DURO-LAST® THE WORLD'S BEST ROOF®

Duro-Last® | Single-ply PVC roof membrane

ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

Company Name	Duro-Last, Inc.
Product Type	Single-ply PVC roofing
Product Name	Duro-Last 40-mil, 50-mil, 60-mil
Manufacturing Site	525 Morley Drive Saginaw, MI 48601
Custom Fabrication Sites	Saginaw, MI; Jackson, MS; Grants Pass, OR; Carrollton, TX; Sigourney, IA; Ludlow, MA
EPD Scope	Cradle-to-gate
Declared Unit	1 m^2

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. Our Founder, John R. Burt, used his experience in fabricating pool liners to develop a remarkable new roofing membrane. Investigation of the roofing industry proved that the majority of roofing system failures then were not due to the roofing system assembly itself but to workmanship on-site. To solve this problem we brought our roofing system "in-house," developing custom prefabrication methods and specialized equipment that allows us to complete nearly all of the difficult roof details and up to 85% of field seams. The result is lower on-site labor costs and better installation quality.

Product Description

The Duro-Last PVC roof membrane is a proprietary thermoplastic formulation which provides highly reflective, durable, superior quality product. An 18 x 14 weft-inserted anti-wicking knit scrim that is laminated between two layers of PVC film gives the membrane its strength and durability. This EPD applies to the Duro-Last single-ply membrane in white, gray, dark gray, and tan in 40-mil, 50-mil, and 60-mil nominal thicknesses as well as the Duro-Fleece Plus, Rock-Ply and Shingle-Ply designer series. The Duro-Last membrane can be prefabricated into deck sheets up to 2,500 square feet in size then mechanically attached to the roof substrate or purchased as a rolled good and installed fully adhered or mechanically attached. Nearly all Duro-Last membrane installations are inspected by Duro-Last's certified Quality Assurance Technical Representatives.

NSF™ Certified Environmental Product Declaration www.nsf.org

EPD Program Operator
NSF International789 N. Dixboro Rd.
Ann Arbor MI 48105 USA
www.nsfsustainability.org

Date of Issue: 01/21/2015
Date of Update: 09/27/2017
Valid Until: 01/21/2020
Declaration#: EPD10049

NSF Sustainability℠ Sustainability Assured

ENVIRONMENTAL PRODUCT DECLARATION

DURO-LAST® THE WORLD'S BEST ROOF®

ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

EPD Information			
Program Operator		NSF International	
Declaration Holder		Duro-Last, Inc.	
Product 40-mil, 50-mil and 60-mil	Date of Issue 01/21/2015 Date of Update 09/27/2017	Valid Until 01/21/2020	Declaration Number EPD10049
This EPD was independently verified by NSF International in accordance with ISO 14025 and ISO 29130: ☐ 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 Single-ply PVC Roofing Membrane November 17, 2014	
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 EcoForm 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.

DURO-LAST® THE WORLD'S BEST ROOF®

Product Specifications

Physical Property	Test Method	ASTM 4434 Requirement	40-mil Result	50-mil Result	60-mil Result
Overall Thickness	ASTM D751	≥ 0.036 in.	PASS	PASS	PASS
Thickness Over Scrim	ASTM D7635	≥ 0.016 in.	PASS	PASS	PASS
Breaking Strength	ASTM D751 Grab Method	≥ 275 lbf./in.	PASS	PASS	PASS
Elongation	ASTM D751 Grab Method	≥ 25%	PASS	PASS	PASS
Seam Strength	ASTM D751 Grab Method	≥ 330 lbf. (75% of Breaking Strength)	PASS	PASS	PASS
Tear Strength	ASTM D751 Procedure B	≥ 90 lbf.	PASS	PASS	PASS
Low Temp. Bend	ASTM D2136	Must pass at -40° F.	PASS	PASS	PASS
Heat Aging	ASTM D3045	Conditioned for 56 days in oven maintained at 176° F.	PASS	PASS	PASS
Accelerated Aging	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.	PASS	PASS	PASS
Dimensional Stability	ASTM D1204	Conditioned for 6 hours in oven maintained at 176° F. Allowable change: ≤ 0.5%	PASS	PASS	PASS
Water Absorption	ASTM D570	Immersed in water at 158° F for 168 hours. Allowable change: ≤ 3%	PASS	PASS	PASS
Static Puncture	ASTM D5602	≥ 33 lbf.	PASS	PASS	PASS
Dynamic Puncture	ASTM 5635	≥ 14.7 ft.-lbf. (20 J)	PASS	PASS	PASS

Additional Testing Requirements

Duro-Last has met or exceeded all major fire and wind code requirements, and regional approvals as necessary throughout the country. Duro-Last has been approved by Factory Mutual as a 1-60, 1-75, 1-90, 1-95, 1-105, 1-135, 1-150, 1-165, 1-195, 1-210, 1-270, 1-435, and 1-495 roofing system. Duro-Last is also listed by Underwriters Laboratories as a Class A, B, & C approved material. Evaluation services ICBO and NES have merged to form ICC-ES, which has evaluated Duro-Last for the International Building Code (IBC). The Duro-Last roofing system has been approved by the IBC and by code agency MIAMI-DADE for use in their respective jurisdictions.

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

DURO-LAST® THE WORLD'S BEST ROOF®

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 are included in the system boundary which incorporates the following processes:

- Extraction and processing of raw materials, including fuels used in product 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

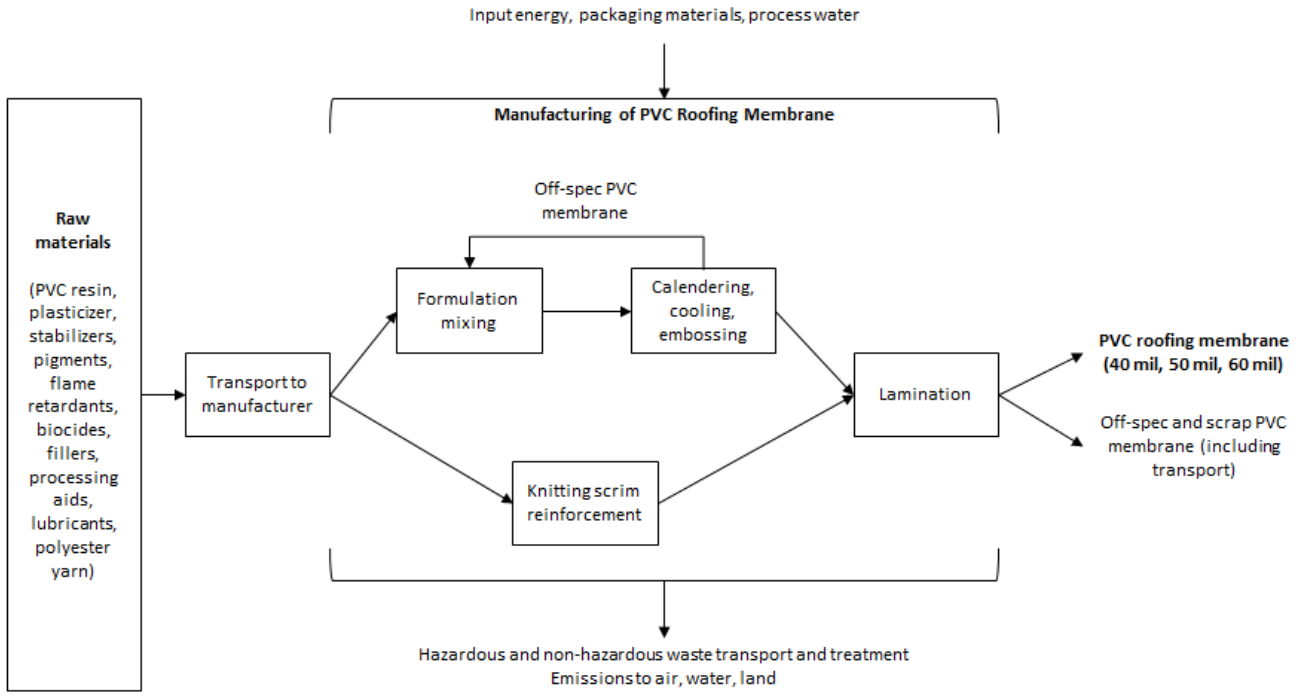
DURO-LAST® THE WORLD'S BEST ROOF®

System Boundary

The PVC single ply membrane is manufactured through a calendering process to make the PVC sheet. A knit scrim reinforcement is laminated between two layers of PVC film. The scrim is knitted onsite at the manufacturing plant. During the calendering process, edge trim is cut off and re-melted in the calender. Internal off-spec scraps cut from rolls during inspection is ground and compounded back into the PVC formulation; this is a closed loop process as there is no external scrap being used in the membrane. Any contaminated or surplus scrap is sent to a sister company, Oscoda Plastics®, where it is made into resilient flooring, walk-way pads, and concrete expansion joints.

The purchased electricity used at the facility is primarily used by process equipment like the calender, laminator, and knitters. The laminator uses an electrostatic precipitator which is a particulate collection device that removes aerosol plasticizer released during manufacturing. There is also a 1,110,000 BTU capacity 2.2.2 induced draft cross flow cooling tower. Natural gas supplied to the plant is used by ovens and space conditioning, while propane is used by fork trucks to internally transport product and materials. A small amount of water is used as non-contact cooling water by the calender equipment. 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. Figure 1 represents the inputs, outputs, and processes within the system boundary.

Figure 1: Product stage system boundary



DURO-LAST® THE WORLD'S BEST ROOF®

Cut-off Rules

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

Data Quality

The inventory data used was collected by the manufacturing facility from calendar year 2013. Electricity, natural gas and water inventories were taken from utility invoices and represent all the manufacturing processes including; compounding, calendering, laminating, grinding of internal scrap, lighting, and building HVAC. Raw material extraction locations and modes of transportation were provided by the raw material supplier. No primary material or process data was excluded in the LCI. The most appropriate LCI datasets were used as found in the U.S. LCI and Ecoinvent 3 databases.

- **Temporal coverage:** foreground data are based on 1 year of data from 2013.
- **Technological coverage**: the raw material inputs in the calculation for this LCA are based on the formulation used for 1 batch each of white 40-mil, 50-mil, and 60-mil membranes.
- **Geographical coverage**: the geographical coverage is the U.S. and Canada. Additionally, European data or global data were used when North American data was not available.

Allocation

The manufacturing site produces a wide range of PVC film products including white and colored roofing membrane, geomembrane, and decking membrane. White roofing membrane accounts for 88% of annual total square footage manufactured while the remaining products make up 12% of production. Given the processes and energy intensity is not significantly different between products, the total energy and water consumption was reduced by 12% before allocating to total length of white membrane produced.
The inherent properties of the internal regrind scrap do not change and is treated as closed-loop recycling. The energy used in the grinding and compounding processes is included in the total building energy consumption.

Product Material Content & Packaging

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

Table 2: Formulation for 1 m^2 of 40-mil, 50-mil, and 60-mil white Duro-Last membrane

Raw Material Input	40-mil	50-mil	60-mil
	% weight of product		
PVC resin	36%	39%	40%
Plasticizer	21%	23%	24%
Polyester scrim reinforcement	24%	19%	16%
PVC film, pre-consumer	9%	9%	10%
Pigment	4%	3%	3%
Flame retardant	2%	3%	3%

Other materials	4%	4%	4%
Total	**100%**	**100%**	**100%**

Table 3: Packaging materials for 1m^2 of 40-mil, 50-mil, and 60-mil white Duro-Last membrane

Packaging Material	Quantity (kg)
Wooden pallet	0.30
Cardboard core	0.08
EPS roll guard	0.02
Plastic banding	0.00
Total	**0.40**

Life Cycle Assessment

Impact Categories and Assessment Methodologies

The life cycle impact assessment (LCIA) method used was the U.S. EPA TRACI 2.1 v1.01/U.S. 2008, as required by ASTM SPRM PCR: 2013. The SPRM PRC 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 three declared units; 40-mil, 50-mil, and 60-mil white PVC membrane.

DURO-LAST® THE WORLD'S BEST ROOF®

Table 4: LCA results for 1 m^2 of 40-mil, 50-mil, and 60-mil white PVC membrane- Product Stage (A1-A3)

Category Indicator	Unit	40-mil	50-mil	60-mil
Ozone depletion potential	kg CFC-11 eq.	4.14E-07	5.11E-07	6.15E-07
Global warming potential	kg CO_2 eq.	5.82	6.70	7.62
Smog creation potential	kg O_3 eq.	0.40	0.47	0.55
Acidification potential	kg SO_2 eq.	0.04	0.04	0.05
Eutrophication potential	kg N eq.	0.03	0.03	0.04
Primary Energy Consumption				
Nonrenewable, fossil	MJ	113	133	154
Nonrenewable, nuclear	MJ	5.69	6.27	6.93
Nonrenewable, biomass	MJ	0.00	0.00	0.00
Renewable, biomass	MJ	8.44	8.74	9.04
Renewable, wind, solar, geothermal	MJ	0.20	0.26	0.25
Renewable, water	MJ	0.82	0.94	1.08
Material Resource Consumption				
Nonrenewable materials	kg	0.28	0.33	0.40
Renewable materials	kg	0.03	0.03	0.04
Fresh water	l	33.40	42.30	51.80
Waste Generated				
Hazardous	kg	1.6E-05	1.6E-05	1.6E-05
Non-hazardous	kg	2.5E-04	2.5E-04	2.5E-04

Interpretation

The above represents a cradle-to-gate life cycle assessment for 1 m^2 of Duro-Last white single-ply scrim reinforcement roofing membrane in the nominal thicknesses of 40-mil, 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 depletion at 99.9% and eutrophication potential at 99%. Manufacturing is the second largest contributor with a higher impact in global warming potential, smog and acidification. Transport to manufacturer has minimal impact in each of the characterizations. However, the transportation's highest impact is smog potential from the combustion of fossil fuels. Primary energy consumption is predominately fossil fuels at 84%, nuclear contributes 8% and biomass and renewable energy make up the remaining. The industry standard scrim reinforcement is 9 x 9 threads per square inch, whereas Duro-Last reinforces its membrane with a high-strength weft-inserted polyester scrim with an 18 x 14 pattern. The high density yarn helps improve the durability, strength and longevity of the membrane but may also increase the carbon footprint.

Additional Environmental Information

- The Duro-Last membrane is NSF 347 Sustainability Assessment for Single-Ply Roofing Platinum certified.
- The white Duro-Last 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.
- Duro-Last membrane contains a maximum amount of 10% pre-consumer recycled content and 0% post-consumer recycled content.
- The membrane is up to 100% recyclable. Post-industrial scrap from the manufacturing process is recycled into new membrane, walk-way pads, concrete expansion joints and resilient flooring.
- Duro-Last 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: 0610-0001 Duro-Last White membrane
    - Solar Reflective Index (initial value): 111

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. ECOBILAN, Eco-profile of high volume commodity phthalate esters (DEHP/DINP/DIDP), January 2001.
8. 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.