An Environmental Product Declaration

According to ISO 14025:2006 and ISO 21930:2017

A Cradle-to-Grave EPD for Flex Roofing Systems

PVC Single-Ply Roofing Membrane

ASTM International Certified Environmental Product Declaration

This document is a Type III environmental product declaration (EPD) for Flex Roofing Systems PVC polyester reinforced single-ply roofing membranes in 50, 60, and 80 mil nominal thicknesses with and without fleece backing (1), as manufactured at the company's Hillside, NJ facility for the reference year 2023.

This declaration has been prepared in accordance with ISO 14025 (2), ISO 21930 (3), ISO 14040/44 (4), (5), the NSF International Product Category Rules for Single-Ply Roofing Membranes (6) and ASTM General Program Instructions for Type III EPD (7).

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 the potential impacts of Flex Roofing Systems PVC roofing membranes in accordance with international standards.

Environmental Product Declaration Summary

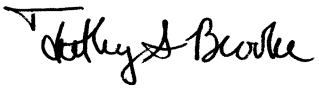
General Information	
Owner of the EPD	**Flex Membrane International Corp. (Flex Roofing Systems)** 5103A Pottsville Pike Reading, PA 19605 USA https://flexroofingsystems.com/ Established in 1990, Flex Roofing Systems (Flex Membrane International Corp.) pioneered the manufacturing of modified PVC single ply roofing membranes incorporating DuPont™ Elvaloy® KEE, a unique plasticizer that keeps the material indefinitely flexible, while making it highly resistant to environmental and temperature extremes and exposure to a wide range of chemicals and pollutants. When it comes to thermoplastic single ply membrane roofing systems, Flex is the expert of choice for architects, contractors and specifiers who won't settle for anything but the highest industry standards. *The owner of the declaration is liable for the underlying information and evidence.*
Manufacturing Sites	1227 Central Avenue, Hillside, NJ 07205 USA
Product Group	Single-Ply Roofing Membranes

Product Name	Flex Roofing Systems roofing membrane with a finished nominal thickness of 50 mil, 60 mil, and 80 mil with and without fleece backing. The following products are included: • MF/R 50 mil PVC • MF/R 60 mil PVC • MF/R 80 mil PVC • FB 50 mil PVC (Fleece backed) • FB 60 mil PVC (Fleece backed) • FB 80 mil PVC (Fleece backed)
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.
Product Category Rule (PCR)	NSF International, Product Category Rule for Environmental Product Declarations for Single Ply Roofing Membranes, October 2019 (6). ISO 21930:2017 serves as the core PCR (3).
Certification Period	March 14th, 2025 – 5-year validity
Declared Unit	1,000 m^2 of installed roofing membrane, with a finished nominal thickness of 50, 60, or 80 mils with and without fleece backing and a reference service life (RSL) of 30 years over a building estimated service life of 75 years.
ASTM Declaration Number	EPD 947
EPD Information	
Program Operator	ASTM International 100 Barr Harbor Drive, PO Box C700 West Conshohocken, PA 19428-2959, USA https://www.astm.org/products-services/certification/environmental-product-declarations/epd-pcr.html

Declaration Type

This product and manufacturer specific “Cradle-to-grave” EPD applies to Flex Roofing Systems’ PVC single-ply roofing membrane (all colors) in 50, 60, and 80 mil nominal thicknesses with and without fleece backing. The life cycle stages covered are the production, construction, use, and end-of-life stages, including the optional module D. The declaration is intended for Business-to-Business (B-to-B) and Business-to-Consumer (B-to-C) communication.

Applicable Countries	North America
Product Applicability	Flex Roofing Systems single-ply roof membranes are designed for low-slope roofing applications.

This EPD was independently verified by ASTM in accordance with ISO 14025:		 Tim Brooke 100 Barr Harbor Drive, PO Box C700 West Conshohocken, PA 19428-2959, USA https://www.astm.org/
Internal	**External**	
	X	
EPD Project Report Information		
EPD Project Report		A Cradle-to-grave Life Cycle Assessment of Flex Roofing Systems' Elvaloy KEE and PVC Single-Ply Roofing Membranes, February 2025 (8).
Prepared by Athena Sustainable Materials Institute		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 and in accordance with ISO 14025 and the reference PCR:		Thomas P. Gloria, Ph.D. Industrial Ecology Consultants 35 Bracebridge Rd. Newton, MA 02459-1728
PCR Information		
Program Operator		NSF International
Reference PCR		NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Single Ply Roofing Membranes (6).
Date of Issue		October 2019
PCR review was conducted by:		Thomas P. Gloria, PhD (Chair), Industrial Ecology Consultants t.gloria@industrial-ecology.com Mr. Jack Geibig, EcoForm Mr. Bill Stough, Sustainable Research Group
EPD Explanatory material		Please contact the program operator for any explanatory material regarding this EPD. ASTM International Environmental Product Declarations 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 USA http://www.astm.org

1 PRODUCT IDENTIFICATION

1.1 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 (6). This EPD applies to Flex Roofing Systems' PVC single-ply roofing membranes (all colors), with a finished nominal thickness of 50, 60 and 80 mils with and without fleece backing, as produced at its manufacturing facility in Hillside, NJ.

Flex Roofing Systems' PVC roofing membrane contributes to LEED® credit requirements and is Cool Roof Rating Council-rated and Title 24 compliant. The PVC product line offers a membrane for virtually any low-slope roofing specification. The membranes weld quickly, cleanly, and consistently. Flex Roofing Systems' roofing membranes can be installed as a mechanically fastened or adhered roofing system.

Table 1 summarizes key technical data for Flex Roofing Systems' PVC roofing membrane by thickness. Flex Roofing Systems' membranes meet or exceed the requirements of ASTM D4434, Standard Specification for Poly(Vinyl Chloride) Based Sheet Roofing (1). Further testing information and results can be found on the Flex Roofing Systems website (9).

Table 1: Key technical data of declared thicknesses (9)

Single-ply roofing membranes	Technical data	Units	Values		
MF/R PVC Roofing Membrane	Finished nominal thickness	mil	50	60	80
		mm	1.3	1.5	2.0
	Finished density	kg/m^2	1.66	1.95	2.53
FB PVC Roofing Membrane (fleece backed)	Finished nominal thickness	mil	50	60	80
		mm	1.3	1.5	2.0
	Finished density	kg/m^2	1.84	2.13	2.71

1.2 PRODUCT STANDARDS

Flex Membrane's roofing membranes meet the following standards and codes:

- ASTM D4434 Standard Specification for Poly (vinyl chloride) based sheet roofing (1)
- FM Approvals
- Miami-Date County Approval
- Texas Department of Insurance
- Underwriters Laboratory Inc.

2 FUNCTIONAL UNIT

The functional unit is defined as 1,000 m^2 of installed roofing membrane, with a finished nominal thickness of 50, 60, or 80 mils with and without fleece backing, and a reference service life (RSL) of 30 years over a building estimated service life of 75 years.

3 MATERIAL CONTENT

The average material composition by input material (in %) for Flex Roofing Systems' PVC roofing membranes is provided in Table 2.

Table 2: Average material content for Flex Roofing Systems' PVC roofing membrane

Material input	**Material Content (in %)**	
	Non-fleece (bareback)	Fleece backed
PVC Resin	51.1%	46.7%
Processing aids	24.9%	22.8%
Pigments	7.2%	6.6%
Fillers	7.2%	6.6%
Polyester reinforcement	4.1%	3.8%
Fleece backing	0.0%	8.4%
Others	5.5%	4.9%
Total weight (Input)	**100%**	**100%**

4 LIFE CYCLE STAGES

Figure 1 shows the life-cycle stages and information modules that are included within the cradle-to-grave LCA system boundary of this EPD. The boundary is “cradle-to-grave”, which consists of the Production stage (A1 to A3 modules), Construction stage (A4 to A5 modules), Use stage (B1 to B7 modules), and End-of-Life stage (C1 to C4 modules). Optional supplementary information beyond the system boundary Module D is also included.

Per ISO 21930, 7.1.7. 1 (3), the information modules A1, A2 and A3 are based on the actual and representative data of the production process of the product. However, as soon as a construction product leaves the factory gate, the assessment shall be based on scenarios and assumptions. The scenarios and assumptions considered depend upon various details, including location, type of transport, method of installation and construction, type of construction works, use, maintenance and repair, end-of-life treatment, and waste handling.

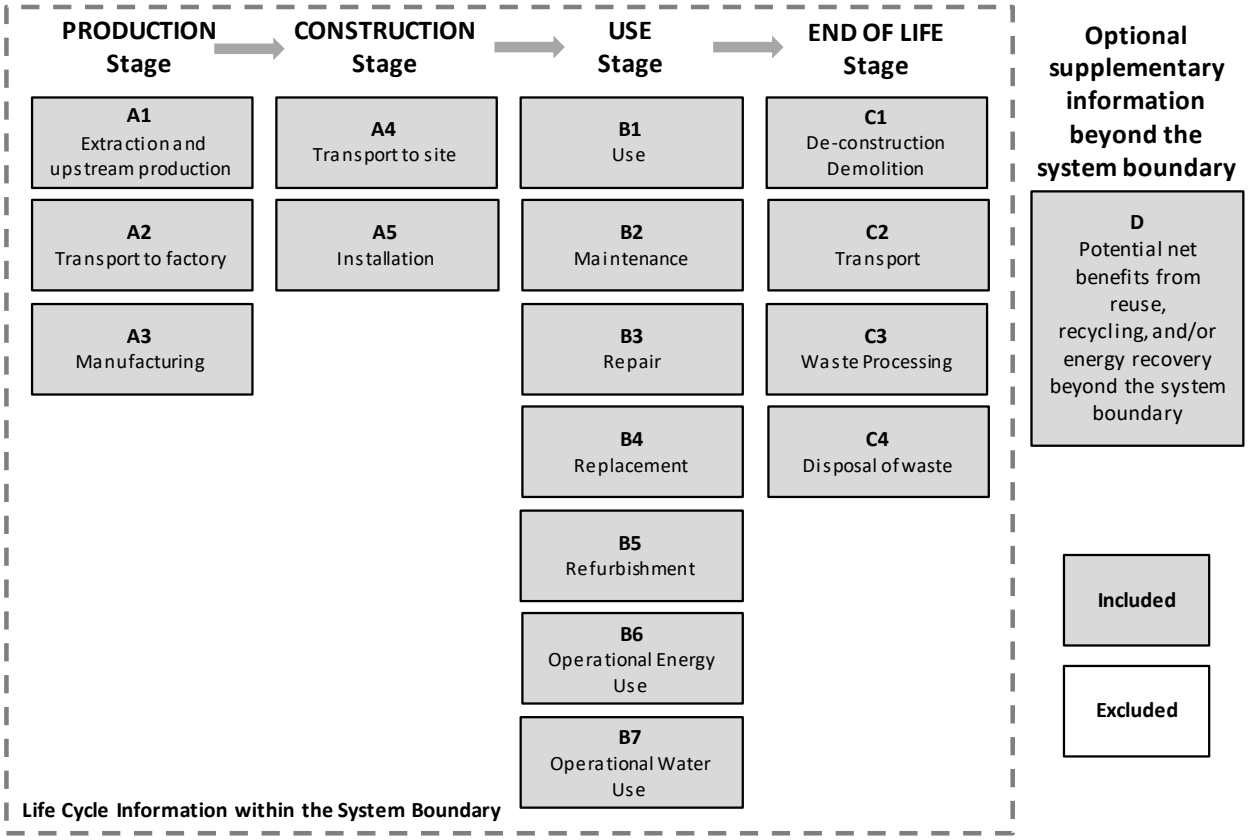


Figure 1 Life Cycle Stages and Modules

The *Production stage* includes the following three information modules A1 to A3: A1, extraction and upstream production; A2, transport to factory; and A3, manufacturing.

The *Construction stage* includes the following two information modules A4 to A5: A4, transport to the site (Table 3); A5, installation (Tables 4 and 5).

For the mechanical fastened installation system, the PVC roofing membranes are rolled out on a suitable substrate (clean, even, solid, on insulation or cover board as required), aligned and fastened with approved fastening systems to the supporting structure according to the manufacturer's specification.

Usually, the fastening is carried out along the membrane overlap (seam area). After installation of the fasteners, seam overlaps are welded for waterproofing. Fasteners may also be placed in the field of the membrane. With mechanical fastening of the roofing membranes, the complete roof build‐up (including thermal insulation, vapor control layer, etc.) is secured to the underlying structure.

The *Use stage* includes the following information modules B1 to B7: B1, use; B2, Maintenance; B3, Repair; B4, Replacement (Table 6); B5, Refurbishment; B6, Operational energy use; and B7, Operational water use. No emissions to air (B1) are released during the use phase of the declared products. No energy (B6) or water use (B7) is required during the service life of the declared products. The burden of use (B1), maintenance (B2), repair (B3), refurbishment (B5), or operational energy use (B6) and water use (B7) modules is assumed null for this EPD. Based on the replacement cycle, replacement module (B4) is calculated by scaling up A1 to A5 and C1 to C4 results to fulfill the building ESL of 75 years.

The *End-of-Life Stage* includes the following information modules (Table 7): C1, Deconstruction/ Demolition; C2, Transport to waste processing and/or disposal; C3, Waste processing of flows resulting in secondary material (post-consumer), materials for reuse (not applicable), or secondary fuels (not applicable); and C4, Disposal of waste.

Optional supplementary module D provides information about the potential net benefits from post-consumer roof recycling beyond the system boundary of the studied PVC roofing membrane system.

The LCA results associated with module D are reported separately. The net output flow for all PVC roofing membranes for secondary material leaving a product system is calculated by adding all output flows of the secondary material and subtracting any input flows of this secondary material from each information module (A1 to A5, and C1 to C4) thus arriving at the net output flow of secondary material from the PVC roofing membrane system (Table 8).

Table 3: A4 Module, Product transport to the building site for Flex Roofing Systems' PVC roofing membrane (50, 60, and 80 mils)

Transport to site (A4)	Units	One-way distance	Comments
Combination truck, diesel, long haul >200 mi	km	947[1)]	Manufacturing site to local distributor
Rail, diesel	km	47[1)]	
Combination truck, diesel, short haul <200 mi	km	25[1)]	Local distributor to building site

Note:

[1)] *Assumed the same as CFFA Industry Average EPD 126, 2020* (10).

Table 4: A5 Module, Installation systems for Flex Roofing Systems' PVC roofing membrane (50, 60, and 80 mils)

Declared membranes	Installation	Seam welding
50 mils	Mechanically fastened	Hot-air welding
60 mils		
80 mils		

Table 5: A5 Module, Installation scenario data for 1,000 m² of installed Flex Roofing Systems' PVC roofing membrane (50, 60, and 80 mils)

Installation (A5) [1)]	Units	Quantity
Fasteners (5" type screws and seam plates)[2)]	kg	111
Electricity for seam welding	kWh	21
Electricity for securing the screws	kWh	15
Seam area	m^2	50
Material loss	m^2	10
Waste transport to landfill (including packaging waste)	km	32

Notes:

[1)] Assumed the same as CFFA Industry Average EPD 126, 2020 (10).

[2)] Each fastener is typically used to hold down 7.5 sq. ft. (0.7 m^2) of PVC roofing membrane, so a fastener usage of 1.5 fasteners per m^2 (=10.76/7.5) is used in the LCA. There are 14 screws per pound (5" type). There are 11 seam plates per pound.

Table 6: B4 Module, Replacement scenario data for 1,000 m² of installed Flex Roofing Systems' PVC roofing membrane (50, 60, and 80 mils)

Replacement (B4)	Value	Unit
Product Reference Service Life (RSL)	30	years
Building Estimated Service Life (ESL)	75	years
Replacement cycle-ESL	1.5[1)]	(ESL/RSL)-1

Note:

[1)] The replacement cycle is rounded to the nearest tenth, as specified in the NSF PCR (6).

Table 7: C1 to C4 Modules, EOL scenario data for 1,000 m² of installed Flex Roofing Systems' PVC roofing membrane (50, 60, and 80 mils)

End-of-life Stage	Flow	Units	Quantity
C1[1)]	Electricity	kWh	2.4
	Diesel	MJ	421
C2[1)]	Discarded PVC membrane[1)]	mi/km	20/32
C3[1)]	Secondary material[2)]	%	10
C4[1)]	Disposal of waste	%	90

Notes:

[1)] C1 to C4 Assumed the same as CFFA Industry Average EPD 126, 2020 (10).

[2)] Secondary material is either recycled back after processing (e.g. pelletization, grinding etc.) to the PVC roofing system or other PVC products (commercial PVC flooring, PVC expansion joint material for the concrete industry).

Table 8: Optional Module D, Supplementary data for 1,000 m² of installed Flex Roofing Systems' PVC roofing membrane (50, 60, and 80 mils)

Membrane thickness	Net output flow	Units	Quantity
No fleece backing			
50 mils	Secondary material	kg	640.70
60 mils		kg	753.87
80 mils		kg	978.71
Fleece backed			
50 mils	Secondary material	kg	712.52
60 mils		kg	825.67
80 mils		kg	1050.51

Note:

[1)] Secondary post-consumer PVC pellets are assumed to be functionally equivalent to primary PVC resin.

5 LIFE CYCLE INVENTORY

5.1 DATA COLLECTION, SOURCES, AND CALCULATIONS

LCI data collection was based on a customized LCI survey. The LCI survey covered the primary data for the 2023 reference year (12 consecutive months). Data calculation procedures follow ISO 14044 (5), and NSF PCR for Single Ply Roofing Membranes (6). Per ISO 21930, 7.2.2 (3), when transforming the inputs and outputs of combustible material into inputs and outputs of energy, the net calorific value (lower heating value) of fuels is applied according to scientifically based and accepted values specific to the combustible material.

5.2 DATA QUALITY REQUIREMENTS AND ASSESSMENTS

The LCA project report provides a detailed description of the collected data and the data quality assessment regarding the NSF PCR requirements (6) and ISO 14044 (5). Data quality is assessed based on its representativeness (technology coverage, geographic coverage, time coverage), completeness, consistency, reproducibility, transparency, and uncertainty (Table 9).

Table 9: Data Quality Requirements and Assessments

Data Quality Requirements	Description
Technology Coverage	Data represents the prevailing technology at Flex Roofing Systems' plant in Hillside, NJ. Whenever available, North American typical or average industry LCI datasets were utilized for all upstream and core materials and processes. *Technological representativeness is characterized as "high".*
Geographic Coverage	The geographic region considered is the U.S. *Geographical representativeness is characterized as "high".*
Time Coverage	Activity data are representative. • Roofing membrane manufacturing process - primary data collected for reference year 2023 (12 months); • In-bound/ out-bound transportation data- primary data collected for reference year 2023 (12 months); • Generic data: the most appropriate LCI datasets were used as found in the US LCI Database, ecoinvent v.3.9.1 database for US and Global, 2023. *Temporal representativeness is characterized as "medium" to "high".*
Completeness	All relevant, specific processes were considered and modelled, including inputs (raw materials, energy, and ancillary materials) and outputs (emissions and production volume). The relevant background materials and processes were taken from the US LCI Database (adjusted for known data placeholders), ecoinvent v 3.9.1 LCI database for US, and modeled in SimaPro software v.9.5, 2024 (11). The completeness of the cradle-to-grave process chain in terms of process steps is rigorously assessed for all membranes and documented in the project report.

Data Quality Requirements	Description
Consistency	To ensure consistency, the input/output LCI modelling of the single-ply roofing membranes used the same LCI modelling structure, which consisted of input raw, secondary, ancillary, and packaging materials, intermediate products, energy flows, water resource inputs, product outputs, co-products, by-products, emissions to air, water and soil, and solid and liquid waste disposal. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the facility level and selected process levels to maintain high consistency.
Reproducibility	Internal reproducibility is possible since the data and the models are stored and available in the *Athena Flex LCI database* developed in SimaPro v.9.5, 2025 (11). A high level of transparency is provided throughout the critically reviewed LCA project report as the LCI profile is presented for each declared product and major upstream inputs. The supporting LCA project report summarizes key primary (manufacturer-specific) and secondary (generic) LCI data sources.
Transparency	Activity and LCI datasets, including data sources, are transparently disclosed in the project report.
Uncertainty	A *sensitivity check* was conducted to assess the reliability of the EPD results and conclusions by determining how they are affected by uncertainties in the data or assumptions on the calculation of LCIA and energy indicator results. The LCA background report includes the results of a *sensitivity analysis* and *Monte Carlo uncertainty analysis of background data sets.*

5.3 ALLOCATION RULES

The Flex Roofing Systems manufacturing facility produces high-performance fabrics for other uses besides the roofing membranes of interest, and as per the PCR, allocation based on the mass of membrane products produced was necessary. “Mass” based, plant-specific formulations for 1,000 m^2 of single-ply roofing membranes were used to calculate the input raw ancillary materials consumed. “Mass” was used as the physical parameter for allocating flows between the products of interest and other co-products to calculate the input energy flows (electricity, natural gas, propane, etc.), shipping and packaging materials, lubricants, hydraulic fluid, greases, and heating oil, total water consumption, process emissions to air and waste flows. No burden is allocated to the by-product of the declared product system, such as off-spec roofing membranes. In addition, allocation related to transport is based on the mass of transported inputs and outputs.

5.4 CUT OFF RULES

The cut-off criteria were followed as per NSF PCR, Section 7.1.6 (6) and ISO 21930, 7.1.8 (3). All input/output data reported by the Hillside, NJ manufacturing plant was included in the LCI modelling. None of the reported flow data were excluded based on the cut-off criteria. No substances with hazardous and toxic properties that concern human health and/or the environment were identified in the framework of this EPD. Any plant-specific data gaps for the reference year (e.g., input hydraulic fluids, lubricants, greases, or heated oil) were filled in with industry average data from 2020. Any data gaps in the material input data are filled in with proxy and conservative generic LCI datasets, as appropriate.

This EPD excludes the following processes and activities:

- Capital goods and infrastructure, and
- Personnel-related activity (travel, furniture, office operations and supplies).

6 LIFE CYCLE ASSESSMENT RESULTS

Tables 10 to 15 present the "cradle-to-grave" LCA results for 1,000 m^2 of installed PVC roofing membrane (50, 60, and 80 mils with and without fleece backing). As per the NSF PCR, the US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), version 2.1, 2012 (12) 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 endpoints, the exceeding of thresholds, safety margins or risks* (4) (5). Additional mandatory resource use, waste categories and output flows are also reported per the PCR. [7] "Emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in these categories: RPR_E, RPR_M, $NRPR_E$, $NRPR_M$, SM, RSF, NRSF, RE, HWD, NHWD, HLRW, ILLRW, CRU, MR, MER, EE" (6). Note that the environmental burden of modules B1, B2, B3, B5, B6, and B7 is null.

Table 10 EPD Results (A1-D) – 1,000 m² of Flex MF/R 50 mil PVC Roofing Membrane

Impact category and inventory indicators	Unit	A1 to A3	A4	A5	B4	C1	C2	C3	C4	D
GWP 100[1)]	kg CO_2 eq	4794	173	542	8466	40.3	6.62	1.23	87	-1058
ODP[1)]	kg CFC-11 eq	4.38E-04	7.24E-09	3.31E-05	7.08E-04	6.63E-07	2.78E-10	1.43E-08	9.87E-08	-8.98E-05
SFP[1)]	kg O_3 eq	271	59	33.2	567	11.6	1.96	0.11	1.69	-18.3
AP[1)]	kg SO_2 eq	29.9	2.27	2.68	53	0.35	0.077	0.004	0.25	-3.13
EP[1)]	kg N eq	23.3	0.14	2.52	55	0.032	0.005	0.005	10.4	-0.76
FFD[1)]	MJ surplus, LHV	10042	363	743	16884	80	14.0	1.74	11.7	-4120
ADPf[2)]	MJ, LHV	72737	2455	6788	124041	528	94	15.2	77	-27820
RPRE	MJ, LHV	23243	0	1494	37126	3.10	0	2.10	7.93	-429
RPRM[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	43475	2483	5288	77972	536	95	21.1	83	-29243
NRPRM[3)]	MJ, LHV	40221	0	2413	63951	0	0	0	0	0
SM[3)]	kg	-	-	-	-	-	-	-	-	-
RSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
RE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
FW[3)]	m^3	3.66E-03	0	2.20E-04	5.83E-03	0	0	0	0	0
HWD[3)]	kg	-	-	-	-	-	-	-	-	-
NHWD[3)]	kg	65	0	3.92	2065	0	0	0	1308	0
HLRW[3)4)]	m^3	5.43E-06	0	4.92E-07	8.90E-06	5.43E-09	0	3.53E-09	3.57E-09	-8.11E-07
ILLRW[3)4)]	m^3	4.42E-05	0	3.79E-06	7.21E-05	3.83E-08	0	2.74E-08	3.17E-08	-6.30E-06
CRU[3)]	kg	-	-	-	-	-	-	-	-	-
MR[3)]	kg	49.7	0	2.98	920	0	0	560	0	0
MER[3)]	kg	65	0	3.90	103	0	0	0	0	0
EE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
$GWP_{bio-pkg}$[3)]	kg CO_2	-68	0	68	0	0	0	0	0	0

Table 11 EPD Results (A1-D) – 1,000 m² of Flex MF/R 60 mil PVC Roofing Membrane

Impact category and inventory indicators	Unit	A1 to A3	A4	A5	B4	C1	C2	C3	C4	D
GWP 100[1)]	kg CO_2 eq	5500	203	586	9661	40.3	7.79	1.45	103	-1245
ODP[1)]	kg CFC-11 eq	5.18E-04	8.49E-09	3.80E-05	8.36E-04	6.62E-07	3.27E-10	1.68E-08	1.16E-07	-1.06E-04
SFP[1)]	kg O_3 eq	316	69	36.6	657	11.6	2.31	0.12	1.99	-21.6
AP[1)]	kg SO_2 eq	35.8	2.66	3.06	63	0.35	0.091	0.005	0.30	-3.69
EP[1)]	kg N eq	26.8	0.16	2.75	63	0.032	0.005	0.005	12.2	-0.90
FFD[1)]	MJ surplus, LHV	11698	426	847	19625	80	16.4	2.05	13.8	-4848
ADPf[2)]	MJ, LHV	84455	2880	7517	143398	528	111	17.9	90	-32734
RPRE	MJ, LHV	25425	0	1625	40598	3.12	0	2.47	9.33	-505
RPRM[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	49927	2912	5701	88969	536	112	24.8	98	-34409
NRPRM[3)]	MJ, LHV	46506	0	2790	73945	0	0	0	0	0
SM[3)]	kg	-	-	-	-	-	-	-	-	-
RSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
RE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
FW[3)]	m^3	4.31E-03	0	2.59E-04	6.86E-03	0	0	0	0	0
HWD[3)]	kg	-	-	-	-	-	-	-	-	-
NHWD[3)]	kg	77	0	4.60	2430	0	0	0	1539	0
HLRW[3)4)]	m^3	5.97E-06	0	5.25E-07	9.77E-06	5.39E-09	0	4.15E-09	4.20E-09	-9.54E-07
ILLRW[3)4)]	m^3	4.83E-05	0	4.04E-06	7.86E-05	3.83E-08	0	3.23E-08	3.73E-08	-7.41E-06
CRU[3)]	kg	-	-	-	-	-	-	-	-	-
MR[3)]	kg	55	0	3.32	1077	0	0	659	0	0
MER[3)]	kg	76	0	4.59	122	0	0	0	0	0
EE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
$GWP_{bio-pkg}$[3)]	kg CO_2	-68	0	68	0	0	0	0	0	0

Table 12 EPD Results (A1-D) – 1,000 m² of Flex MF/R 80 mil PVC Roofing Membrane

Impact category and inventory indicators	Unit	A1 to A3	A4	A5	B4	C1	C2	C3	C4	D
GWP 100[1)]	kg CO_2 eq	6958	262	678	12125	40.3	10.1	1.88	133	-1616
ODP[1)]	kg CFC-11 eq	6.62E-04	1.10E-08	4.66E-05	1.06E-03	6.62E-07	4.25E-10	2.19E-08	1.51E-07	-1.37E-04
SFP[1)]	kg O_3 eq	409	89	43.4	839	11.6	3.00	0.16	2.59	-28.0
AP[1)]	kg SO_2 eq	45.7	3.44	3.70	81	0.35	0.12	0.007	0.39	-4.79
EP[1)]	kg N eq	34.6	0.21	3.27	81	0.032	0.007	0.007	15.8	-1.17
FFD[1)]	MJ surplus, LHV	14727	551	1036	24654	80	21.3	2.66	17.9	-6294
ADPf[2)]	MJ, LHV	105725	3724	8845	178660	528	144	23.2	117	-42497
RPRE	MJ, LHV	35645	0	2239	56853	3.12	0	3.21	12.1	-656
RPRM[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	58400	3766	6262	103905	536	146	32.2	127	-44671
NRPRM[3)]	MJ, LHV	61253	0	3675	97392	0	0	0	0	0
SM[3)]	kg	-	-	-	-	-	-	-	-	-
RSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
RE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
FW[3)]	m^3	5.60E-03	0	3.36E-04	8.90E-03	0	0	0	0	0
HWD[3)]	kg	-	-	-	-	-	-	-	-	-
NHWD[3)]	kg	100	0	5.97	3155	0	0	0	1998	0
HLRW[3)4)]	m^3	6.86E-06	0	5.78E-07	1.12E-05	5.39E-09	0	5.39E-09	5.45E-09	-1.24E-06
ILLRW[3)4)]	m^3	5.48E-05	0	4.43E-06	8.91E-05	3.83E-08	0	4.19E-08	4.85E-08	-9.62E-06
CRU[3)]	kg	-	-	-	-	-	-	-	-	-
MR[3)]	kg	67	0	4.00	1390	0	0	856	0	0
MER[3)]	kg	99	0	5.95	158	0	0	0	0	0
EE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
$GWP_{bio-pkg}$[3)]	kg CO_2	-68	0	68	0	0	0	0	0	0

Table 13 EPD Results (A1-D) – 1,000 m² of Flex FB 50 mil PVC Roofing Membrane (Fleece Backed)

Impact category and inventory indicators	Unit	A1 to A3	A4	A5	B4	C1	C2	C3	C4	D
GWP 100[1)]	kg CO_2 eq	5418	192	581	9505	40.3	7.36	1.37	97	-1177
ODP[1)]	kg CFC-11 eq	4.46E-04	8.03E-09	3.36E-05	7.20E-04	6.63E-07	3.09E-10	1.59E-08	1.10E-07	-9.98E-05
SFP[1)]	kg O_3 eq	303	65	35.5	629	11.6	2.18	0.12	1.88	-20.4
AP[1)]	kg SO_2 eq	31.9	2.52	2.81	57	0.35	0.086	0.005	0.28	-3.48
EP[1)]	kg N eq	25.7	0.15	2.68	60	0.032	0.005	0.005	11.5	-0.85
FFD[1)]	MJ surplus, LHV	12412	403	888	20721	80	15.5	1.94	13.0	-4582
ADPf[2)]	MJ, LHV	89115	2725	7787	150542	528	105	16.9	85	-30939
RPRE	MJ, LHV	23727	0	1523	37897	3.10	0	2.34	8.81	-477
RPRM[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	55882	2755	6049	98167	536	106	23.5	93	-32521
NRPRM[3)]	MJ, LHV	44981	0	2699	71519	0	0	0	0	0
SM[3)]	kg	-	-	-	-	-	-	-	-	-
RSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
RE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
FW[3)]	m^3	4.07E-03	0	2.44E-04	6.48E-03	0	0	0	0	0
HWD[3)]	kg	-	-	-	-	-	-	-	-	-
NHWD[3)]	kg	73	0	4.37	2297	0	0	0	1454	0
HLRW[3)4)]	m^3	5.72E-06	0	5.10E-07	9.37E-06	5.43E-09	0	3.93E-09	3.97E-09	-9.02E-07
ILLRW[3)4)]	m^3	4.61E-05	0	3.91E-06	7.52E-05	3.83E-08	0	3.05E-08	3.53E-08	-7.00E-06
CRU[3)]	kg	-	-	-	-	-	-	-	-	-
MR[3)]	kg	53	0	3.20	1020	0	0	623	0	0
MER[3)]	kg	72	0	4.34	115	0	0	0	0	0
EE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
$GWP_{bio-pkg}$[3)]	kg CO_2	-68	0	68	0	0	0	0	0	0

Table 14 EPD Results (A1-D) – 1,000 m² of Flex FB 60 mil PVC Roofing Membrane (Fleece Backed)

Impact category and inventory indicators	Unit	A1 to A3	A4	A5	B4	C1	C2	C3	C4	D
GWP 100[1)]	kg CO_2 eq	6124	222	625	10700	40.3	8.53	1.59	112	-1364
ODP[1)]	kg CFC-11 eq	5.26E-04	9.28E-09	3.84E-05	8.47E-04	6.62E-07	3.58E-10	1.84E-08	1.27E-07	-1.16E-04
SFP[1)]	kg O_3 eq	349	76	38.9	719	11.6	2.53	0.14	2.18	-23.6
AP[1)]	kg SO_2 eq	37.8	2.91	3.19	67	0.35	0.099	0.006	0.33	-4.04
EP[1)]	kg N eq	29.1	0.18	2.91	68	0.032	0.006	0.006	13.3	-0.98
FFD[1)]	MJ surplus, LHV	14068	466	991	23461	80	18.0	2.24	15.1	-5309
ADPf[2)]	MJ, LHV	100831	3149	8516	169897	528	122	19.6	99	-35852
RPRE	MJ, LHV	25905	0	1654	41363	3.12	0	2.71	10.2	-553
RPRM[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	62335	3185	6463	109164	536	123	27.2	107	-37686
NRPRM[3)]	MJ, LHV	51265	0	3076	81511	0	0	0	0	0
SM[3)]	kg	-	-	-	-	-	-	-	-	-
RSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
RE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
FW[3)]	m^3	4.72E-03	0	2.83E-04	7.51E-03	0	0	0	0	0
HWD[3)]	kg	-	-	-	-	-	-	-	-	-
NHWD[3)]	kg	84	0	5.04	2661	0	0	0	1685	0
HLRW[3)4)]	m^3	6.27E-06	0	5.43E-07	1.02E-05	5.39E-09	0	4.55E-09	4.60E-09	-1.05E-06
ILLRW[3)4)]	m^3	5.02E-05	0	4.15E-06	8.17E-05	3.83E-08	0	3.53E-08	4.09E-08	-8.11E-06
CRU[3)]	kg	-	-	-	-	-	-	-	-	-
MR[3)]	kg	59	0	3.54	1177	0	0	722	0	0
MER[3)]	kg	84	0	5.02	133	0	0	0	0	0
EE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
$GWP_{bio\text{-}pkg}$[3)]	kg CO_2	-68	0	68	0	0	0	0	0	0

Table 15 EPD Results (A1-D) – 1,000 m² of Flex FB 80 mil PVC Roofing Membrane (Fleece Backed)

Impact category and inventory indicators	Unit	A1 to A3	A4	A5	B4	C1	C2	C3	C4	D
GWP 100[1)]	kg CO_2 eq	7582	281	717	13164	40.3	10.9	2.02	143	-1735
ODP[1)]	kg CFC-11 eq	6.69E-04	1.18E-08	4.70E-05	1.08E-03	6.62E-07	4.56E-10	2.35E-08	1.62E-07	-1.47E-04
SFP[1)]	kg O_3 eq	441	96	45.7	901	11.6	3.22	0.17	2.78	-30.1
AP[1)]	kg SO_2 eq	47.6	3.69	3.83	84	0.35	0.13	0.007	0.41	-5.14
EP[1)]	kg N eq	37.0	0.22	3.43	86	0.032	0.008	0.008	17.0	-1.25
FFD[1)]	MJ surplus, LHV	17097	591	1181	28491	80	22.9	2.85	19.2	-6755
ADPf[2)]	MJ, LHV	122102	3993	9844	205159	528	155	24.9	126	-45615
RPRE	MJ, LHV	36125	0	2267	57619	3.12	0	3.45	13.0	-704
RPRM[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	70808	4038	7024	124101	536	156	34.6	137	-47948
NRPRM[3)]	MJ, LHV	66011	0	3961	104957	0	0	0	0	0
SM[3)]	kg	-	-	-	-	-	-	-	-	-
RSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
RE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
FW[3)]	m^3	6.01E-03	0	3.60E-04	9.55E-03	0	0	0	0	0
HWD[3)]	kg	-	-	-	-	-	-	-	-	-
NHWD[3)]	kg	107	0	6.41	3386	0	0	0	2144	0
HLRW[3)4)]	m^3	7.16E-06	0	5.96E-07	1.17E-05	5.39E-09	0	5.79E-09	5.85E-09	-1.33E-06
ILLRW[3)4)]	m^3	5.67E-05	0	4.54E-06	9.21E-05	3.83E-08	0	4.49E-08	5.20E-08	-1.03E-05
CRU[3)]	kg	-	-	-	-	-	-	-	-	-
MR[3)]	kg	70	0	4.21	1490	0	0	919	0	0
MER[3)]	kg	107	0	6.39	169	0	0	0	0	0
EE[3)]	MJ, LHV	-	-	-	-	-	-	-	-	-
$GWP_{bio\text{-}pkg}$[3)]	kg CO_2	-68	0	68	0	0	0	0	0	0

Notes:

[1)] Calculated as per U.S EPA TRACI 2.1, v1.05, SimaPro v.9.5.0.2 GWP-100 (11), excludes biogenic CO_2 removals and emissions associated with biobased products, including bio-based packaging. There is no biogenic content in the declared products. CO_2 emissions from calcination and carbonation do not apply to the declared products; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5), TRACI 2.1, v1.05 (12). FFD is required in LEED V4.1 MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations (13).

[2)] Calculated as per CML-IA Baseline v3.05, SimaPro v.9.5.0.2 (11). ADP_f is also required in LEED v4.0/v4.1 MR2 Credit: Building Product Disclosure and Optimization – Environmental Product Declarations (14), (13).

[3)] Calculated as per ACLCA ISO 21930 Guidance (15), respective sections 6.2 to 10.8.

[4)] It should be noted that the foreground system (Flex Roofing Systems' roofing membrane manufacturing process) does not generate any HLRW or ILLRW. High, intermediate or low-level radioactive waste is generated by electricity production (spent fuel from reactors, routine facility maintenance and operations)" (ISO 21930:2017, clause 7.2.14). High-level radioactive waste, e.g., when generated by electricity production, consists mainly of spent fuel from reactors." (ISO 21930:2017, clause 7.2.14).

[5)] "-"N/A for this product system. "*Not all LCA datasets for upstream materials include these impact categories, and thus results may be incomplete. Use caution when interpreting data in these categories"* (6).
[6)] The environmental burden of modules B1, B2, B3, B5, B6, and B7 is null.
[7)] The following abbreviations are used for impact category and inventory indicators:

GWP 100	Global warming potential
ODP	Ozone depletion potential
SFP	Smog formation potential
AP	Acidification potential
EP	Eutrophication potential
FFD	Fossil fuel depletion
ADPf	Abiotic depletion potential, fossil
RPR_E	Renewable primary resources used as an energy carrier (fuel)
RPR_M	Renewable primary resources with energy content used as material
$NRPR_E$	Non-renewable primary resources used as an energy carrier (fuel)
$NRPR_M$	Non-renewable primary resources with energy content used as material
SM	Secondary materials
RSF	Renewable secondary fuels
NRSF	Non-renewable secondary fuels
RE	Recovered energy
FW	Consumption of freshwater
HWD	Hazardous waste disposed
NHWD	Non-hazardous waste disposed
HLRW	High-level radioactive waste, conditioned, to the final repository
ILLRW	Intermediate- and low-level radioactive waste, conditioned, to the final repository
CRU	Components for re-use
MR	Materials for recycling
MER	Materials for energy recovery
EE	Recovered energy exported from the product system
$GWP_{bio-pkg}$	Removals and emissions associated with biogenic carbon contained within bio-based packaging

7 INTERPRETATION

The Flex Roofing System PVC roofing membrane EPD results represent a "cradle-to-grave" environmental profile per 1,000 m^2 for each declared single-ply roofing membrane thickness as manufactured at its Hillside, NJ manufacturing facility for the 2023 reference year.

For each declared membrane thickness, the Use stage (B4) dominates the LCIA and energy indicator results, ranging from around 60% of the total potential impacts. It should be noted that the environmental burden of modules B1, B2, B3, B5, B6, and B7 is null.

The Production stage (A1 to A3) is the second largest contributor to the LCIA and energy indicator results, contributing 20% to 40% of the total potential impacts, depending on the impact category. Except for SFP (around 10%), the Construction stage (A4 to A5) accounted for less than 10% of the total potential impacts. The End-of-life stage (C1 to C4) was generally found to be a minor contributor to the declared product

potential impacts; however, it did account for around 11% of the eutrophication potential due to disposal of waste. The net benefits of recycling (Module D) vary significantly across LCIA indicators, and rage from less than 1% to approximately 30%.

Regarding the Production stage (A1 to A3), module A1 Extraction and upstream production contribute the largest share of the LCIA category indicator results, accounting for between 70% and 97% of the Production stage (A1 to A3) potential environmental burdens. Module A3 Manufacturing is the second largest contributor (<20%) to membrane manufacture's overall potential environmental impacts. Module A2 transportation significantly contributes to the smog formation potential but otherwise contributes less than 10% to the other environmental indicator metrics.

8 ADDITIONAL ENVIRONMENTAL INFORMATION

Select roofing membranes manufactured by Flex Membrane comply with efficiency programs requiring the use of a highly reflective roof like California Title 24, U.S. Green Building Council's (USBGC) Leadership in Energy and Environmental Design (LEED) rating system, the International Green Construction Code (IgCC), IECC, Cool Roof Rating Council (CRRC), and Green Building Institute's Green Globes.

9 DECLARATION TYPE

This "Cradle-to-grave" EPD applies to Flex Roofing Systems' PVC roofing membranes (all colors) of 50, 60, and 80-mil nominal thickness with and without fleece backing. The life cycle stages covered are the production, construction, use, and end-of-life stages, including the optional module D. The declaration is intended for use in Business-to-Business (B-to-B) and Business -to-Consumer communication.

The three declared thicknesses (50, 60, and 80 mils) of Flex Roofing Systems' PVC roofing membrane fall under the description:

- A product and manufacturer-specific EPD.

10 EPD COMPARABILITY LIMITATION STATEMENT

Only EPDs prepared from cradle-to-grave life cycle results, and based on the same function, quantified by the same functional unit, and taking account of replacement based on the product reference service life (RSL) relative to an assumed building service life, and meeting all the conditions for comparability listed in ISO 14025:2006 and ISO 21930:2017 can be used to make comparisons between products (6).

Declarations based on the NSF Product category rules are not comparative assertions; no claim of environmental superiority may be inferred or implied.

11 REFERENCES

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6. NSF International, Product Category Rule Environmental Product Declarations, PCR for Single Ply Roofing Membrane, October 2019. Extended 12 months per PCRExt 2024-113 – valid until July 17, 2025.
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