ENVIRONMENTAL PRODUCT DECLARATION

NON-REINFORCED EPDM MEMBRANE

SINGLE PLY ROOFING MEMBRANE
INSTALLATION: FULLY ADHERED

Singly ply, non-reinforced EPDM membrane installed using low-VOC adhesive and representative of 45, 60, and 90 mil thicknesses

SPRI is the recognized technical and statistical authority on the Single Ply Roofing Industry. SPRI provides the best forum for its members to collectively focus their industry expertise and efforts on critical industry issues. By acting as a trade organization, as opposed to each member working individually, the group can effectively improve product quality, installation techniques, workforce training and other issues common to the industry. This approach enables every SPRI member to operate more effectively in the commercial roofing marketplace.

SPRI represents sheet membrane and related component suppliers in the commercial roofing industry. Since 1981, SPRI has been an excellent resource for building owners, architects, engineers, specifiers, contractors and maintenance personnel, providing objective information about commercial roofing components and systems.

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.

PROGRAM OPERATOR	UL Provided
DECLARATION HOLDER	UL Provided
DECLARATION NUMBER	UL Provided
DECLARED PRODUCT	EPDM Non-Reinforced Single Ply Roofing Membrane (Fully Adhered)
REFERENCE PCR	UL Provided
DATE OF ISSUE	UL Provided
PERIOD OF VALIDITY	UL Provided
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications
The PCR review was conducted by:	UL Provided
	UL Provided
	UL Provided
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	
	UL Provided
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	
	UL Provided

Participating Members

The following SPRI members provided data for the product under study:

Carlisle SynTec Systems
1285 Ritner Hwy
Carlisle, PA 17013
www.carlislesyntec.com

Johns Manville
P. O. Box 5108
717 17th Street
Denver, CO 80217-5108
www.jm.com

Firestone Building Products
250 West 96th Street
Indianapolis, IN 46260
www.firestonebpco.com

Product Definition

Description of Product

The product system evaluated in this report is an installed single ply non-reinforced EPDM roofing membrane at the finished nominal thicknesses listed in Table 1.

Table 1: Membrane specification and standard

Roof System	Roof System Component	Declared Thicknesses and Weights	Standard
Non-reinforced ethylene propylene diene monomer (EPDM)	Membrane	45 mils: 1.55 kg/m^2 60 mils: 2.07 kg/m^2 90 mils: 3.12 kg/m^2	ASTM D4637

Application and Uses

EPDM is an extremely durable synthetic rubber single-ply roofing membrane used worldwide in low-slope buildings (roof slope < 2:12). It is classified as a thermoset material with the seams of the roofing system sealed with liquid adhesives or specially formulated tape. EPDM is available in both black and white and is sold in a variety of widths and thicknesses. Non-reinforced EPDM membranes do not have a reinforcement scrim and are designed for use in adhered assemblies.

There are many variables that must be considered when deciding which single ply membrane to select for a particular job. Some examples of variables that should be considered are; meeting local building and energy code requirements, roof layout (e.g. are there numerous penetrations?), required design life, cost (initial and over the required design life), and product instillation expertise of the roofing contractor.

Installation

The installation process was modeled following common practice in which non-reinforced EPDM is fully adhered using appropriate adhesives. The most common low slope roof consists of a metal deck, then a layer of insulation; cover board (optional) and then the roof membrane. Fully adhered systems can be installed in a variety of ways. The underlying boards (insulation/cover boards) can be either mechanically attached or glued to the roof deck and each other. The roof membrane is glued directly to the insulation below. Securement of the boards to the structural deck requires more fasteners because these boards are serving the dual role of insulating and securing the roof to the metal deck.

Product Life Cycle Description

Material Content

Table 2 shows the input material for non-reinforced EPDM roofing membranes and their material percentages for the three membrane thicknesses.

Table 2: Average composition of non-reinforced EPDM roofing membrane

Material	45 mils [%]	60 mils [%]	90 mils [%]
EPDM base resin	28	29	30
Filler	25	24	25
Pigment	21	20	19
Paraffinic oil	18	17	17
EPDM scrap (internal)	5	5	4
Curative	1	1	1
Activator	1	1	1
Fire retardant	<1	2	2
Processing aid	<1	<1	<1
Naphthenic oil	<1	<1	<1
Anti-oxidizing agent	<1	<1	<1

Manufacturing Process

The main material input into the manufacturing process is EPDM rubber in the form of pellets and (uncured) scrap. Additional materials include various additives, which aid in the manufacturing process (e.g., accelerators) and which enhance the membrane's performance (e.g., fire retardants and pigments). The mix is heated, stirred and extruded into a sheet. The sheet is then pressed to achieve the specified thickness, cut and rolled up along with protective plastic sheeting. EPDM scrap generated during the aforementioned steps can be directly looped back as a material input, before the subsequent curing (or vulcanizing) process alters the rubber material irreversibly, making it unfit as a scrap input. Curing entails the rolled up membrane being wrapped to create pressure and placed in an oven. Once cured, the membrane sheet maintains its shape and size. Optionally, a reinforcing polyester scrim can be applied to the membrane before curing, producing reinforced EPDM (see SPRI's EPD for EPDM reinforced roofing membranes

for details). The finished product is allowed to cool on rollers, then transferred onto large cardboard rolls and wrapped in plastic film to be shipped to building sites for installation.

Figure 1 shows the manufacturing process for EPDM; certain aspects may vary by manufacturer.

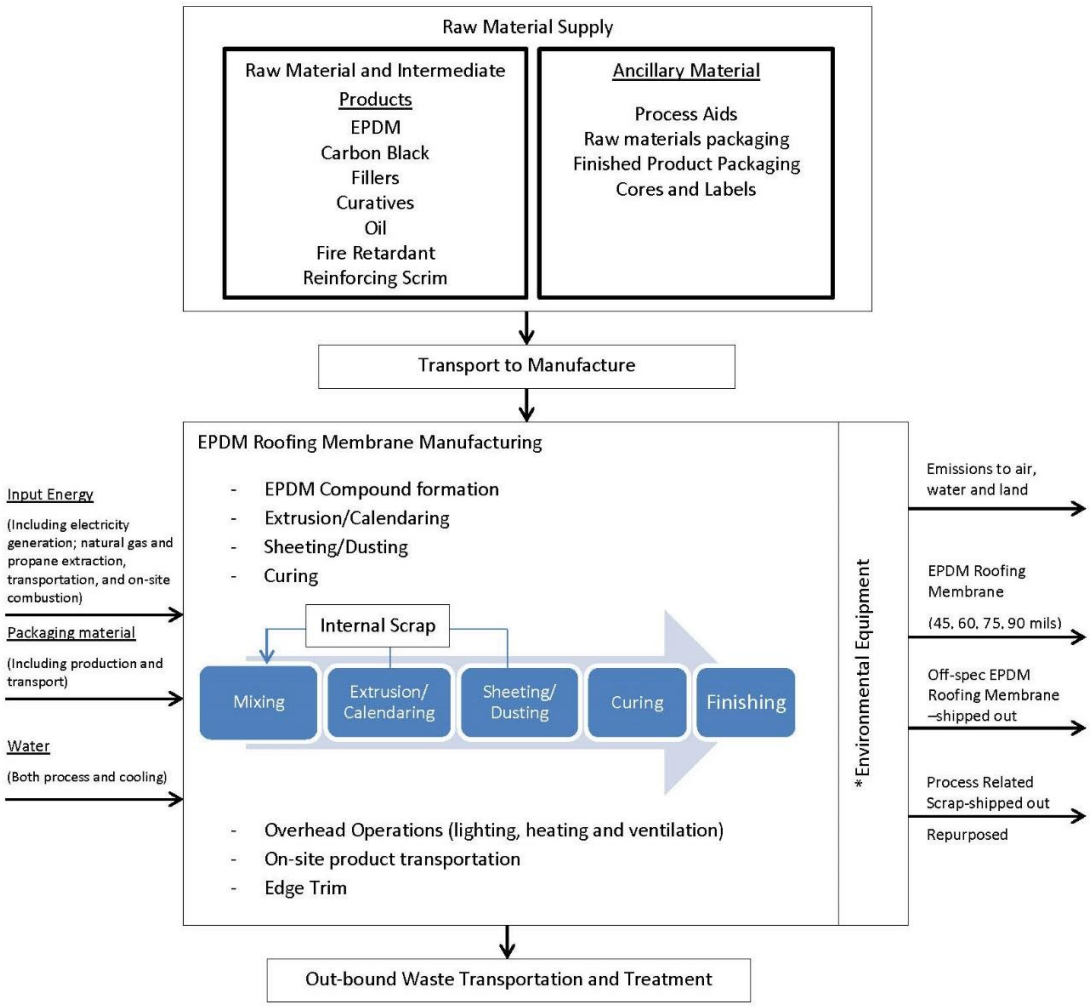

Figure 1: EPDM production process map (courtesy of Johns Manville)

Installation

Table 3 shows the production-weighted industry average material inputs, material outputs, and emissions associated with the installation of 1 m^2 of non-reinforced EPDM membrane. This scenario is based on information provided by three SPRI members and is intended to represent a typical installation. It is assumed to be representative for all thicknesses. Packaging materials are disposed of after the membrane is installed at the building site.

Table 3: Installation of non-reinforced EPDM, unit process (per declared unit)

I/O	Material	Value	Unit
Inputs	Non-reinforced EPDM roofing membrane (packaged), incl. 2.5% overlap	1.025	m^2
	Low-VOC adhesive	0.699	kg
Outputs	1 m^2 of installed non-reinforced EPDM roofing membrane	1	m^2
	VOC (toluene) emissions to air	0.161	kg
	Packaging waste (from membrane and adhesive)	*	kg

* varies with membrane thickness

End-of-Life

At the end of the roofing membrane's useful life, it was assumed that the membrane material, as well as any fasteners or adhesive substances, are manually removed from the building and then landfilled. This disposal method was most commonly practiced at the time of this study, according to the reporting manufacturers. Transport to landfill was approximated with 20 miles via large dump truck.

Life Cycle Assessment – Product Systems and Modeling

Declared Unit

The declared unit evaluated is 1 m^2 of single ply roofing membrane for a stated product thickness. As the use stage is excluded from this study, no reference service life is defined.

Life Cycle Stages Assessed

The life cycle assessment (LCA) conducted includes the production, transport to installation site, installation and end-of-life (EoL) stages.

System Boundaries

System boundaries are summarized in Figure 2 for the analysis scope of "cradle-to-building with EoL stage" (i.e., production with installation and EoL stages). Excluded modules are indicated by "MND" or "module not declared". As is typical of works of life cycle assessment, the construction and maintenance of capital equipment, such as production equipment in the manufacturing stage, are not included in the system, nor are human labor and employee commute. The use stage is also outside the scope of this study.

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	X	MND	MND	MND	MND	MND	MND	MND	X	X	X	X

Figure 2: Life cycle stages included in system boundary

Assumptions

In cases where no matching life cycle inventories were available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts.

Transportation

Unless specified by manufacturers, estimated transportation distances and modes of transport are included for the transport of the raw materials, operating materials, and auxiliary materials to production facilities.

Period under Consideration

All primary data were collected for the year 2014. All secondary data come from the GaBi Professional databases and are representative of the years 2010-2013.

Manufacturing Locations

This study represents three SPRI member companies with facilities across the United States, including Arizona, Illinois, Ohio, and Pennsylvania. As such, the geographical coverage for this study is based on US system boundaries for all processes and products. Whenever US background data were not readily available, European data or global data were used as proxies.

Background Data

The LCA model was created using the GaBi ts software system for life cycle engineering, developed by thinkstep AG. The GaBi Professional LCI database provides the life cycle inventory data for several of the raw and process materials obtained from the background system.

Cut- Off Criteria

Per the PCR, the cut-off criteria for flows to be considered within each system boundary are as follows:

- Mass: If a flow is less than 1% of the cumulative mass of the model flows, it may be excluded, provided its environmental relevance is minor, based on a sensitivity analysis.
- Energy: If a flow is less than 1% of the cumulative energy of the system model, it may be excluded, provided its environmental relevance is minor, based on a sensitivity analysis.
- Environmental relevance: If a flow meets the above two criteria, but is determined to contribute 2% or more to the selected impact categories of the products underlying the EPD, based on a sensitivity analysis, it is included within the system boundary.

At least 95% of the mass flows shall be included and the life-cycle impact data shall contain at least 95% of all elementary flows that contribute to each of the declared category indicators. A list of hazardous and toxic materials and substances shall be included in the inventory and the cut-off rules do not apply to such substances.

No cut-off criteria had to be applied for this study. All available energy and material flow data were included in the model.

Data Quality Requirements

As the majority of the relevant foreground data are measured data or calculated based on primary information sources of the owner of the technology, precision is considered to be high. Seasonal variations were balanced out by using yearly averages that were then weighted according to each manufacturer's production volume. All background data are sourced from GaBi databases with the documented precision. Each foreground process was checked for mass balance and completeness of the emission inventory. No data were knowingly omitted. Completeness of foreground unit process data is considered to be high. All background data are sourced from GaBi databases with the documented completeness.

Allocation

As several products are often manufactured at the same plant, participating companies used mass allocation to report data. Mass allocation was selected since the environmental burden in the industrial process (energy consumption, emissions, etc.) is primarily governed by the mass throughput of each sub-process.

Life Cycle Assessment – Results and Analysis

Use of Material Resources

The material resource consumption associated with the non-reinforced roofing membranes is presented below in Table 4 for the production (A1-A3), transport to installation site (A4), installation (A5), and EoL (C1-C4) stages.

Table 4: Use of material resources for non-reinforced EPDM, per declared unit

Indicator	Production A1-A3	Transport to Site A4	Installation A5	EoL C1-C4	Total
Non-renewable materials [kg]					
EPDM (NR) 45 mils	4.22	0.014	2.10	0.51	**6.85**
EPDM (NR) 60 mils	5.69	0.018	2.11	0.628	**8.45**
EPDM (NR) 90 mils	8.31	0.024	2.13	0.865	**11.3**
Renewable materials [kg]					
EPDM (NR) 45 mils	1,190	10.4	639	44.0	**1,890**
EPDM (NR) 60 mils	1,590	12.8	639	54.2	**2,300**
EPDM (NR) 90 mils	2,300	17.7	640	74.6	**3,030**
Fresh water [L]					
EPDM (NR) 45 mils	30.0	0.626	125	-1.40	**154**
EPDM (NR) 60 mils	38.0	0.773	125	-1.73	**162**
EPDM (NR) 90 mils	54.7	1.06	125	-2.38	**179**

* Water consumption values are negative due to waste sent to landfill during construction and at EoL. A landfill introduces blue water to the watershed because it collects rainwater during its lifetime that is eventually released as ground water, therefore more water is coming out of the process than going in. Rainwater is not blue water and is therefore not included in the water consumption metric.

Primary Energy by Life Cycle Stage

The primary energy demand associated with the non-reinforced roofing membranes is presented below in Table 5 for the production (A1-A3), transport to installation site (A4), installation (A5), and EoL (C1-C4) stages.

Table 5: Primary energy consumption results for non-reinforced EPDM, per declared unit

Indicator	Production A1-A3	Transport to Site A4	Installation A5	EoL C1-C4	Total
Non-renewable fossil [MJ, LHV]					
EPDM (NR) 45 mils	112	3.13	56.1	1.56	**173**
EPDM (NR) 60 mils	152	3.86	56.1	1.93	**214**
EPDM (NR) 90 mils	221	5.31	56.2	2.65	**285**
Non-renewable nuclear [MJ, LHV]					
EPDM (NR) 45 mils	4.65	0.0167	1.31	0.0435	**6.02**
EPDM (NR) 60 mils	6.32	0.0205	1.30	0.0536	**7.69**
EPDM (NR) 90 mils	8.99	0.0283	1.30	0.0738	**10.4**

Indicator	Production A1-A3	Transport to Site A4	Installation A5	EoL C1-C4	Total
Renewable (solar, wind, hydroelectric, geothermal) [MJ, LHV]					
EPDM (NR) 45 mils	2.79	0.0493	2.06	0.0844	**4.98**
EPDM (NR) 60 mils	3.85	0.0608	2.03	0.104	**6.05**
EPDM (NR) 90 mils	5.03	0.0836	2.01	0.143	**7.26**
Renewable (biomass) [MJ, LHV]					
EPDM (NR) 45 mils	2.56×10^{-11}	4.06×10^{-14}	3.16×10^{-9}	1.83×10^{-12}	**3.18×10^{-9}**
EPDM (NR) 60 mils	3.25×10^{-11}	5.01×10^{-14}	3.16×10^{-9}	2.26×10^{-12}	**3.19×10^{-9}**
EPDM (NR) 90 mils	4.69×10^{-11}	6.90×10^{-14}	3.16×10^{-9}	3.11×10^{-12}	**3.21×10^{-9}**

Life Cycle Impact Assessment

The environmental impacts associated with the non-reinforced roofing membrane is presented below in Table 6 for the production (A1-A3), transport to installation site (A4), installation (A5), and EoL (C1-C4) stages.

Table 6: Life cycle impact category results for non-reinforced EPDM, per declared unit

Indicator	Production A1-A3	Transport to Site A4	Installation A5	EoL C1-C4	Total
GWP [kg CO_2-eq]					
EPDM (NR) 45 mils	4.90	0.223	2.33	0.102	**7.55**
EPDM (NR) 60 mils	6.69	0.275	2.35	0.126	**9.44**
EPDM (NR) 90 mils	9.62	0.378	2.37	0.174	**12.5**
AP [kg SO_2-eq]					
EPDM (NR) 45 mils	0.0128	0.00108	0.00638	0.00154	**0.0218**
EPDM (NR) 60 mils	0.0173	0.00133	0.00650	0.00190	**0.0270**
EPDM (NR) 90 mils	0.0248	0.00184	0.00662	0.00261	**0.0359**
EP [kg N-eq]					
EPDM (NR) 45 mils	9.59×10^{-4}	9.84×10^{-5}	6.09×10^{-4}	5.75×10^{-4}	**0.00224**
EPDM (NR) 60 mils	0.00136	1.21×10^{-4}	6.38×10^{-4}	7.09×10^{-4}	**0.00283**
EPDM (NR) 90 mils	0.00185	1.67×10^{-4}	6.69×10^{-4}	9.76×10^{-4}	**0.00366**
ODP [kg CFC 11-eq]					
EPDM (NR) 45 mils	5.26×10^{-10}	1.91×10^{-12}	1.46×10^{-10}	2.38×10^{-12}	**6.76×10^{-10}**
EPDM (NR) 60 mils	7.16×10^{-10}	2.35×10^{-12}	1.45×10^{-10}	2.93×10^{-12}	**8.66×10^{-10}**
EPDM (NR) 90 mils	1.01×10^{-9}	3.24×10^{-12}	1.45×10^{-10}	4.03×10^{-12}	**1.17×10^{-9}**

SFP [kg O_3-eq]					
EPDM (NR) 45 mils	0.179	0.0342	0.7480	0.0135	**0.975**
EPDM (NR) 60 mils	0.244	0.0422	0.7490	0.0167	**1.05**
EPDM (NR) 90 mils	0.355	0.0580	0.7490	0.0230	**1.19**

Waste Generation

The waste generation associated with the non-reinforced roofing membrane is presented below in Table 7 for the production (A1-A3), transport to installation site (A4), installation (A5), and EoL (C1-C4) stages.

Table 7: Waste generation results for non-reinforced EPDM, per declared unit

Indicator	Production A1-A3	Transport to Site A4	Installation A5	EoL C1-C4	Total
Waste generated [kg]					
EPDM (NR) 45 mils	0.102	1.04×10^{-4}	0.239	2.14	**2.48**
EPDM (NR) 60 mils	0.133	1.28×10^{-4}	0.297	2.64	**3.07**
EPDM (NR) 90 mils	0.204	1.76×10^{-4}	0.376	3.63	**4.21**

References

- ASTM. (2013). Product Category Rule for Preparing an Environmental Product Declaration for Single Ply Roofing Membranes. West Conshohocken, PA: ASTM International.
- thinkstep. (2014). GaBi LCA Database Documentation. Retrieved from thinkstep AG: http://database-documentation.gabi-software.com

LCA Development

The EPD and background LCA were prepared by thinkstep, Inc.

thinkstep, Inc.
170 Milk Street, 3rd Floor
Boston, MA 02109
info@thinkstep.com
www.thinkstep.com

Contact Information

Single Ply Roofing Industry
465 Waverley Oaks Road, Suite 421
Waltham, MA 02452
Tel: (781) 647-7026
Email: info@spri.org