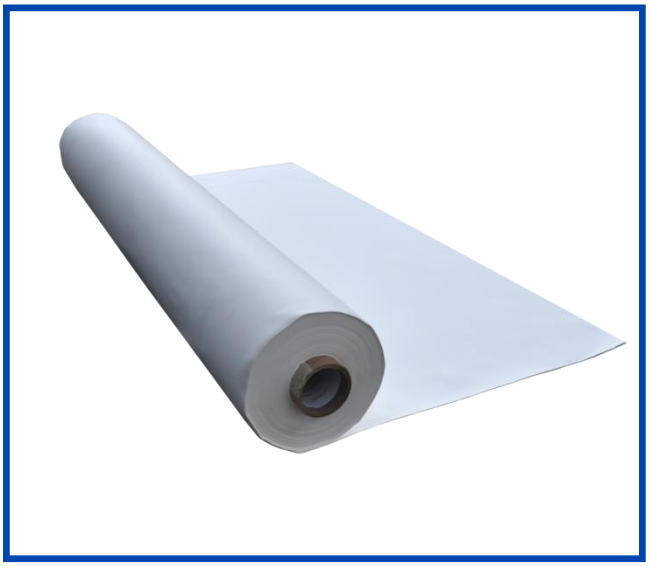
ENVIRONMENTAL PRODUCT DECLARATION

Duro-Last® EV | Single-Ply PVC Roof Membrane

ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION



Company Name	Duro-Last®, Inc.
Product Type	Single-ply PVC roofing
Product Name	Duro-Last EV 50-mil & 60-mil
Manufacturing Site	525 Morley Drive Saginaw, MI 48601
EPD Scope	Cradle-to-gate
Declared Unit	1 m^2

Product Description

The Duro-Last® EV PVC roof membrane is a proprietary thermoplastic formulation which 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. Duro-Last EV 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 Duro-Last EV single-ply membrane in 50-mil and 60-mil nominal thicknesses. The Duro-Last EV membrane was engineered to be used with the complete line of Duro-Last EV precision-fabricated flashings for curbs, stacks, and parapets. Duro-Last EV can be applied by a Duro-Last certified contractor using a variety of methods including: mechanically fastened, Duro-Bond® induction welding, or fully adhered. Nearly all Duro-Last EV membrane installations are inspected by Duro-Last's certified Quality Assurance Technical Representatives.

Company Information

Duro-Last, Inc. began in 1978 with the simple need to find a roofing system that worked. Existing roofing systems presented a common problem - they required ongoing maintenance and continual expense, with no long-term solution in sight. Investigation of the roofing industry proved that the majority of roofing system failures then (and still today) is not due to the roofing system assembly itself, but to workmanship onsite. To solve this problem we brought our roofing system "in-house," developing custom prefabrication methods and specialized equipment that allows us to complete the difficult details with custom prefabricated accessories. The result is lower on-site labor costs and better installation quality. Duro-Last is now the world's largest manufacturer of prefabricated roofing systems. The Duro-Last Roofing System, contractor installation team, customer service and warranty all set the quality standards for the roofing industry.

Certified Environmental Product Declaration
www.nsf.org

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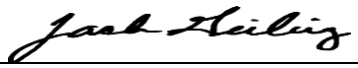
EPD Information			
Program Operator		NSF International	
Declaration Holder		Duro-Last, Inc.	
Product: Duro-Last EV 50-mil and 60-mil	Date of Issue 10/08/2015 Date of Update 09/27/2017	Valid Until 10/08/2020	Declaration Number EPD10066
This EPD was independently verified by NSF International in accordance with ISO 14025: ☐ Internal ☒ External		 Jenny Oorbeck joorbeck@nsf.org	
This life cycle assessment was independently verified by in accordance with ISO 14044 and the reference PCR:		 Jack Geibig jgeibig@ecoform.com	
LCA Information			
Basis LCA		Product Stage Life Cycle Assessment of Duro-Last EV Single-Ply PVC Roofing Membrane July 15, 2015	
LCA Preparer		Katie Chapman Duro-Last, Inc. kchapman@duro-last.com	
This life cycle assessment was critically reviewed in accordance with ISO 14044 by:		Jack Geibig jgeibig@ecoform.com	
PCR Information			
Program Operator		ASTM International	
Reference PCR		PCR for Single-Ply Roofing Membranes	
Date of Issue		November 13, 2014	
PCR review was conducted by:		Francois Charron-Doucet Quantis International Francois.charron@quantis-intl.com	

The underlying LCA report for EPD development purposes does not include comparative assertions. LCAs and EPDs not covering all life cycle stages, or based on different PCR, are examples of studies and EPDs offering limited comparability. This LCA report is based on cradle-to-gate information and, therefore, shall not be used for comparisons unless such comparisons are made in a building context using a functional unit, and comply with all the requirements set out in ISO 14025, section 6.7.2.
Given the LCA study included only the product stage in the system boundary, the intended audience of this EPD is for business-to-business purposes only.

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Product Specifications

Physical Property	Test Method	ASTM 4434 Requirement for Type III Sheet	50-mil Result	60-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	Pending
Heat Aging	ASTM D3045	Conditioned for 56 days in oven maintained at 176° F.	Pending	Pending
Accelerated Weathering	ASTM G154 (formerly G53)	5,000 hours total test time. Irradiance level of 0.68 W/m^2-nm. Cycle: 8 hours at 145° F, 4 hours condensation at 122° F.	Pending	Pending
Dimensional Stability	ASTM D1204	Conditioned for 6 hours in oven maintained at 176° F. Allowable change: ≤ 0.5%	PASS	Pending
Water Absorption	ASTM D570	Immersed in water at 158° F for 168 hours. Allowable change: ≤ 3%	Pending	Pending
Static Puncture	ASTM D5602	≥ 33 lbf.	PASS	Pending
Dynamic Puncture	ASTM 5635	≥ 14.7 ft.-lbf. (20 J)	PASS	Pending

Additional Testing Requirements

Duro-Last EV has met or exceeded all major fire and wind code requirements, and regional approvals as necessary throughout the country. Duro-Last EV has been approved by Factory Mutual as a 1-60, 1-90, 1-165, and 1-915 roofing system. Duro-Last is also listed by Underwriters Laboratories as a Class A, B, & C approved material.

Further testing information and results can be found in the Specs & Technical Info section of the Duro-Last website at duro-last.com.

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Life Cycle Stages

The LCA was conducted on a "cradle-to-gate" basis- Table 1 shows the life-cycle stages and individual modules that are included within the LCA system boundary. The product stage modules included in the system boundary incorporate the following processes:

- Extraction and processing of raw materials, including fuels used in production;
- Transportation of raw materials and recycled materials from extraction site to manufacturing site, including empty backhauls;
- Manufacturing of the product;
- Packaging of product ready for shipment;
- Transportation from manufacturing site to recycling/reuse/landfill for pre-consumer wastes and unutilized by-products from manufacturing, including empty backhauls; and
- Recycling/reuse/energy recovery of pre-consumer wastes and by-products from production.

Construction process, use, and end-of-life stages are excluded from the system boundary. Those life cycle stages include:

- Transportation of product from manufacturing site to building site, including empty backhauls;
- Installation on the building site including all ancillary materials and taking account of whether the roofing product is fully adhered or mechanically attached;
- Waste produced on the building site;
- Service life of the building;
- Any maintenance/replacement of the building product;
- Dismantling/demolition;
- Transportation from building site to recycling/reuse/landfill, including empty backhauls;
- Disposal.

Table 1: Life cycle stages and modules

Product Stage			Construction Process Stage		Use Stage							End-of-Life Stage			
Raw Material Supply	Transport	Manufacturing	Transport	Construction- Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition	Transport	Waste processing	Disposal
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-

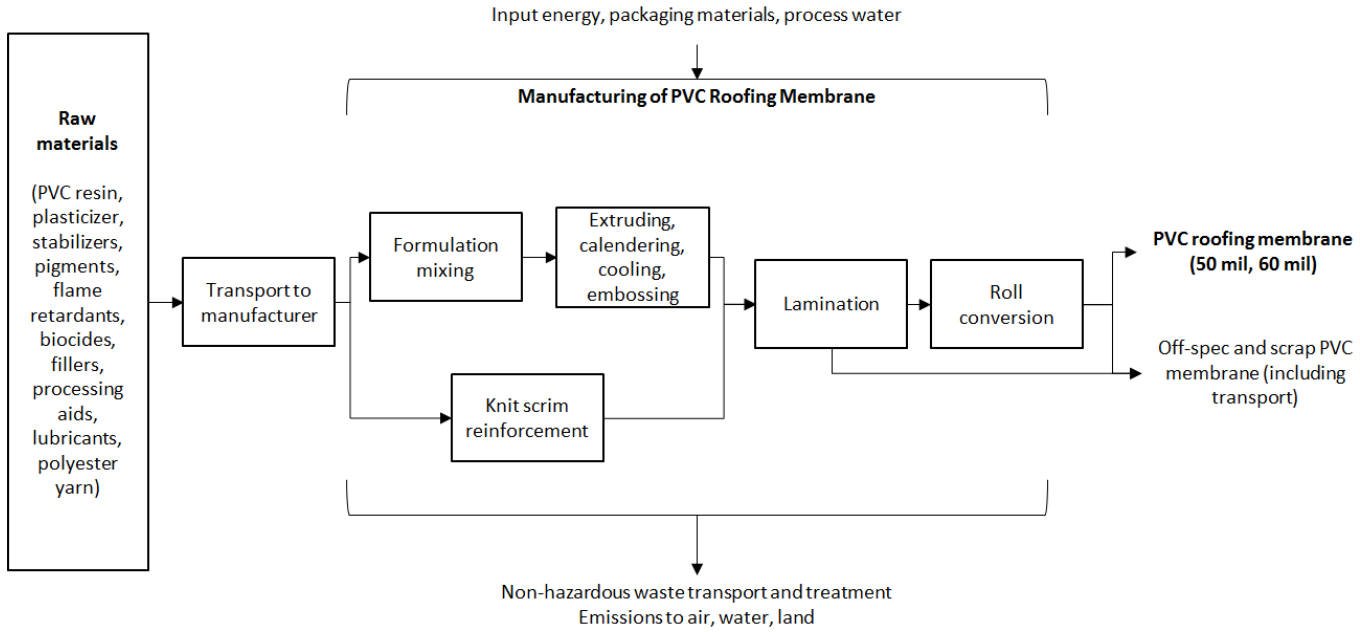
X: included in system boundary - : excluded from system boundary

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 is ground and compounded back into other processes; there is no external scrap being used in the membrane. Any contaminated or surplus scrap is sent to the Duro-Last sister company, Oscoda Plastics®, where it is recycled into concrete expansion joints.

The purchased electricity used at the facility is primarily used by process equipment like the extruder, cooling tower, and knitters. Natural gas supplied to the plant is used only for space conditioning, and propane is used by fork trucks to internally transport product and materials. There are two closed-loop cooling processes which cycle water through a cooling tower and back into the manufacturing process. The water does not come into contact with any chemicals, so 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. The manufacturing process does not produce any regulated hazardous waste. Figure 1 represents the inputs, outputs, and processes within the system boundary.

Figure 1: Product stage system boundary



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Cut-off Rules

The cut-off criteria for flows to be considered within each system boundary as described in ASTM Single-Ply Roofing Membrane PCR: 2013, section 7.2, are applied.
No flow data were excluded based on the PCR cut-off criteria.

Data Quality

Duro-Last EV is manufactured on new extruding equipment installed in 2014. The construction was completed in November 2014 and production began the following month. Metered data that reflects current production volumes is available from December 2014 to June 2015. Electricity and natural gas inventories were collected from utility invoices and represent all the manufacturing processes including: compounding, extruding, laminating, roll conversion, lighting, and building HVAC. Water consumption data was read directly from the equipment's water meter. Raw material extraction locations and modes of transportation were provided by the raw material suppliers. No primary material or process data was excluded in the LCI. The most appropriate LCI datasets were used as found in the US LCI and Ecoinvent 3 databases.

- **Temporal coverage:** Foreground data are based on 7 months of data due to the recent installation of the manufacturing equipment.
- **Technological coverage**: The raw material inputs in the calculation for this LCA are based on the formulation used for 1 batch of white 50-mil and 60-mil membrane.
- **Geographical coverage:** The geographical coverage is the US and Canada. Additionally, European data or global data were used when North American data was not available.

Allocation

The extruder equipment, which manufactures Duro-Last EV, produces three different PVC roofing product lines. The processes to manufacture each product are very similar and there is no significant difference in equipment operation. Therefore the electricity, natural gas, and water consumption was allocated equally amongst the total material produced.

Product Material Content & Packaging

Tables 2 and 3 represent the formulation for the two declared products which consists of polyester scrim reinforcement between a top and bottom layer of PVC film as well as the packaging materials. The finished product is rolled onto cardboard cores and stored on wood pallets. Each pallet holds ten rolls and is secured with plastic banding and stretch wrap.

Table 2: Formulation for 1 m^2 of 50-mil and 60-mil white Duro-Last EV membrane

Raw Material Input	50-mil	60-mil
	% weight of product	
PVC resin	39%	39%
Plasticizer & Elvaloy resin	28%	29%
Polyester scrim reinforcement	22%	21%
Pigment	5%	5%
Flame retardant	<1%	<1%
Other materials	5%	5%
Biocide, Phonoxarsine, 10, 10'-oxydi-	<1%	<1%

Total	**100%**	**100%**

Table 3: Packaging materials for 1m^2 of 50-mil and 60-mil white Duro-Last EV membrane

Packaging Material	Quantity (kg)
Wooden pallet	0.06
Cardboard core	0.04
Stretch wrap	1.44E-03
Plastic banding	4.88E-04
Total	**0.10**

Life Cycle Assessment

Impact Categories and Assessment Methodologies

The life cycle impact assessment (LCIA) method used was the U.S. EPA TRACI 2.1 v1.02/U.S. 2008, as required by ASTM SPRM PCR: 2013. The SPRM PCR also requires the following resource use and waste indicators to be reported:

- Total primary energy consumption in MJ; renewable and non-renewables.
- Material resource consumption; renewable and non-renewable materials, and fresh water.
- Hazardous and non-hazardous waste generated.

The total primary energy consumption information was compiled by the Cumulative Energy Demand method. The material resource consumption and generated wastes were compiled by a custom method to represent cumulative life cycle inventory data.

Life Cycle Assessment Results

The LCIA describes the potential environmental impacts based on the life cycle inventory. Table 4 details the cradle-to-gate LCA results from the two declared units; 50-mil and 60-mil white PVC membrane.

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Table 4: LCA results for 1 m^2 of 50-mil and 60-mil white PVC membrane: Product Stage (A1-A3)

Category Indicator	Unit	50-mil	60-mil
Ozone depletion potential	kg CFC-11 eq.	3.81E-07	4.59E-07
Global warming potential	kg CO_2 eq.	4.52	4.93
Smog creation potential	kg O_3 eq.	0.26	0.29
Acidification potential	kg SO_2 eq.	0.03	0.03
Eutrophication potential	kg N eq.	0.01	0.01
Primary Energy Consumption			
Nonrenewable, fossil	MJ	98.78	106.5
Nonrenewable, nuclear	MJ	6.81	7.63
Nonrenewable, biomass	MJ	0.00	0.00
Renewable, biomass	MJ	2.46	2.53
Renewable, wind, solar, geothermal	MJ	0.16	0.18
Renewable, water	MJ	0.67	0.77
Material Resource Consumption			
Nonrenewable materials	kg	0.47	0.54
Renewable materials	kg	0.02	0.03
Fresh water	l	12.83	16.83
Waste Generated			
Hazardous	kg	0.00	0.00
Non-hazardous	kg	3.59E-04	3.85E-04

Interpretation

The above represents a cradle-to-gate life cycle assessment for 1 m^2 of Duro-Last EV white single-ply polyester reinforced roofing membrane in the nominal thicknesses of 50-mil and 60-mil. Raw material extraction contributes to the largest percentage for all membrane thicknesses in all of the impact categories, especially ozone deletion at 100% and eutrophication potential at 99%. Manufacturing is the second largest contributor with a higher impact in global warming potential, smog and acidification. Transportation to the manufacturer has minimal impact in each of the characterizations. However, the transportation's highest impact is smog potential.

There are some limitations of the study since only the product stage is represented and not the full life cycle of the product. As more data are collected on building service life and maintenance of the product then it is recommended to complete another LCA study to include all life cycle stages. Another limitation of this study is the energy and water data is based on 7 months of operation given the product is manufactured on new equipment. However, the LCA exercise is an opportunity to set a baseline to improve upon the future years of operation.

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Additional Environmental Information

- Duro-Last EV is NSF 347 Sustainability Assessment for Single-Ply Roofing Gold Certified
- White Duro-Last EV complies with efficiency programs requiring the use of highly reflective roofing like California Title 24, U.S Green Building Council's Leadership in Energy and Environmental Design (LEED®) rating system, the International Green Construction Code (IgCC), International Energy Conservation Code (IECC), and the Green Building Initiative's Green Globes.
- The membrane is up to 100% recyclable. Post-industrial scrap from the manufacturing process is recycled into new membrane and concrete expansion joints.
- Existing Duro-Last EV roofs can also be taken back from the roofing contractor and recycled into new products.
- Duro-Last EV white reflective roofs, when designed and installed properly, can help increase energy efficiency, especially in relation to the building's peak energy demand.
- Cool Roof Rating Council Product ID: 0610-0011

	Solar Reflectance		Thermal Emittance		Solar Reflective Index (SRI)	
	Initial	3-yr	Initial	3-yr	Initial	3-yr
White	0.86	Pending	0.89	Pending	108	Pending

References

1. ASTM International, Product Category Rules for Preparing an Environmental Product Declaration for Single-Ply Roofing Membranes, November 2013.
2. ISO 21930: 2007 Building Construction – Sustainability in building construction – Environmental declaration of building products.
3. ISO 14025: 2006 Environmental labeling and declarations – Type III environmental declarations – Principles and procedures.
4. ISO 14044: 2006 Environmental management – Life cycle assessment – Requirements and guidelines.
5. ISO 14040: 2006 Environmental management – Life cycle assessment – Principles and framework.
6. EN 15804: 2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.
7. Athena Sustainable Materials Institute, A Cradle-to-Building with EOL stage Life Cycle Assessment of White, Single-Ply Polyester Reinforced PVC Roofing Membrane Products, April 2014.

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