ASTM International Certified Environmental Product Declaration

This document is a Type III environmental product declaration for Carlisle’s Sure-Flex™ Single-ply PVC (Polyvinyl chloride) Roofing Membrane for 50, 60 and 80 mils finished nominal thicknesses, as manufactured at the Carlisle’s Greenville, IL facility for the reference year 2015.


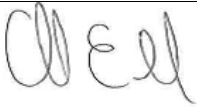
This declaration has been prepared in accordance with ISO 14025 [5], ISO 21930 [4], ISO 14040/44 [6-7], the ASTM international’s Single-Ply Roofing Membranes Product Category Rules (PCR) [1] and ASTM General Program Instructions for Type III Environmental Declaration [10].


The intent of this document is to further the development of environmentally compatible and more sustainable construction methods by providing comprehensive environmental information related to potential impacts of Sure-Flex PVC roofing membranes in accordance with international standards.

### Environmental Product Declaration Summary

General Information	
<b>Owner of the EPD</b>	 <p><b>Carlisle SynTec Systems</b>                      Carlisle Construction Materials                      P.O. Box 7000                      Carlisle, PA 17013                      Link (URL): <a href="http://www.carlislesyntec.com">www.carlislesyntec.com</a></p> <p>Carlisle SynTec Systems has been the leader in the commercial single-ply roofing industry for more than 50 years. It continues to lead the roofing industry today by providing its customers with superior roofing systems and services through a select network of manufacturer’s representatives, distributors and applicators.</p> <p>The owner of the declaration is liable for the underlying information and evidence.</p>
<b>Manufacturing Site</b>	Greenville, IL 1825 East U.S. Route 40 Greenville, IL 62246
<b>Product Group</b>	Single Ply Roofing Membranes
<b>Product Name</b>	Carlisle’s Sure-Flex Single-ply PVC roofing membrane with a finished nominal thickness of 1.270 mm (50 mils), 1.524 mm (60 mils) and 2.032 (80 mils).



<b>Product Definition</b>		Single Ply Roofing Membranes are defined as thermoplastic or thermoset membranes of compounded synthetic materials manufactured in a factory for use in roofing [1].	
<b>Product Category Rule (PCR)</b>		ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Single Ply Roofing Membranes, Version 2, Issued: January 2016 [1].	
<b>Certification Period</b>		07.18.2016 – 07.18.2021	
<b>Declared Unit</b>		1 m <sup>2</sup> manufactured of Carlisle’s Sure-Flex Single-ply PVC Roofing Membrane	
<b>ASTM Declaration Number</b>		EPD – 036	
<b>EPD Information</b>			
<b>Program Operator</b> 		ASTM International	
<b>Declaration Holder</b>		Carlisle SynTec Systems	
<b>Product group</b> Single Ply Roofing Membranes	<b>Date of Issue</b> 07.18.2016	<b>Period of Validity</b> 5 years	<b>Declaration Number</b> EPD-036
<b>Declaration Type</b> This “Cradle-to-gate” EPD applies to the Carlisle’s Sure-Flex PVC roofing membrane in white, gray, and tan in 50, 60, and 80 mils nominal thicknesses. Product activities covered include the raw material supply, transport and manufacturing (modules A1 to A3). The declaration is intended for Business-to-Business (B-to-B) communication.			
<b>Applicable Countries</b> United States and Canada			
<b>Product Applicability and Characteristics</b> Carlisle’s Sure-Flex PVC is an advanced-formula, heat-weldable PVC thermoplastic membrane that is designed for long-term weatherability and performance. The physical properties of the membrane are enhanced by a tenacious, weft-inserted polyester fabric that is encapsulated by thick PVC based top and bottom plies. The smooth surface of the PVC membrane allows for a total-surface fusion and permanent weld, creating a consistent, watertight, monolithic roof assembly. The gray-colored bottom ply provides a visual confirmation of a proper weld during the lap welding process. PVC roofing membrane can be used in adhered and mechanically fastened systems.			
<b>Content of the Declaration</b> The declaration follows Section 11, Content of the EPD, ASTM International, Product Category Rules for Preparing an Environmental Product Declaration For Single Ply Roofing Membranes, Version 2, Issued: January 2016 [1].			
<b>This EPD was independently verified by ASTM in accordance with ISO 14025:</b>		 Christopher Surak 100 Barr Harbor Drive, PO Box C700 West Conshohocken, PA 19428-2959, USA <a href="http://www.astm.org/EPDs.htm">www.astm.org/EPDs.htm</a>	
<b>Internal</b>	<b>External</b>		
	X		

EPD Project Report Information	
<b>EPD Project Report</b>	A Cradle-to-gate Life Cycle Assessment of Carlisle Sure-Flex™ Single-ply PVC and KEE HP Roofing Membrane in 50 mils, 60 mils and 80 mils finished nominal thicknesses, July 2016 [3].
<b>Prepared by</b>  	Lindita Bushi Ph.D. and Jamie Meil Athena Sustainable Materials Institute 119 Ross Avenue, Suite 100 Ottawa, Ontario, K1Y 0N6, Canada <a href="mailto:info@athenasmi.org">info@athenasmi.org</a>
<b>This EPD project report was independently verified by in accordance with ISO 14025 and the reference PCR:</b>	Thomas P. Gloria, Ph.D. Industrial Ecology Consultants 35 Bracebridge Rd. Newton, MA 02459-1728 direct: 617.553.4929 mobile: 857.636.0585 email: <a href="mailto:t.gloria@industrial-ecology.com">t.gloria@industrial-ecology.com</a>
PCR Information	
<b>Program Operator</b>	ASTM International
<b>Reference PCR</b>	ASTM International, Product Category Rules for Preparing an Environmental Product Declaration for Single Ply Roofing Membranes
<b>Date of Issue</b>	Version 2, Issued: January 2016
<b>PCR review was conducted by:</b>	François Charron Doucet Groupe AGÉCO <a href="mailto:francois.charron@groupeageco.ca">francois.charron@groupeageco.ca</a>

## 1 PRODUCT IDENTIFICATION

### 1.1 PRODUCT DEFINITION

This EPD applies to the Carlisle's Sure-Flex Single-ply PVC Roofing Membrane in white, gray, and tan, with a finished nominal thickness of 50, 60 and 80 mils, as produced at its Greenville, IL plant.

PVC is a trusted membrane that has been providing decades of waterproofing protection in North America and Europe. PVC's popularity stems from its dependable, heat-welded seams, high reflectivity, superior physical attributes and resistance to water, chemicals, grease, fire and punctures.

Carlisle's Sure-Flex PVC is an advanced-formula, heat-weldable PVC thermoplastic membrane that is designed for long-term weatherability and performance. The physical properties of the membrane are enhanced by a weft-inserted polyester fabric that is encapsulated by thick PVC based top and bottom plies.

The smooth surface of the PVC membrane allows for a total-surface fusion and permanent weld, creating a consistent, watertight, monolithic roof assembly. The gray-colored bottom ply provides a visual confirmation of a proper weld during the lap welding process.

Carlisle's Sure-Flex PVC feature ENERGY STAR® qualification, contribute to LEED® credit requirements and is Cool Roof Rating Council (CRRC)-rated and Title 24 compliant. The Sure-Flex product line is one of the broadest in the industry, offering a PVC membrane for virtually any low-slope roofing specification.



**Figure 1 Carlisle Sure-Flex Single-ply PVC Roofing Membrane**

## 1.2 PRODUCT STANDARDS

The Carlisle Sure-Flex Single-ply PVC Roofing Membrane, with a finished nominal thickness of 50, 60 and 80 mils meet the following standards and requirements,

- ASTM D4434 Standard Specification for Poly (Vinyl Chloride) Sheet Roofing [2]
- ANSI NSF 347 Sustainability Assessment for Single Ply Roof Membranes [12]
- Cool Roof Rating Council®
- ENERGY STAR®
- FM Approvals
- Miami-Dade County Approval
- California’s Building Energy Code (Title 24) Compliant
- Underwriters Laboratory Inc.
- Underwriters Laboratories of Canada

## 1.3 TECHNICAL DATA

Table 1 summarizes key technical data for Carlisle Sure-Flex Single-ply PVC Roofing Membrane by nominal thickness. Sure-Flex PVC meets or exceeds the requirements of ASTM D4434 Standard Specification for Poly (Vinyl Chloride) Sheet Roofing. Sure-Flex PVC is classified as Type III and/or Type IV as defined by ASTM D4434.

**Table 1. Technical data**

Technical data *)	ASTM D4434 Requirement	Value /Test Results		
		50 mils	60 mils	80 mils
<b>Thickness over scrim, in. (mm)</b> ASTM D4434 optical method average	0.016 min (0.40)	0.017 (0.432)	0.025 (0.635)	0.030 (0.762)
<b>Weight, lbs/ft<sup>2</sup> (kg/m<sup>2</sup>)</b>	No requirement	0.33 (1.6)	0.40 (1.9)	0.55 (2.68)
<b>Breaking strength (MD x CD), lbf/in (kN/m)</b> ASTM D751 grab method	275 min (48)	320 x 300 (56 x 53)	330 x 300 (58x 55)	360 x 330 (63 x 58)
<b>Elongation</b> break of reinforcement (MD x CD), % ASTM D751 grab method	25 min	30 x 30	30 x 30	30 x 30
<b>Seam strength</b> , min. ASTM D751 grab method (% of breaking strength)	>75	PASS	PASS	PASS
<b>Tearing strength (MD x CD), lbf (N)</b> ASTM D751 proc. B, 8 in. x 8 in.	90 min (400)	100 x 120 (445 x 534)	100 x 130 (445 x 578)	100 x 132 (445 x 587)
<b>Low temperature bend</b> , ASTM D2135, no cracks 5x at -40°C	PASS	PASS (-40°C)	PASS (-40°C)	PASS (-40°C)
<b>Linear dimensional change</b> , % ASTM D1204, 6 hours at 176°F	±0.5 max	0.4	0.4	0.4

Technical data <sup>*)</sup>	ASTM D4434 Requirement	Value /Test Results		
		50 mils	60 mils	80 mils
<b>Ozone resistance</b> , no cracks 7x ASTM D1149, 100pphm, 168 hrs	PASS	PASS	PASS	PASS
<b>Water absorption resistance</b> , mass % ASTM D570, 166 hours at 158°F water	±3.0 max	2.0	2.0	2.0
<b>Field seam strength</b> , lbf/in. (kN/m) ASTM D1876 tested in peel	No requirement	25 (4.4) min 60 (10.5) typ.	25 (4.4) min 60 (10.5) typ.	25 (4.4) min 60 (10.5) typ.
<b>Water vapor permeance</b> , Perms, ASTM E96 proc. B	No requirement	0.10 max 0.05 typ	0.10 max 0.05 typ	0.10 max 0.05 typ
<b>Puncture resistance – Federal</b> , lbf (kN) FTM 101C, method 2031	No requirement	280	320	380
<b>Puncture resistance – Dynamic</b> , J (ft-lbf) ASTM D5635	20 (14.7)	PASS	PASS	PASS
<b>Puncture resistance – Static</b> , lbf (N) ASTM D5602	33 (145)	PASS	PASS	PASS
<b>Xenon-Arc resistance</b> , no cracks/crazing 10x, ASTM G155 0.35 W/m <sup>2</sup> at 340-nm, 63°C B.P.T. 12,600 kJ/m <sup>2</sup>	PASS	PASS	PASS	PASS
<b>Properties after heat aging</b> , ASTM D3045, 56 days at 176°F Breaking strength, % retained	90 min 90 min	90 min 90 min	90 min 90 min	90 min 90 min
<b>Solar Reflectance Index (SRI)</b>	No requirement	White: 111		

<sup>\*)</sup> Further testing information and results can be found in the Carlisle SynTec Systems's website at [www.carlisesyntec.com](http://www.carlisesyntec.com).

#### 1.4 PACKAGING

Table 2 shows the packaging materials for Carlisle Sure-Flex Single-ply PVC Roofing Membrane (applicable to all finished nominal thicknesses).

**Table 2. Packaging materials for 1m<sup>2</sup> of Carlisle Sure-Flex PVC Membrane**

Packaging material	Quantity
Cardboard core [kg]	0.111
PE Stretch film [kg]	0.002
Wooden pallet [kg]	0.078
<b>Total [kg/m<sup>2</sup>]</b>	<b>0.191</b>





## 2 PRODUCT APPLICATION AND INSTALATION

The three declared Carlisle Sure-Flex Single-ply PVC Roofing Membrane thicknesses are designed for low-slope roofing applications. The membranes weld quickly, cleanly, and consistently. Carlisle’s KEE HP roofing membrane can be either installed as a mechanically fastened or adhered roofing system.

## 3 DECLARED UNIT

The declared product is 1 m<sup>2</sup> manufactured of Carlisle Sure-Flex Single-ply PVC Roofing Membrane, with a finished nominal thickness of 50, 60 or 80 mils.

## 4 MATERIAL CONTENT DECLARATION

The material average percentage by weight for 1m<sup>2</sup> for the Carlisle Sure-Flex 50, 60 and 80 mils is provided in Table 3.

**Table 3. Average material content percentage by weight for 1 m<sup>2</sup> of 50, 60 and 80 mils Carlisle Sure-Flex PVC Membrane**

Raw material input <sup>*)</sup>	Total weight by [%]
PVC Resin	46
Plasticizers	28
Pigments	2
Fire retardant	15
Stabilizers	3
Processing aids, oils and lubricants	0.1
Biocide	0.1
Adhesive	0
Polyester reinforcement	6
<b>Total weight (Input)</b>	<b>100</b>

<sup>\*)</sup> For confidentiality reasons the chemical names of plant specific input material are not divulged. For general information on input materials, please check the CFFA Industry Average EPD of PVC roofing membrane, Section 4.2 [11].



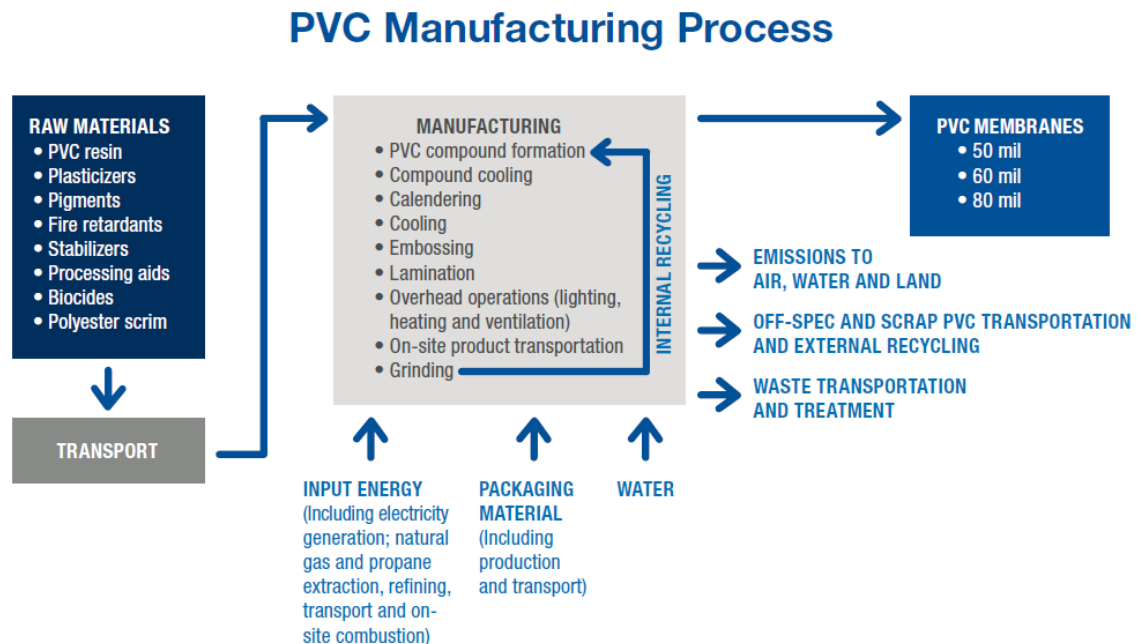
## 5 LIFE CYCLE STAGES

Figure 2 shows the life-cycle stages and information modules that are included within the cradle-to-gate LCA system boundary of this EPD [9].

Product stage			Construction process stage		Use stage							End-of-life stage			
Raw Material supply	Transport	Manufacturing	Transport	Construction-Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/Demolition	Transport	Waste processing	Disposal
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X			MND												
X- module is included in system boundary; MND- module is not declared (excluded from system boundary)															

**Figure 2 Life Cycle Stages and Modules**

The Product Stage system boundary is shown in Figure 3. All included and excluded product stage processes are listed in Table 4.



**Figure 3 Carlisle Sure-Flex PVC Membrane System Boundaries**



**Table 4: Product stage system boundaries –Included and excluded processes**

Product Stage	Included	Excluded
<b>A1-A3 Modules</b>	<ul style="list-style-type: none"> <li>• Extraction and processing of raw materials, including fuels used in product production;</li> <li>• Average and/or specific transportation of raw materials (including fuels and recycled materials) from the extraction site or source to manufacturing site (including any recovered materials from the source to be recycled in the process), inclusive of empty backhauls;</li> <li>• Manufacturing of the product; it includes the storage of raw materials, PVC compound formation &amp; cooling, calendaring &amp; cooling, embossing, lamination, overhead operations, on-site product transportation, and recycling (on-site)-grinding;</li> <li>• Packaging with product ready for shipment;</li> <li>• Average or specific transportation from manufacturing site to recycling/landfill for pre-consumer secondary material and waste from manufacturing, including empty backhauls; and</li> <li>• Recycling of pre-consumer secondary material from manufacturing.</li> </ul>	<p>The capital goods &amp; infrastructure, production equipment, delivery vehicles, lab equipment, personnel-related activities and energy &amp; water use related to company management and sales have been excluded from the scope of the study.</p>

## 6 CUT-OFF RULES, ALLOCATION RULES AND DATA QUALITY REQUIREMENTS

Cut-off Rules	Allocation Rules	Data Quality Requirements
<p>ASTM SPRM PCR: 2016, Section 7.2 cut-off rules were applied [1]. All input/output data reported by the Greenville, IL manufacturing plant were included in the LCI modelling. None of the reported flow data were excluded based on the cut-off criteria.</p>	<p>ASTM SPRM PCR: 2016, Section 5 allocation rules, based on the requirements and guidance of ISO 14044:2006, Clause 4.3.4, were followed [6]. Mass allocation was used to partition shared processes across all product thicknesses within the manufacturing facility. The inherent properties of the internal regrind PVC scrap do not change and is treated as closed-loop recycling. An ISO conforming “system expansion” method was used to account for the PVC scrap to external recycling [11].</p>	<p>ASTM SPRM PCR: 2016, sections 7.1 and 7.3 data quality requirements were met [1].</p> <p><b>Temporal scope:</b> Primary data collected from the Greenville, IL plant for its production activities (gate-to-gate manufacturing and product formulations) are representative for the year 2015 (12 months). Additional life cycle inventory data necessary to model and account for base and intermediate material flows as well as energy use, etc. were from US LCI database (update Sept 2015) or the ecoinvent v.2.2 database, SimaPro v8.1 2016. Both databases required adjustment to either fill known data gaps or reflect the United States system boundary.</p> <p><b>Geographic scope:</b> based on the United States system boundaries for all processes and product systems. The United States background data were the preferred source, but when not available European data (adjusted for the United States system boundary) were used.</p> <p><b>Technology scope:</b> Prevailing the up-to date technology as employed at the Carlisle’s Greenville, IL plant.</p>

## 7 LIFE CYCLE ASSESSMENT RESULTS

Table 5 details the “cradle-to-gate” LCA results for 1 m<sup>2</sup> of 50, 60 and 80 mils Carlisle Sure-Flex PVC Membrane on an absolute basis. As required in ASTM SPRM PCR: 2016, Section 8, the US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), version 2.1, 2012 impact categories are used as they provide a North American context for the mandatory category indicators to be included in this EPD. These are relative expressions only and do not predict category impact end-points, the exceeding of thresholds, safety margins or risks.

Total primary and sub-set energy consumption were compiled using a cumulative energy demand model. In accordance with the updated PCR [1], non-renewable energy flows used as feedstock energy which is defined as the portion of resource input that ends up in the polymer (e.g. plastics) rather than being used as a fuel, are accounted for, and reported under, the “non-renewable fossil” energy metric. Material resource consumption and generated waste reflect cumulative life cycle inventory flow information as generated. Material resource consumption and generated wastes also reflect cumulative life cycle inventory flow information.

**Table 5: EPD results for 1 m<sup>2</sup> manufactured of 50, 60 and 80 mils Carlisle Sure-Flex PVC Membrane - Product Stage (A1-A3), in absolute basis**

Category Indicator	Unit	PVC membrane- Product stage (A1-A3 modules)		
		50 mils	60 mils	80 mils
Global warming potential, GWP	kg CO <sub>2</sub> eq.	4.4	5.3	7.3
Acidification potential, AP	kg SO <sub>2</sub> eq.	0.034	0.041	0.056
Eutrophication potential, EP	kg N eq.	0.032	0.039	0.053
Smog creation potential, POCP	kg O <sub>3</sub> eq.	0.32	0.39	0.53
Ozone depletion potential, ODP	kg CFC-11 eq.	4.7E-07	5.7E-07	7.8E-07
<b>Total Primary Energy (TPE) consumption</b>				
Non-renewable fossil, PENR-fossil (including feedstock energy)	MJ	100.3	121.8	166.1
Non-renewable nuclear, PENR-nuclear	MJ	6.1	7.4	10.2
Renewable (solar, wind, hydroelectric, and geothermal), PER-HWSG	MJ	0.54	0.66	0.90
Renewable (biomass), PER-biomass	MJ	1.4	1.7	2.3
<b>Material resources consumption</b>				
Non-renewable materials, NRM	kg	0.71	0.87	1.18

Category Indicator	Unit	PVC membrane- Product stage (A1-A3 modules)		
		50 mils	60 mils	80 mils
Renewable materials, RM	kg	0.46	0.56	0.76
Fresh water, FW	l	9.1	11.2	15.2
<b>Waste generated</b>				
Hazardous waste, HW	kg	1.8E-04	2.2E-04	3.0E-04
Non-hazardous waste, NHW	kg	1.6E-03	2.0E-03	2.7E-03

## 8 INTERPRETATION

The above EPD results represent a “cradle-to-gate” EPD per 1 m<sup>2</sup> manufactured for each declared Carlisle’s PVC roofing membrane thickness as manufactured at the Greenville, IL plant for the reference year 2015.

For each of the declared PVC membrane thicknesses, A1 module: Raw Material Supply dominates the EPD results – ranging from 72% to 100% of the total effects. With the exception of the non-renewable nuclear, the A3 module: Manufacturing accounted for less than 12% of the overall impacts. The A2 module: Transport was generally found to be a minor contributor to the declared product impacts; however, it did account for about 20% of the smog creation potential.

Primary energy consumption is predominately fossil fuels at 93%, nuclear contributes 6% and biomass and renewable energy make up the remaining of 2%.

## 9 ADDITIONAL AND ENVIRONMENTAL INFORMATION

- Recycled content data

Pre-consumer Recycled Content [12]	5 %
Post-consumer Recycled Content [8]	0 %

- The Carlisle Sure-Flex PVC roof membranes meet the requirements of LEED®, Green Globes™ and exceed the cool roof requirements of ENERGYSTAR®, and California’s Building Energy Code (Title 24). The white, Carlisle Sure-Flex PVC roof membrane utilizes a highly reflective white surface that reduces cooling and overall energy consumption in climate conditioned buildings.

- Carlisle diverts all pre-consumer off-specs vinyl membrane from landfill, by recycling it back into their PVC roofing membrane products or shipping it to external PVC recyclers.
- Carlisle Sure-Flex PVC membrane surpasses the requirements and is certified with SECO, Intron and BBA with routine audits to maintain certification which validates plant processes and product characteristics.
- Carlisle PVC roof membranes help building owners achieve LEED and Green Globes certification.

## 10 DECLARATION TYPE

This “Cradle-to-gate” EPD applies to the Carlisle’s Sure-Flex PVC roofing membrane in white, gray, and tan in 50, 60, and 80 mils nominal thicknesses. Product activities covered include the raw material supply, transport and manufacturing (modules A1 to A3). The declaration is intended for Business-to-Business (B-to-B) communication.

## 11 PRODUCT SPECIFIC DECLARATION

The three declared thicknesses (50, 60 and 80 mils), Carlisle Sure-Flex PVC roofing membrane fall under the description:

- A specific product EPD, from a manufacturer’s plant.

## 12 EPD LIMITATIONS

- EPDs from different programs (using different PCR) may not be comparable.
- Declarations based on the ASTM SPRM PCR [1] are not comparative assertions; that is, no claim of environmental superiority may be inferred or implied.

## 13 EPD Explanatory Material

For any explanatory material, in regard to this EPD, please contact the program operator.

ASTM International  
Environmental Product Declarations  
100 Barr Harbor Drive,  
West Conshohocken,  
PA 19428-2959, <http://www.astm.org>

## 14 REFERENCES

1. ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Single Ply Roofing Membranes, Version 2, Issued: January 2016.
2. ASTM D4434, Standard Specification for Poly (Vinyl Chloride) Sheet Roofing.
3. Athena Sustainable Materials Institute, A Cradle-to-gate Life Cycle Assessment of Carlisle Sure-Flex™ Single-ply PVC and KEE HP Roofing Membrane in 50 mils, 60 mils and 80 mils finished nominal thicknesses, July 2016 [3].
4. ISO 21930: 2007 Building construction – Sustainability in building construction – Environmental declaration of building products.
5. ISO 14025: 2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.
6. ISO 14044: 2006 Environmental management - Life cycle assessment - Requirements and guidelines.
7. ISO 14040: 2006 Environmental management - Life cycle assessment - Principles and framework.
8. ISO 14021:1999 Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling).
9. EN 15804: 2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.
10. ASTM Program Operator for Product Category Rules (PCRs) and Environmental Product Declarations (EPDs), General Program Instructions, 12/5/2014.
11. Athena Sustainable Materials Institute, A Cradle-to-Building with EOL stage Life Cycle Assessment for Three Thicknesses of White, Single-Ply Polyester Reinforced PVC Roofing Membrane (40, 48 and 60 mils), Prepared for Chemical Fabrics and Film Association, Inc., March 2016.
12. ANSI NSF 347 Sustainability Assessment for Single Ply Roofing Membranes.