



An Environmental Product Declaration

According to ISO 14025:2006 and ISO 21930:2017

A Cradle-to-Grave EPD for Flex Roofing Systems

Elvaloy® KEE Single-Ply Roofing Membrane




ASTM International Certified Environmental Product Declaration

This document is a Type III environmental product declaration (EPD) for Flex Roofing Systems Elvaloy® KEE 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 Elvaloy® KEE roofing membranes in accordance with international standards.

Environmental Product Declaration Summary

General Information	
Owner of the EPD	 <p>Flex Membrane International Corp. (Flex Roofing Systems) 5103A Pottsville Pike Reading, PA 19605 USA https://flexroofingsystems.com/</p> <p>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.</p> <p><i>The owner of the declaration is liable for the underlying information and evidence.</i></p>
Manufacturing Sites	1227 Central Avenue, Hillside, NJ 07205 USA
Product Group	Single-Ply Roofing Membranes

Product Name	Flex Roofing Systems Elvaloy® KEE 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: <ul style="list-style-type: none"> • MF/R 50 mil Elvaloy® KEE • MF/R 60 mil Elvaloy® KEE • MF/R 80 mil Elvaloy® KEE • FB 50 mil Elvaloy® KEE (Fleece backed) • FB 60 mil Elvaloy® KEE (Fleece backed) • FB 80 mil Elvaloy® KEE (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 14 th , 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 948
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’ Elvaloy® KEE 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	<u>External</u>	
	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' Elvaloy® KEE 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' Elvaloy® KEE roofing membrane contributes to LEED® credit requirements and is Cool Roof Rating Council-rated and Title 24 compliant. The Elvaloy® KEE 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' Elvaloy® KEE 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 Elvaloy® KEE Roofing Membrane	Finished nominal thickness	mil	50	60	80
		mm	1.3	1.5	2.0
	Finished density	kg/m ²	1.66	1.96	2.48
FB Elvaloy® KEE 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	2.14	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-Dade County Approval
- Texas Department of Insurance
- Underwriters Laboratory Inc.

2 FUNCTIONAL UNIT

The functional unit is defined as 1,000 m² 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' Elvaloy® KEE roofing membranes is provided in Table 2.

Table 2: Average material content for Flex Roofing Systems' Elvaloy® KEE roofing membrane

Material input	Material Content (in %)	
	Non-fleece (bareback)	Fleece backed
PVC Resin & KEE co-polymer	72.5%	65.9%
Processing aids	7.8%	7.1%
Pigments	6.2%	6.2%
Fillers	4.5%	4.1%
Polyester reinforcement	4.1%	3.8%
Fleece backing	0.0%	8.4%
Others	4.9%	4.6%
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.

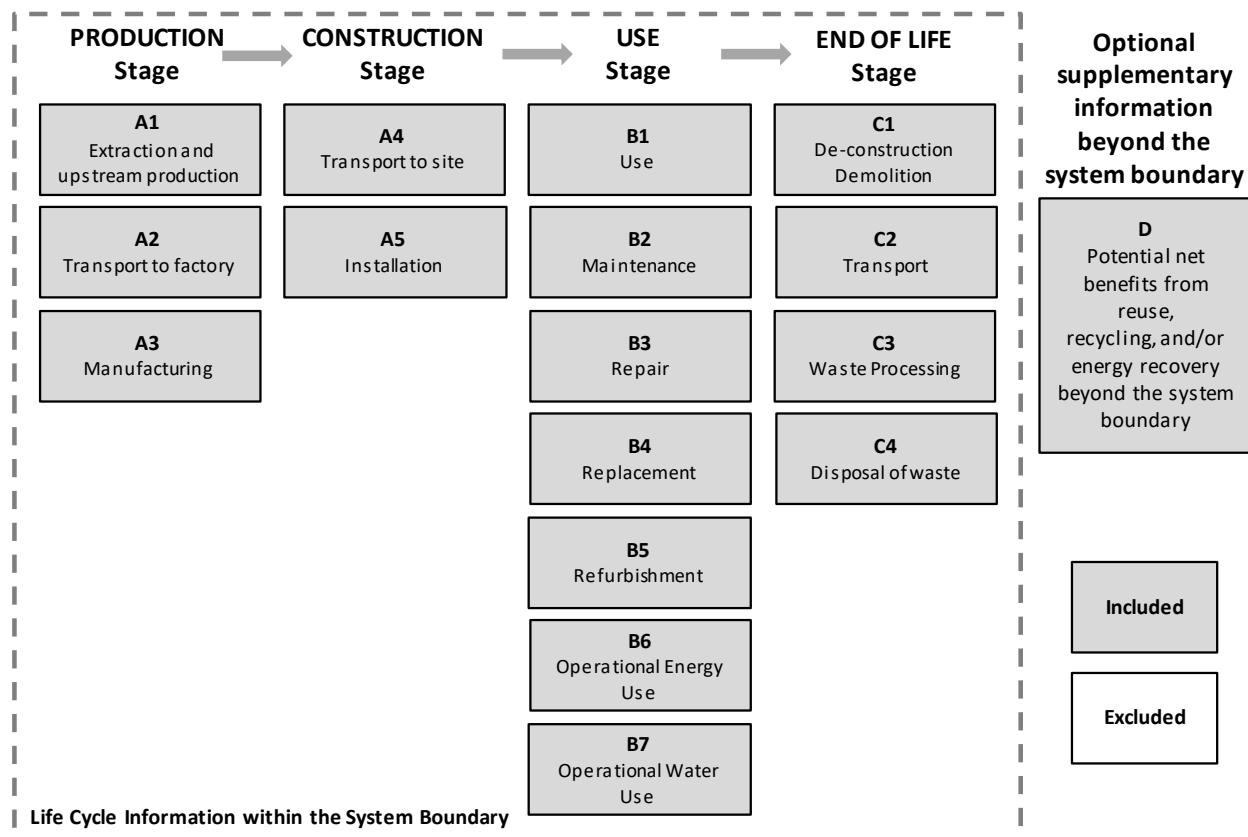


Figure 1 Life Cycle Stages and Modules

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 Elvaloy® KEE 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 Elvaloy® KEE roofing membrane system.

The LCA results associated with module D are reported separately. The net output flow for all Elvaloy® KEE 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 Elvaloy® KEE roofing membrane system (Table 8).

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

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

Table 5: A5 Module, Installation scenario data for 1,000 m² of installed Flex Roofing Systems' Elvaloy® KEE 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 m²) of PVC roofing membrane, so a fastener usage of 1.5 fasteners per m² (=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' Elvaloy® KEE 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' Elvaloy® KEE 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' Elvaloy® KEE roofing membrane (50, 60, and 80 mils)

Membrane thickness	Net output flow	Units	Quantity
No fleece backing			
50 mils		kg	640.70
60 mils	Secondary material	kg	753.87
80 mils		kg	978.71
Fleece backed			
50 mils		kg	712.33
60 mils	Secondary material	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	<p>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.</p> <p><i>Technological representativeness is characterized as "high".</i></p>
Geographic Coverage	<p>The geographic region considered is the U.S.</p> <p><i>Geographical representativeness is characterized as "high".</i></p>
Time Coverage	<p>Activity data are representative.</p> <ul style="list-style-type: none"> • 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. <p><i>Temporal representativeness is characterized as "medium" to "high".</i></p>
Completeness	<p>All relevant, specific processes were considered and modelled, including inputs (raw materials, energy, and ancillary materials) and outputs (emissions and production volume).</p> <p>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.</p>

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 <i>Athena Flex LCI database</i> 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 <i>sensitivity check</i> 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 <i>sensitivity analysis</i> and <i>Monte Carlo uncertainty analysis of background data sets</i> .

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 m² 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 m² of installed Elvaloy® KEE 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 Elvaloy® KEE 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	4989	173	554	8776	40.3	6.62	1.23	87	-1058
ODP ¹⁾	kg CFC-11 eq	4.99E-04	7.24E-09	3.68E-05	8.06E-04	6.62E-07	2.78E-10	1.43E-08	9.87E-08	-8.98E-05
SFP ¹⁾	kg O ₃ eq	277	59	33.6	578	11.6	1.96	0.11	1.69	-18.3
AP ¹⁾	kg SO ₂ eq	31.7	2.27	2.79	56	0.35	0.077	0.004	0.25	-3.13
EP ¹⁾	kg N eq	20.9	0.14	2.37	51	0.032	0.005	0.005	10.4	-0.76
FFD ¹⁾	MJ surplus, LHV	13733	363	965	22753	80	14.0	1.74	11.7	-4119
ADPf ²⁾	MJ, LHV	98040	2454	8306	164272	528	94	15.2	77	-27812
RPRE	MJ, LHV	10136	0	708	16286	3.12	0	2.10	7.92	-429
RPRM ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	66764	2482	6685	115000	536	95	21.1	83	-29235
NRPRM ³⁾	MJ, LHV	42579	0	2555	67701	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	5.82E-03	0	0	0	0	0
HWD ³⁾	kg	-	-	-	-	-	-	-	-	-
NHWD ³⁾	kg	65	0	3.91	2065	0	0	0	1307	0
HLRW ³⁾⁴⁾	m ³	5.87E-06	0	5.19E-07	9.60E-06	5.39E-09	0	3.53E-09	3.57E-09	-8.11E-07
ILLRW ³⁾⁴⁾	m ³	4.78E-05	0	4.01E-06	7.78E-05	3.83E-08	0	2.74E-08	3.17E-08	-6.29E-06
CRU ³⁾	kg	-	-	-	-	-	-	-	-	-
MR ³⁾	kg	49.7	0	2.98	919	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 Elvaloy® KEE 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	5768	204	603	10090	40.3	7.83	1.46	103	-1251
ODP ¹⁾	kg CFC-11 eq	5.79E-04	8.53E-09	4.16E-05	9.32E-04	6.62E-07	3.29E-10	1.69E-08	1.17E-07	-1.06E-04
SFP ¹⁾	kg O ₃ eq	326	69	37.2	672	11.6	2.32	0.12	2.00	-21.7
AP ¹⁾	kg SO ₂ eq	37.7	2.67	3.17	66	0.35	0.091	0.005	0.30	-3.71
EP ¹⁾	kg N eq	24.3	0.16	2.60	59	0.032	0.005	0.006	12.2	-0.90
FFD ¹⁾	MJ surplus, LHV	16086	428	1110	26605	80	16.5	2.06	13.8	-4872
ADPf ²⁾	MJ, LHV	114473	2894	9319	191151	528	112	17.9	91	-32898
RPRE	MJ, LHV	11453	0	787	18383	3.12	0	2.49	9.37	-508
RPRM ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	76701	2927	7309	131563	536	113	25.0	99	-34581
NRPRM ³⁾	MJ, LHV	50169	0	3010	79768	0	0	0	0	0
SM ³⁾	kg	-	-	-	-	-	-	-	-	-
RSF ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
RE ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
FW ³⁾	m ³	4.33E-03	0	2.60E-04	6.89E-03	0	0	0	0	0
HWD ³⁾	kg	-	-	-	-	-	-	-	-	-
NHWD ³⁾	kg	77	0	4.63	2442	0	0	0	1546	0
HLRW ³⁾⁴⁾	m ³	6.46E-06	0	5.54E-07	1.05E-05	5.39E-09	0	4.18E-09	4.22E-09	-9.59E-07
ILLRW ³⁾⁴⁾	m ³	5.23E-05	0	4.27E-06	8.50E-05	3.83E-08	0	3.24E-08	3.75E-08	-7.44E-06
CRU ³⁾	kg	-	-	-	-	-	-	-	-	-
MR ³⁾	kg	56	0	3.33	1082	0	0	663	0	0
MER ³⁾	kg	77	0	4.61	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 Elvaloy® KEE 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	7056	257	683	12269	40.3	9.92	1.85	131	-1585
ODP ¹⁾	kg CFC-11 eq	7.72E-04	1.08E-08	5.32E-05	1.24E-03	6.62E-07	4.17E-10	2.14E-08	1.48E-07	-1.35E-04
SFP ¹⁾	kg O ₃ eq	408	88	43.2	835	11.6	2.94	0.16	2.54	-27.5
AP ¹⁾	kg SO ₂ eq	43.0	3.37	3.53	76	0.35	0.12	0.007	0.38	-4.69
EP ¹⁾	kg N eq	30.0	0.20	2.99	73	0.032	0.007	0.007	15.5	-1.14
FFD ¹⁾	MJ surplus, LHV	20196	541	1364	33333	80	20.9	2.61	17.5	-6172
ADP ^{f2)}	MJ, LHV	143167	3653	11087	238071	528	141	22.7	115	-41677
RPRE	MJ, LHV	14498	0	970	23229	3.12	0	3.15	11.9	-643
RPRM ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	93446	3694	8361	159504	536	143	31.6	125	-43809
NRPRM ³⁾	MJ, LHV	63913	0	3835	101622	0	0	0	0	0
SM ³⁾	kg	-	-	-	-	-	-	-	-	-
RSF ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
RE ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
FW ³⁾	m ³	5.49E-03	0	3.29E-04	8.73E-03	0	0	0	0	0
HWD ³⁾	kg	-	-	-	-	-	-	-	-	-
NHWD ³⁾	kg	98	0	5.86	3094	0	0	0	1959	0
HLRW ³⁾⁴⁾	m ³	7.40E-06	0	6.10E-07	1.20E-05	5.39E-09	0	5.29E-09	5.34E-09	-1.21E-06
ILLRW ³⁾⁴⁾	m ³	5.93E-05	0	4.70E-06	9.62E-05	3.83E-08	0	4.11E-08	4.76E-08	-9.43E-06
CRU ³⁾	kg	-	-	-	-	-	-	-	-	-
MR ³⁾	kg	66	0	3.94	1364	0	0	840	0	0
MER ³⁾	kg	97	0	5.84	155	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 Elvaloy® KEE 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	5613	192	592	9814	40.3	7.36	1.37	97	-1176
ODP ¹⁾	kg CFC-11 eq	5.07E-04	8.03E-09	3.73E-05	8.17E-04	6.62E-07	3.09E-10	1.59E-08	1.10E-07	-9.98E-05
SFP ¹⁾	kg O ₃ eq	309	65	35.9	640	11.6	2.18	0.12	1.88	-20.4
AP ¹⁾	kg SO ₂ eq	33.7	2.51	2.92	60	0.35	0.086	0.005	0.28	-3.48
EP ¹⁾	kg N eq	23.3	0.15	2.53	56	0.032	0.005	0.005	11.5	-0.85
FFD ¹⁾	MJ surplus, LHV	16102	403	1110	26588	80	15.5	1.94	13.0	-4581
ADP ^{f2)}	MJ, LHV	114410	2724	9305	190760	528	105	16.9	85	-30930
RPRE	MJ, LHV	10620	0	737	17057	3.12	0	2.34	8.81	-477
RPRM ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	79163	2755	7446	135183	536	106	23.5	93	-32513
NRPRM ³⁾	MJ, LHV	47339	0	2840	75269	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	4.35	2296	0	0	0	1454	0
HLRW ³⁾⁴⁾	m ³	6.17E-06	0	5.37E-07	1.01E-05	5.39E-09	0	3.93E-09	3.97E-09	-9.02E-07
ILLRW ³⁾⁴⁾	m ³	4.97E-05	0	4.12E-06	8.09E-05	3.83E-08	0	3.05E-08	3.53E-08	-7.00E-06
CRU ³⁾	kg	-	-	-	-	-	-	-	-	-
MR ³⁾	kg	53	0	3.20	1019	0	0	623	0	0
MER ³⁾	kg	72	0	4.33	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 Elvaloy® KEE 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	6392	223	641	11129	40.3	8.57	1.60	113	-1370
ODP ¹⁾	kg CFC-11 eq	5.86E-04	9.33E-09	4.20E-05	9.44E-04	6.62E-07	3.60E-10	1.85E-08	1.28E-07	-1.16E-04
SFP ¹⁾	kg O ₃ eq	358	76	39.5	734	11.6	2.54	0.14	2.19	-23.8
AP ¹⁾	kg SO ₂ eq	39.6	2.92	3.30	70	0.35	0.100	0.006	0.33	-4.06
EP ¹⁾	kg N eq	26.6	0.18	2.76	65	0.032	0.006	0.006	13.4	-0.99
FFD ¹⁾	MJ surplus, LHV	18456	468	1255	30441	80	18.1	2.25	15.2	-5334
ADPF ²⁾	MJ, LHV	130849	3163	10318	217650	528	122	19.7	99	-36016
RPRE	MJ, LHV	11934	0	816	19148	3.12	0	2.72	10.3	-556
RPRM ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	89108	3199	8070	151759	536	123	27.3	108	-37859
NRPRM ³⁾	MJ, LHV	54927	0	3296	87334	0	0	0	0	0
SM ³⁾	kg	-	-	-	-	-	-	-	-	-
RSF ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRSF ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
RE ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
FW ³⁾	m ³	4.74E-03	0	2.85E-04	7.54E-03	0	0	0	0	0
HWD ³⁾	kg	-	-	-	-	-	-	-	-	-
NHWD ³⁾	kg	84	0	5.06	2674	0	0	0	1693	0
HLRW ³⁾⁴⁾	m ³	6.76E-06	0	5.72E-07	1.10E-05	5.39E-09	0	4.57E-09	4.62E-09	-1.05E-06
ILLRW ³⁾⁴⁾	m ³	5.42E-05	0	4.39E-06	8.80E-05	3.83E-08	0	3.55E-08	4.11E-08	-8.15E-06
CRU ³⁾	kg	-	-	-	-	-	-	-	-	-
MR ³⁾	kg	59	0	3.55	1182	0	0	726	0	0
MER ³⁾	kg	84	0	5.05	134	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 15 EPD Results (A1-D) – 1,000 m² of Flex FB 80 mil Elvaloy® KEE 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	7862	281	733	13609	40.3	10.9	2.02	143	-1735
ODP ¹⁾	kg CFC-11 eq	7.85E-04	1.18E-08	5.39E-05	1.26E-03	6.62E-07	4.56E-10	2.35E-08	1.62E-07	-1.47E-04
SFP ¹⁾	kg O ₃ eq	451	96	46.3	915	11.6	3.22	0.17	2.78	-30.1
AP ¹⁾	kg SO ₂ eq	50	3.69	3.98	88	0.35	0.13	0.007	0.41	-5.14
EP ¹⁾	kg N eq	33.1	0.22	3.20	80	0.032	0.008	0.008	17.0	-1.25
FFD ¹⁾	MJ surplus, LHV	22829	591	1525	37605	80	22.9	2.85	19.2	-6755
ADPf ²⁾	MJ, LHV	161415	3993	12203	267667	528	155	24.9	126	-45615
RPRE	MJ, LHV	15143	0	1008	24256	3.12	0	3.45	13.0	-704
RPRM ³⁾	MJ, LHV	-	-	-	-	-	-	-	-	-
NRPRE	MJ, LHV	107151	4038	9204	181886	536	156	34.6	137	-47948
NRPRM ³⁾	MJ, LHV	69495	0	4170	110497	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	7.85E-06	0	6.37E-07	1.28E-05	5.39E-09	0	5.79E-09	5.85E-09	-1.33E-06
ILLRW ³⁾⁴⁾	m ³	6.23E-05	0	4.88E-06	1.01E-04	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-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 CO₂ removals and emissions associated with biobased products, including bio-based packaging. There is no biogenic content in the declared products. CO₂ 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	RSF	Renewable secondary fuels
ODP	Ozone depletion potential	NRSF	Non-renewable secondary fuels
SFP	Smog formation potential	RE	Recovered energy
AP	Acidification potential	FW	Consumption of freshwater
EP	Eutrophication potential	HWD	Hazardous waste disposed
FFD	Fossil fuel depletion	NHWD	Non-hazardous waste disposed
ADP _f	Abiotic depletion potential, fossil	HLRW	High-level radioactive waste, conditioned, to the final repository
RPR _E	Renewable primary resources used as an energy carrier (fuel)	ILLRW	Intermediate- and low-level radioactive waste, conditioned, to the final repository
RPR _M	Renewable primary resources with energy content used as material	CRU	Components for re-use
NRPR _E	Non-renewable primary resources used as an energy carrier (fuel)	MR	Materials for recycling
NRPR _M	Non-renewable primary resources with energy content used as material	MER	Materials for energy recovery
SM	Secondary materials	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 Elvaloy® KEE roofing membrane EPD results represent a “cradle-to-grave” environmental profile per 1,000 m² 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 range 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 (USGBC) 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.

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.

9 DECLARATION TYPE

This "Cradle-to-grave" EPD applies to Flex Roofing Systems' Elvaloy® KEE 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' Elvaloy® KEE roofing membrane fall under the description:

- A product and manufacturer-specific EPD.

11 REFERENCES

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