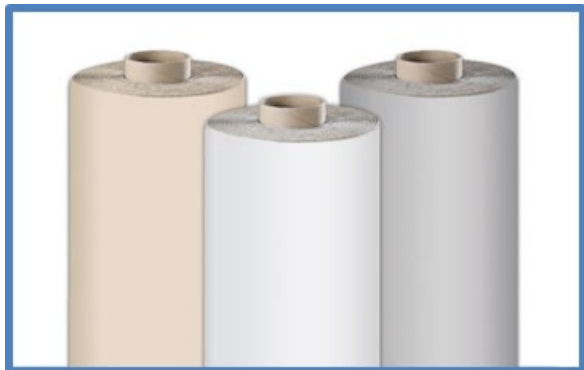




Sentinel KEE P150 & P200 | Single-Ply PVC Roof Membrane



EPD Owner	SOPREMA US 310 Quadral Dr. Wadsworth, OH, 44281
Product Type	Single-ply PVC roofing
Product Name	Sentinel KEE P150 (60-mil), Sentinel KEE P200 (80-mil)
EPD Scope	Cradle-to-gate
Declared Unit	1 m ²
Product Colors	white

Company Information

SOPREMA is an international manufacturer specializing in the production of innovative products for waterproofing, insulation, sound proofing and vegetated solutions for the roofing, building envelope and civil engineering sectors. Founded in 1908 in Strasbourg, France, SOPREMA now operates in over 90 countries.

Product Description

SOPREMA's KEE PVC roof membrane is a proprietary thermoplastic formulation that provides a highly reflective, durable, and superior quality product. An 18 x 9 weft-inserted anti-wicking knit scrim that is laminated between two layers of PVC film gives the membrane its strength and durability. This membrane product line contains Elvaloy® KEE (Ketone Ethylene Ester), a polymer manufactured by DuPont™ that provides non-migrating flexibility in roofing membranes. This molecule may replace plasticizers in roofing products, and when mixed with PVC, provides resistance to chemical attack, weather resistance, long-term flexibility, durability, and resistance to microbial growth. This EPD applies to the white Sentinel KEE P150 (60-mil) and Sentinel KEE P200 (80-mil) nominal thicknesses. The SOPREMA membrane was engineered to be used with the complete line of SOPREMA's proven, precision-fabricated flashings for curbs, stacks, and parapets. SOPREMA can be installed using mechanically attached or adhered methods.




EPD Program Operator
NSF International
789 N. Dixboro Rd.
Ann Arbor MI 48105 USA
www.nsf.org



Date of Issue: 01/04/2022
Valid Until: 01/04/2027
Declaration#: EPD10858



ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

EPD Information			
Program Operator		NSF International	
Declaration Holder		SOPREMA	
Product Sentinel KEE P150 (60-mil) Sentinel KEE P200 (80-mil)	Date of Issue 01/04/2022	Valid Until 01/04/2027	Declaration Number EPD10858
This EPD was independently verified by NSF International in accordance with ISO 14025 and ISO 21930: <input type="checkbox"/> Internal <input checked="" type="checkbox"/> External		 Jack Geibig jgeibig@ecoform.com	
This life cycle assessment was independently verified by in accordance with ISO 14044 and the reference PCR:		 Jack Geibig jgeibig@ecoform.com	
LCA Information			
LCA report		A Cradle-to-Gate Life Cycle Assessment of Private Label Manufacturer's Single-ply PVC Roofing Membranes, December 2021 (Revised May 2023)	
LCA Preparer 		Lindita Bushi Ph.D., Mr. Jamie Meil and Mr. Grant Finlayson Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, Ontario, Canada K1P 5G8 info@athenasmi.org www.athenasmi.org	
PCR Information			
Program Operator		NSF International	
Reference PCR		NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Single Ply Roofing Membranes	
Date of Issue		October 2019	
PCR review was conducted by:		Thomas P. Gloria, PhD (Chair), Industrial Ecology Consultants Mr. Jack Geibig, EcoForm Mr. Bill Stough, Sustainable Research Group	



Product Specifications

Physical Property	Test Method	ASTM 4434 Requirement for Type III Sheet	60-mil Result	80-mil Result
Overall Thickness	ASTM D751	≥ 0.045 in.	PASS	PASS
Thickness Over Scrim	ASTM D7635	≥ 0.016 in.	PASS	PASS
Breaking Strength	ASTM D751 Grab Method	≥ 200 lbf./in.	PASS	PASS
Elongation	ASTM D751 Grab Method	≥ 15%	PASS	PASS
Seam Strength	ASTM D751 Grab Method	≥ 317 lbf. (75% of Breaking Strength)	PASS	PASS
Tear Strength	ASTM D751 Procedure B	≥ 45 lbf.	PASS	PASS
Low Temp. Bend	ASTM D2136	Must pass at -40° F.	PASS	PASS
Heat Aging	ASTM D3045	Conditioned for 56 days in oven maintained at 176° F.	PASS	PASS
Accelerated Weathering	ASTM G155	5,000 hours total test time. Irradiance level of 0.35 W/m ² -340nm. Cycle: 102 minutes light, 18 minutes light + H ₂ O spray, 63±2.5° C black panel, 30±5% RH	PASS	PASS
Dimensional Stability	ASTM D1204	Conditioned for 6 hours in oven maintained at 176° F. Allowable change: ≤ 0.5%	PASS	PASS
Water Absorption	ASTM D570	Immersed in water at 158° F for 168 hours. Allowable change: ≤ 3%	PASS	PASS
Static Puncture	ASTM D5602	≥ 33 lbf.	PASS	PASS
Dynamic Puncture	ASTM 5635	≥ 14.7 ft.-lbf.	PASS	PASS

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Life Cycle Stages

Figure 1 shows the life-cycle stages and information modules that are included within the cradle-to-gate LCA system boundary of this EPD. The boundary is “cradle-to-gate”, including the Production stage (A1 to A3 modules). Construction, Use, and End-of-Life stages - are excluded from the system boundary. The Production stage system boundary is shown in Figure 3. Per ISO 21930, 7.1.7.2.1 [3], the system boundary with nature (natural environment) includes those technical processes that provide the material and energy inputs into the system and the subsequent manufacturing and transport processes up to the factory gate, as well as the processing of any waste arising from those processes.

Figure 1: Life cycle stages and modules

Production stage			Construction stage		Use stage							End-of-life stage			
Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition	Transport to waste processing or disposal	Waste processing	Disposal of waste
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)															

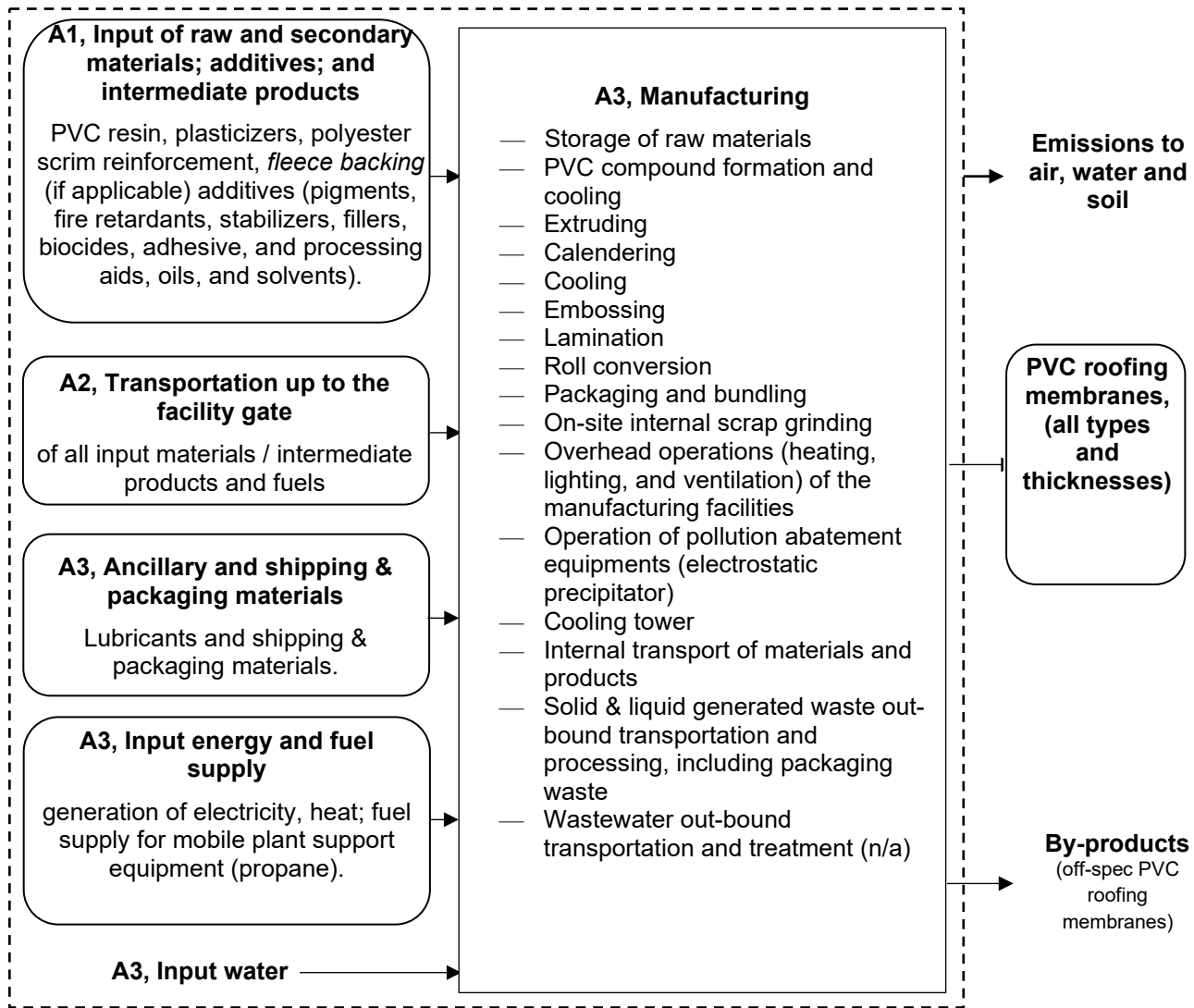
System Boundary

The PVC single-ply membrane is manufactured through an extruding process. Two layers of PVC sheet are laminated together with knit scrim reinforcement between. The polyester scrim is knit onsite at the manufacturing plant. The extruder manufactures master rolls of material which are then cut to length into smaller rolls. Internal off-spec scraps and edge trim cut from rolls during manufacturing are ground and compounded back into other processes; no external scrap is used in the membrane. Any off-spec or surplus scrap is sent to a company, where it is recycled into resilient flooring and concrete expansion joints.

The purchased electricity used at the facility is primarily used by process equipment like the calender, laminator, extruder, and roll converters. The laminator uses an electrostatic precipitator, a particulate collection device that removes aerosol plasticizers released during manufacturing. There is also a 1,110,000 BTU capacity 2.2.2 induced draft crossflow cooling tower. Natural gas supplied to the plant is used by IR heaters on the extruder and laminators and space conditioning, while propane is used by fork trucks to internally transport products and materials. The calender equipment uses a small amount of water as non-contact cooling water. The water does not come into contact with any chemicals; therefore, there is little to no risk of contamination. VOC emissions from the manufacturing process are calculated based on the amount of product manufactured and stack testing that took place when the equipment was installed. Minimal VOCs are produced during manufacturing which exempts the extruder from requiring any pollution abatement equipment. Figure 2 represents the inputs, outputs, and processes within the system boundary.



Figure 2: Product stage system boundary





Cut-off Rules

The cut-off criteria as per NSF PCR, Section 7.1.6 [6] and ISO 21930, 7.1.8 [3], were followed. All input/output data reported by the Michigan manufacturing plant were 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 pose a concern for 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 with generic plant data from 2018. Safety Data Sheet (SDSs) were provided for each additive, e.g., plasticizer, fire retardant, stabilizer, fleece backing, etc. As appropriate, any data gaps in the SDS are filled in with proxy and conservative generic LCI datasets.

This EPD excludes the following processes:

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

Data Quality

The LCA project report provides a detailed description of collected data and the data quality assessment regarding the NSF PCR requirements and ISO 14044. Data quality is assessed based on its representativeness (technology coverage, geographic coverage, time coverage), completeness, consistency, reproducibility, transparency, and uncertainty (Table 1).

Table 1. Data Quality Requirements and Assessments

Data Quality Requirements	Description
Technology Coverage	Data represents the prevailing technology at the Michigan facility. Whenever available, North American typical or average industry LCI datasets were utilized for all upstream and core material and processes. <i>Technological representativeness is characterized as "high".</i>
Geographic Coverage	The geographic region considered is the U.S. <i>Geographical representativeness is characterized as "high".</i>
Time Coverage	Activity data are representative. - Roofing membrane manufacturing process - primary data collected for the reference year 2020 (12 months) - In-bound/ out-bound transportation data- primary data collected for reference year 2020 (12 months) - Polyester scrim reinforcement production- U.S. industry data for the reference year 2010 (12 months) - Fleece backing data- SDS and confidential data provided by SOPREMA (2021) - Generic data: the most appropriate LCI datasets were used as found in the US LCI Database, ecoinvent v.3.5 database for the US and Global, 2018. <i>Temporal representativeness is characterized as "medium" to "high".</i>
Completeness	All relevant, specific processes, including inputs (raw materials, energy, and ancillary materials) and outputs (emissions and production volume), were considered and modelled. The relevant background materials and processes were taken from the US LCI Database (adjusted for known data placeholders), ecoinvent v 3.5 LCI database for the US, and modelled in SimaPro software v.9.2, 2021. The completeness of the cradle-to-gate 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 PVC single-ply roofing membranes used the same LCI modelling structure, which consisted of input raw, secondary (if applicable), 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 a high level of consistency.
Reproducibility	Internal reproducibility is possible since the data and the models are stored and available in the <i>Athena SOPREMA LCI database</i> developed in SimaPro, 2021. A high level of transparency is provided throughout the report as the LCI profile is presented for each of the declared products and primary upstream inputs. The supporting LCA project report summarizes key primary (manufacturer specific) and secondary (generic) LCI data sources.
Transparency	Activity and LCI datasets are transparently disclosed in the project report, including data sources.
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 sensitivity check includes the results of <i>sensitivity analysis</i> and <i>Monte Carlo uncertainty analysis of background data sets</i> .

Allocation

Per NSF PCR, Section 7.2 [6], allocation, if required, shall follow the requirements and guidance of ISO 14044:2006, Section 4.3.4 and ISO 21930, Section 7.2.5.

The Michigan manufacturing facility produces other co-products besides selected membranes, and as such and as per the PCR, allocation based on the mass of membrane products was necessary. “Mass” based, plant-specific formulation for 1m² of PVC roofing membranes were used to calculate the input raw the 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 PVC roofing membranes. In addition, allocation related to transport is based on the mass of transported inputs and outputs.





Product Material Content & Packaging

Tables 2 and 3 represent the formulation for the two declared products, consisting of polyester scrim reinforcement between a top and bottom layer of PVC film and the packaging materials. The membrane is rolled onto cardboard cores and stored on wood pallets with Styrofoam roll guards. Each pallet typically holds ten rolls and is secured with plastic banding.

Table 2: Formulation for 1 m² of Sentinel KEE P150 (60-mil) and Sentinel KEE P200 (80-mil) membrane

Raw Material Input	60-mil	80-mil
	% weight of the product	
PVC resin	59%	45%
Plasticizer	17%	29%
Polyester scrim reinforcement	12%	14%
Pigment	4%	4%
Flame retardant	<1%	<1%
Others – stabilizer, filler, processing aids, biocide	7%	6%
Total	100%	100%

Note: Total may not add to 100 due to rounding.

Table 3: Packaging materials for 1m² of Sentinel KEE P150 and Sentinel KEE P200

Packaging Material	Quantity (kg)
Wooden pallet	0.10
Cardboard core	0.04
Total	0.14





Life Cycle Assessment Results

Table 4 presents the “cradle-to-gate” LCA results for 1 m² of Sentinel KEE P150 & P200 PVC membrane for two nominal thickness.

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 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. *It is also noted that a number of LCA impact categories and inventory items are still emerging and/or under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in these categories: RPPE, RPRM, NRPPE, NRPRM, SM, RSF, NRSF, RE, HWD, NHWD, HLRW, ILLRW, CRU, MR, MER, EE” [6].*

Table 4: LCA results for 1 m² of Sentinel KEE P150 (60-mil) and Sentinel KEE P200 (80-mil) PVC membrane- Product Stage (A1-A3)

Impact category and inventory indicators	Unit	Sentinel KEE P150 & P200 PVC membrane Production stage (A1 to A3)	
		60 mils	80 mils
Global warming potential, GWP 100 ¹⁾	kg CO ₂ eq	5.1	8.1
Ozone depletion potential, ODP ¹⁾	kg CFC-11 eq	8.0E-07	1.1E-06
Smog formation potential, SFP ¹⁾	kg O ₃ eq	0.26	0.44
Acidification potential, AP ¹⁾	kg SO ₂ eq	0.026	0.041
Eutrophication potential, EP ¹⁾	kg N eq	0.041	0.085
Fossil fuel depletion, FFD ¹⁾	MJ surplus	11.6	17.9
Abiotic depletion potential, fossil ADPf ²⁾	MJ LHV	88.7	136.8
Renewable primary resources used as an energy carrier (fuel), RPR _E	MJ LHV	4.5	8.6
Renewable primary resources with energy content used as material, RPR _M ³⁾	MJ LHV	-	-
Non-renewable primary resources used as an energy carrier (fuel), NRPR _E	MJ LHV	69.0	103.5
Non-renewable primary resources with energy content used as material, NRPR _M ³⁾	MJ LHV	31.1	51.5
Secondary materials, SM ³⁾	kg	0	0
Renewable secondary fuels, RSF ³⁾	MJ LHV	-	-
Non-renewable secondary fuels, NRSF ³⁾	MJ LHV	-	-
Recovered energy, RE ³⁾	MJ LHV	-	-
Consumption of freshwater, FW ³⁾	m ³	1.4E-03	2.2E-03
Hazardous waste disposed, HWD ³⁾	kg	5.2E-03	7.9E-03
Non-hazardous waste disposed,	kg	1.5E-02	2.2E-02





Impact category and inventory indicators	Unit	Sentinel KEE P150 & P200 PVC membrane Production stage (A1 to A3)	
		60 mils	80 mils
NHWD ³⁾			
High-level radioactive waste, conditioned, to the final repository, HLRW ^{3) 4)}	m ³	5.8E-09	8.9E-09
Intermediate- and low-level radioactive waste, conditioned, to the final repository, ILLRW ^{3) 4)}	m ³	7.8E-10	1.3E-07
Components for re-use, CRU ³⁾	kg	-	-
Materials for recycling, MR ³⁾	kg	0.036	0.061
Materials for energy recovery, MER ³⁾	kg	-	-
Recovered energy exported from the product system, EE ³⁾	MJ LHV	-	-

Notes:

- ¹⁾ Calculated as per U.S EPA TRACI 2.1, v1.05, SimaPro v 9.2 [10]. GWP 100, 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 are not applicable 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 [10]. FFD is required in LEED V4.1 MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations [12].
- ²⁾ Calculated as per CML-IA Baseline V3.05, SimaPro v 9.2. ADP_f is also required in LEED V4.1 MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations [12].
- ³⁾ Calculated as per ACLCA ISO 21930 Guidance [11], respective sections 6.2 to 10.8.
- ⁴⁾ It should be noted that the foreground system (SOPREMA 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).
- 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].

Interpretation

The above represents a cradle-to-gate life cycle assessment for 1 m² of Sentinel’s KEE single-ply scrim reinforcement PVC roofing membrane in the nominal thicknesses of 60-mil and 80-mil. Across all the declared membranes, Module A1 *Extraction and upstream material input production* contributes the largest share of the LCIA category and energy indicator results – accounting for between 69% (smog) and 95% (eutrophication) of the potential environmental burdens. Module A2 *Transportation* contributed around 22% of the smog-related emissions, but was otherwise, a minor contributor (<10%) to the overall impact of membrane manufacture. Module A3 *Manufacturing* contributed 18% to non-renewable primary energy and is the second-largest contributor (<14%) to the overall potential environmental impacts of the membrane manufacture. Primary energy consumption is predominately fossil fuels at 96%. The industry standard scrim reinforcement is 9 x 9 threads per square inch, whereas SOPREMA reinforces its membrane with a high-strength weft-inserted polyester scrim with an 18 x 9 pattern. The high-density yarn helps improve the membrane's durability, strength, and longevity but may also increase the carbon footprint.





Additional Environmental Information

- The white and tan Sentinel membrane complies 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, and Green Building Institute's Green Globes. It is also an ENERGY STAR® qualified product.
- Sentinel membrane contains a maximum amount of around 10% secondary material.
- The membrane is up to 100% recyclable. Post-industrial scrap from the manufacturing process is recycled into the new membrane, walk-way pads, concrete expansion joints and resilient flooring.
- Sentinel white reflective roofs, when designed and installed properly, can help increase energy efficiency, especially the building's peak energy demand.
- Cool Roof Rating Council Product ID: 0610-0008.
 - Solar Reflective Index (initial value): 108 (White) and 88 (Tan).

Declaration Type

This "Cradle-to-gate" EPD applies to the Sentinel PVC roofing membranes (all colours) 60 and 80 mils nominal thicknesses. Production activities covered include the *extraction and upstream production, transport to factory and manufacturing* (modules A1 to A3). The declaration is intended for Business-to-Business (B-to-B) communication.

This Sentinel PVC roofing membrane EPD falls under the description:

- *A product-specific EPD from a manufacturer's plant.*

EPD Comparability Limitation Statement

- *Only EPDs prepared from cradle-to-grave life cycle results and based on the same function, RSL, quantified by the same functional unit, and meeting all the conditions for comparability listed in ISO 14025:2006 and ISO 21930:2017 can be used to make comparison between products.*
- *Declarations based on the NSF Product category rules are not comparative assertions; that is, no claim of environmental superiority may be inferred or implied.*





References

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