



Environmental Product Declaration

According to ISO 14025 and ISO 21930

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

Sponsored by the Carlisle SynTec Systems

Sure-Flex™ KEE HP Membrane






ASTM International Certified Environmental Product Declaration

This document is a Type III environmental product declaration for Carlisle’s Sure-Flex™ Single-ply KEE HP (Ketone Ethylene Ester High Performance) Roofing Membrane in 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 KEE HP roofing membranes in accordance with international standards.

Environmental Product Declaration Summary

General Information	
Owner of the EPD	 <p>Carlisle SynTec Systems Carlisle Construction Materials P.O. Box 7000 Carlisle, PA 17013 Link (URL): www.carlislesyntec.com</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>
Manufacturing Site	Greenville, IL 1825 East U.S. Route 40 Greenville, IL 62246
Product Group	Single Ply Roofing Membranes
Product Name	Carlisle’s Sure-Flex Single-ply KEE HP roofing membrane with a finished nominal thickness of 1.270 mm (50 mils), 1.524 mm (60 mils) and 2.032 (80 mils).



Product Definition	Single Ply Roofing Membranes are defined as thermoplastic or thermoset membranes of compounded synthetic materials manufactured in a factory for use in roofing [1].
Product Category Rule (PCR)	ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Single Ply Roofing Membranes, Version 2, Issued: January 2016 [1].
Certification Period	07.18.2016 – 07.18.2021
Declared Unit	1 m ² manufactured of Carlisle’s Sure-Flex Single-ply KEE HP Roofing Membrane
ASTM Declaration Number	EPD-037

EPD Information

Program Operator ASTM International



Declaration Holder Carlisle SynTec Systems

Product group	Date of Issue	Period of Validity	Declaration Number
Single Ply Roofing Membranes	07.18.2016	5 years	EPD-037

Declaration Type

This “Cradle-to-gate” EPD applies to the Carlisle’s Sure-Flex KEE HP 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.

Applicable Countries

United States and Canada

Product Applicability and Characteristics

Carlisle’s Sure-Flex KEE HP membrane is manufactured using DuPont® Elvaloy® KEE HP resin modifier. KEE HP enhances the performance of PVC compounds by providing outstanding thermal stability and flexibility while extending the low- and high-temperature performance limits of standard KEE. The addition of Elvaloy KEE HP, a non-volatile resin modifier, provides enhanced heat and chemical resistance. The physical properties of the membrane are enhanced by a polyester fabric that is encapsulated by thick KEE HP-based top and bottom plies. The smooth surface of the KEE HP membrane allows a total surface fusion weld over a wide temperature range, creating a consistent, watertight, one-piece roof assembly.

Content of the Declaration

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].


This EPD was independently verified by ASTM in accordance with ISO 14025:

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www.astm.org/EPDs.htm

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EPD Project Report Information	
EPD Project Report	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].
Prepared by 	Lindita Bushi Ph.D. and Jamie Meil Athena Sustainable Materials Institute 119 Ross Avenue, Suite 100 Ottawa, Ontario, K1Y 0N6, Canada info@athenasmi.org
This EPD project report was independently verified by in accordance with ISO 14025 and the reference PCR:	Thomas P. Gloria, Ph.D. Industrial Ecology Consultants 35 Bracebridge Rd. Newton, MA 02459-1728 direct: 617.553.4929 mobile: 857.636.0585 email: t.gloria@industrial-ecology.com
PCR Information	
Program Operator	ASTM International
Reference PCR	ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Single Ply Roofing Membranes
Date of Issue	Version 2, Issued: January 2016
PCR review was conducted by:	François Charron Doucet Groupe AGÉCO francois.charron@groupeageco.ca

1 PRODUCT IDENTIFICATION

1.1 PRODUCT DEFINITION

This EPD applies to the Carlisle's Sure-Flex Single-ply KEE HP 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 KEE HP membrane is manufactured using DuPont® Elvaloy® KEE HP resin modifier. KEE HP enhances the performance of PVC compounds by providing outstanding thermal stability and flexibility while extending the low- and high-temperature performance limits of standard KEE. The addition of Elvaloy KEE HP, a non-volatile resin modifier, provides enhanced heat and chemical resistance. The physical properties of the membrane are enhanced by a polyester fabric that is encapsulated by thick KEE HP-based top and bottom plies. The smooth surface of the KEE HP membrane allows a total surface fusion weld over a wide temperature range, creating a consistent, watertight, one-piece roof assembly.

Carlisle's Sure-Flex KEE HP feature ENERGY STAR® qualification, contribute to LEED® credit requirements and is Cool Roof Rating Council (CRRCC)-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 KEE HP Roofing Membrane



1.2 PRODUCT STANDARDS

The Carlisle Sure-Flex Single-ply KEE HP 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 50, 60 and 80 mils, Carlisle Sure-Flex Single-ply KEE HP Roofing Membrane thicknesses. KEE HP meets or exceeds the requirements of ASTM D4434 Standard Specification for Poly(Vinyl Chloride) Sheet Roofing. KEE HP 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
Tolerance on nominal thickness, % ASTM D751 test method	+10, -10	±10	±10	±10
Thickness over scrim, in. (mm) ASTM D4434 optical method average of 3 areas	0.016 min (0.40)	0.024 (0.61)	0.029 (0.74)	0.036 (0.91)
Weight, lbs/ft2 (kg/m²)	No requirement	0.33 (1.61)	0.38 (1.86)	0.51 (2.49)
Breaking strength (MD x CD), lbf/in (kN/m) ASTM D751 grab method	275 min (48)	290 x 290 (51 x 51)	320 x 300 (56 x 52)	330 x 320 (58 x 56)
Elongation break of reinforcement (MDx CD), % ASTM D751 grab method	25 min	30 x 30	30 x 30	30 x 30
Tearing strength (MD x CD), lbf (N) ASTM D751 proc. B, 8 in. x 8 in.	90 min (400)	120 x 125 (534 x 556)	120 x 125 (534 x 556)	140 x 150 (623 x 667)
Low temperature bend, ASTM D2135, no cracks 5x at -40°C	PASS	PASS (-46°C)	PASS (-46°C)	PASS (-46°C)

Technical data ^{*)}	ASTM D4434 Requirement	Value /Test Results		
		50 mils	60 mils	80 mils
Linear dimensional change , % ASTM D1204, 6 hours at 176°F	±0.5 max	0.4 typ.	0.4 typ.	0.4 typ.
Ozone resistance , no cracks 7x ASTM D1149, 100pphm, 168 hrs	PASS	PASS	PASS	PASS
Water absorption resistance , mass % ASTM D570, 166 hours at 158°F water	±3.0 max	1.25	0.87	0.89
Puncture resistance – Dynamic, J (ft-lbf) ASTM D5635	20 (14.7)	PASS	PASS	320
Puncture resistance – Static, lbf (N) ASTM D5602	33 (145)	PASS	PASS	PASS
Xenon-Arc resistance , no cracks/crazing 10x, ASTM G155 0.35 W/m ² at 340-nm, 63°C B.P.T. 12,600 kJ/m ²	PASS	PASS	PASS	PASS
Properties after heat aging , 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
Solar Reflectance Index (SRI)	No requirement	White: 108		

^{*)} Further testing information and results can be found in the Carlisle SynTec Systems's website at www.carlisesyntec.com.

1.4 PACKAGING

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

Table 2. Packaging materials for 1m² of 50, 60 and 80 mils Carlisle Sure-Flex KEE HP Membrane

Packaging material	Quantity
Cardboard core [kg]	0.111
PE Stretch film [kg]	0.002
Wooden pallet [kg]	0.078
Total [kg/m²]	0.191



2 PRODUCT APPLICATION AND INSTALATION

The three declared Carlisle Sure-Flex KEE HP 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 m² manufactured of Carlisle Sure-Flex Single-ply KEE HP Roofing Membrane, with a finished nominal thickness of 50, 60 and 80 mils.

4 MATERIAL CONTENT DECLARATION

The material average percentage by weight for 1m² for the Carlisle Sure-Flex KEE HP 50, 60 and 80 mils is provided in Table 3.

Table 3. The material average percentage by weight for 1 m² of 50, 60 and 80 mils Carlisle Sure-Flex KEE HP Membrane

Raw material input ^{*)}	Total weight by [%]
PVC Resin	48
Plasticizer	29
Pigment	4
Fire retardant	8
Stabilizer	5
Processing aids, oils and lubricants	0.1
Biocide	0.1
Adhesives	0
Polyester fabric (scrim reinforcement)	6
Total weight (Input)	100

^{*)} 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.

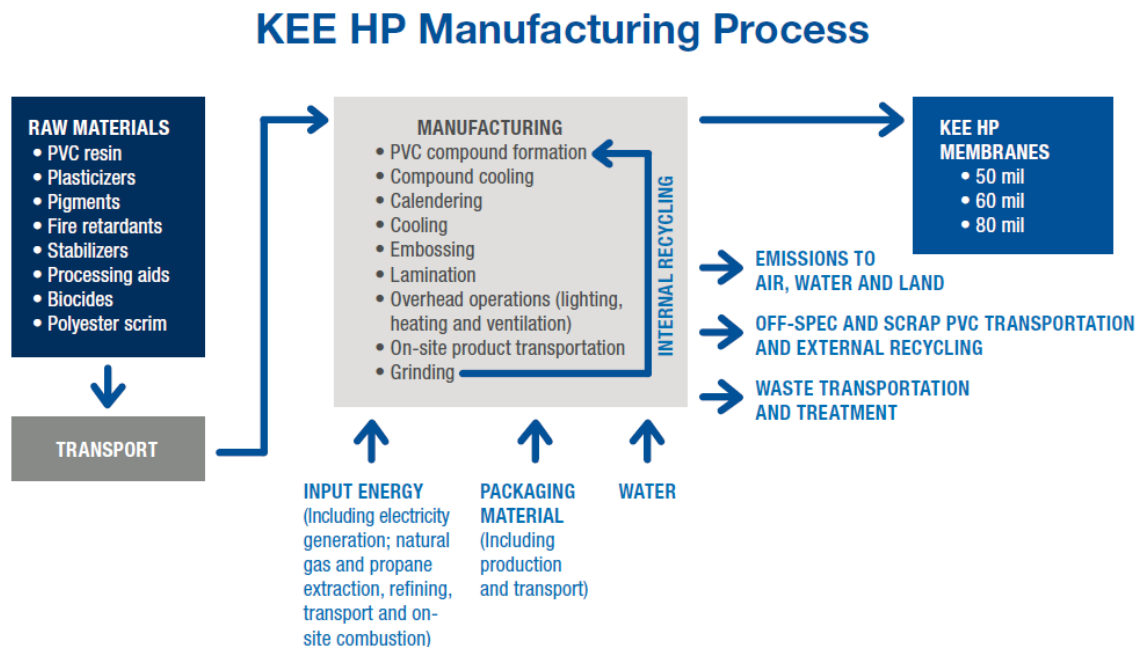


Figure 3 Carlisle Sure-Flex KEE HP Membrane System Boundaries



Table 4: Product Stage system boundaries- –Included and excluded processes

Product Stage	Included	Excluded
A1-A3 Modules	<ul style="list-style-type: none"> • Extraction and processing of raw materials, including fuels used in product production; • 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; • Manufacturing of the product; it includes the storage of raw materials, PVC compound formation & cooling, calendaring & cooling, embossing, lamination, overhead operations, on-site product transportation, and recycling (on-site)-grinding; • Packaging with product ready for shipment; • Average or specific transportation from manufacturing site to recycling/landfill for pre-consumer secondary material and waste from manufacturing, including empty backhauls; and • Recycling of pre-consumer secondary material from manufacturing. 	<p>The capital goods & infrastructure, production equipment, delivery vehicles, lab equipment, personnel-related activities and energy & 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>Temporal scope: 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>Geographic scope: 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>Technology scope: 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 m² of 50, 60 and 80 mils Carlisle Sure-Flex KEE HP 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 counted and reported under the “non-renewable fossil” energy. Material resource consumption and generated waste reflect cumulative life cycle inventory flow information as generated with the SimaPro v 8.1, 2016. Material resource consumption and generated waste reflect cumulative life cycle inventory flow information.

Table 5: EPD results for 1 m² manufactured of 50, 60 and 80 mils Carlisle Sure-Flex KEE HP Membrane - Product Stage (A1-A3), in absolute basis

Category Indicator	Unit	KEE HP membrane- Product stage (A1-A3 modules)		
		50 mils	60 mils	80 mils
Global warming potential, GWP	kg CO ₂ eq.	4.8	5.6	7.4
Acidification potential, AP	kg SO ₂ eq.	0.038	0.044	0.059
Eutrophication potential, EP	kg N eq.	0.035	0.041	0.055
Smog creation potential, POCP	kg O ₃ eq.	0.34	0.39	0.52
Ozone depletion potential, ODP	kg CFC-11 eq.	4.3E-07	5.0E-07	6.6E-07
Total Primary Energy consumption				
Non-renewable fossil, PENR-fossil (including feedstock energy)	MJ	110.4	128.3	169.9
Non-renewable nuclear, PENR-nuclear	MJ	6.4	7.5	9.9
Renewable (solar, wind, hydroelectric, and geothermal), PER-HWSG	MJ	0.57	0.67	0.89
Renewable (biomass), PER-biomass	MJ	2.6	3.1	4.1
Material resources consumption				
Non-renewable materials, NRM	kg	0.72	0.83	1.10

Category Indicator	Unit	KEE HP membrane- Product stage (A1-A3 modules)		
		50 mils	60 mils	80 mils
Renewable materials, RM	kg	0.57	0.67	0.90
Fresh water, FW	l	9.6	11.5	15.4
Waste generated				
Hazardous waste, HW	kg	1.8E-04	2.1E-04	2.8E-04
Non-hazardous waste, NHW	kg	1.6E-03	1.9E-03	2.5E-03

8 INTERPRETATION

The above EPD results represent a “cradle-to-gate” EPD per 1 m² manufactured for each declared Carlisle’s KEE HP roofing membrane thickness as manufactured at the Greenville, IL plant for the reference year 2015.

For each of the declared KEE HP membrane thicknesses, A1 module: Raw Material Supply dominates the EPD results – ranging from 71% to 100% of the total effects.

With the exception of the non-renewable nuclear, the A3 module: Manufacturing accounted for less than 11% 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 around 20% of the smog creation potential.

Primary energy consumption is predominately fossil fuels at 92%, nuclear contributes 5% and biomass and renewable energy make up the remaining of 3%.

9 ADDITIONAL AND ENVIRONMENTAL INFORMATION

- The Carlisle Sure-Flex KEE HP roof membranes meet the requirements of LEED®, Green Globes™ and exceed the exceed the cool roof requirements of ENERGYSTAR®, and California’s Building Energy Code (Title 24). The white, Carlisle Sure-Flex KEE HP 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 KEE HP 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 KEE HP 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 KEE HP 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 use in Business-to-Business (B-to-B) communication.

11 PRODUCT SPECIFIC DECLARATION

The three declared thicknesses (50, 60 and 80 mils), Carlisle Sure-Flex™ KEE HP 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,
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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.
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.