ENVIRONMENTAL PRODUCT DECLARATION

REINFORCED EPDM MEMBRANE

SINGLE PLY ROOFING MEMBRANE
INSTALLATION: MECHANICALLY FASTENED

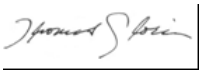
Singly ply, reinforced EPDM membrane mechanically fastened and representative of 60 and 75 mil thicknesses

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 Environment
DECLARATION HOLDER	Single Ply Roofing Industry (SPRI)
DECLARATION NUMBER	4786842353.101.1
DECLARED PRODUCT	EPDM Reinforced Single Ply Roofing Membrane (Mechanically Fastened)
REFERENCE PCR	PCR for Single Ply Roofing Membranes. ASTM International.
DATE OF ISSUE	September 23, 2016
PERIOD OF VALIDITY	5 Years
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:	PCR Review Panel
	Peer review report available upon request
	cert@astm.org
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	
	Wade Stout, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	
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Participating Members

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

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Product Definition

Description of Product

The product system evaluated in this report is an installed single ply reinforced EPDM roofing membrane at the finished nominal thicknesses produced by SPRI members. See Table 1 for membrane specification and standard.

Table 1: Membrane specification and standard

Roof System	Roof System Component	Declared Thicknesses and Weights	Standard
Reinforced ethylene propylene diene monomer (EPDM)	Membrane	60 mils: 2.06 kg/m^2 75 mils: 2.54 kg/m^2	ASTM D4637

Application and Uses

EPDM membranes are typically used in low slope (roof slope < 2:12), however they can also be used in steep slope applications. For example, there are some PVC membranes that are designed to provide the visual appearance of a standing seam metal roof. The maximum slope roof membrane products can be used at is typically determined by the maximum slope they can achieve and still meet building code required fire classifications.

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 reinforced EPDM is mechanically fastened.

The most common low slope roof consists of a metal deck, then a layer of insulation; cover board (optional) and then the roof membrane. For mechanically attached systems, the insulation and cover boards (if present) are screwed directly to the metal deck below. Typically a mechanically attached single ply membrane is installed by rolling out the membrane screws are then drilled in at the edge of the membrane to the metal deck below and then covered with the edge of the next sheet as the rolls are successively put down. A watertight seal is created by either heat-welding or taping the membranes together. This seals any gaps and creates a single, flat, waterproof surface.

Product Life Cycle Description

Material Content

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

Table 2: Average composition of reinforced EPDM roofing membrane

Material	60 mils [%]	90 mils [%]
Material	30	30
Base resin (EPDM)	29	30
Filler	19	19
Paraffinic oil	12	11
Pigment	4	3
EPDM scrap (internal)	2	2
Fire retardant	2	1
Activator	1	1
Curative	<1	1
Polyester scrim	<1	<1
Processing aid	<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—the product evaluated in this EPD. 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.

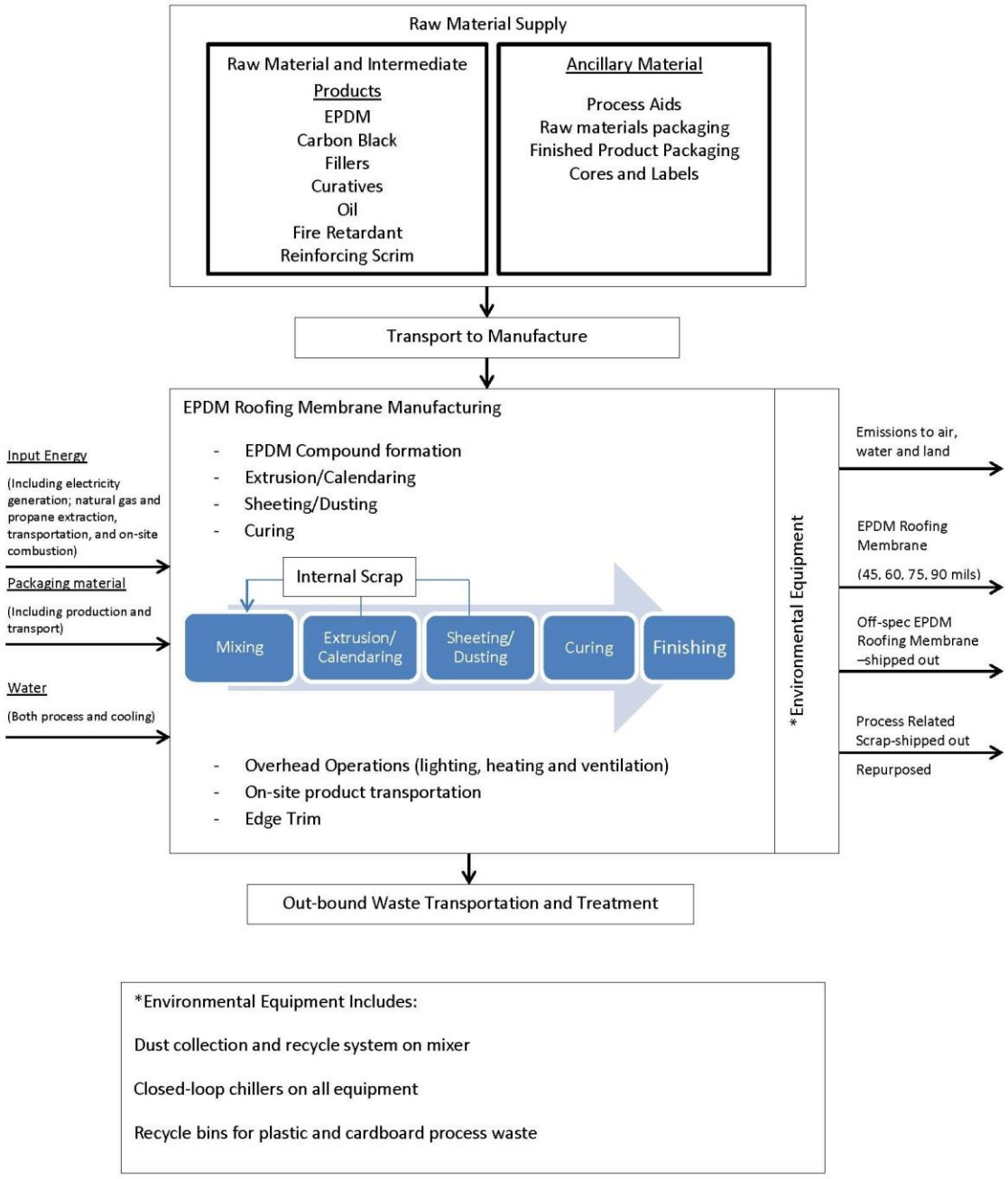

Figure 1: EPDM production process map (courtesy of Johns Manville)

Installation

Table 3 shows the production-weighted industry average material inputs, material outputs and emissions associated with the installation of 1 m^2 of 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 reinforced EPDM, unit process (per declared unit)

I/O	Material	Value	Unit
Inputs	Reinforced EPDM roofing membrane (packaged), incl. 2.5% overlap	1.025	m^2
	Steel fasteners	0.0242	kg
	Electricity for power tools	0.00360	MJ
Outputs	1 m^2 of installed reinforced EPDM roofing membrane	1	m^2
	Packaging waste (from membrane)	*	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, 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 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 reinforced EPDM, per declared unit

Indicator	Production A1-A3	Transport to Site A4	Installation A5	EoL C1-C4	Total
Non-renewable materials [kg]					
EPDM (R) 60 mils	9.27	0.0133	0.104	0.469	**9.86**
EPDM (R) 75 mils	11.5	0.0164	0.115	0.579	**12.3**

Indicator	Production A1-A3	Transport to Site A4	Installation A5	EoL C1-C4	Total
Renewable materials [kg]					
EPDM (R) 60 mils	2,080	9.64	24.0	40.5	**2,150**
EPDM (R) 75 mils	2,430	11.9	24.2	49.9	**2,510**
Fresh water [L]					
EPDM (R) 60 mils	34.2	0.580	-0.120	-1.29	**33.4**
EPDM (R) 75 mils	42.1	0.716	-0.169	-1.59	**41.0**
* 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 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 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 (R) 60 mils	156	2.90	0.242	1.44	**161**
EPDM (R) 75 mils	187	3.57	0.260	1.78	**192**
Non-renewable nuclear [MJ, LHV]					
EPDM (R) 60 mils	7.66	0.0154	0.0201	0.0401	**7.73**
EPDM (R) 75 mils	8.92	0.0190	0.0160	0.0494	**9.00**
Renewable (solar, wind, hydroelectric, geothermal) [MJ, LHV]					
EPDM (R) 60 mils	4.30	0.0456	-0.120	0.0777	**4.30**
EPDM (R) 75 mils	5.13	0.0563	-0.138	0.096	**5.14**
Renewable (biomass) [MJ, LHV]					
EPDM (R) 60 mils	6.25×10^{-11}	3.76×10^{-14}	2.08×10^{-12}	1.69×10^{-12}	**6.63×10^{-11}**
EPDM (R) 75 mils	7.08×10^{-11}	4.64×10^{-14}	2.11×10^{-12}	2.08×10^{-12}	**7.50×10^{-11}**

Life Cycle Impact Assessment

The environmental impacts associated with the 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 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 (R) 60 mils	7.14	0.206	0.0659	0.0942	**7.50**
EPDM (R) 75 mils	8.47	0.255	0.0792	0.116	**8.92**
AP [kg SO_2-eq]					
EPDM (R) 60 mils	0.0221	0.00100	4.87×10^{-4}	0.00142	**0.0250**
EPDM (R) 75 mils	0.0271	0.00124	6.05×10^{-4}	0.00175	**0.0307**
EP [kg N-eq]					
EPDM (R) 60 mils	0.00147	9.11×10^{-5}	1.09×10^{-4}	5.29×10^{-4}	**0.00220**
EPDM (R) 75 mils	0.00182	1.12×10^{-4}	1.37×10^{-4}	6.53×10^{-4}	**0.00272**
ODP [kg CFC 11-eq]					
EPDM (R) 60 mils	8.34×10^{-10}	1.77×10^{-12}	-7.96×10^{-13}	2.19×10^{-12}	**8.73×10^{-10}**
EPDM (R) 75 mils	9.37×10^{-10}	2.18×10^{-12}	-1.35×10^{-12}	2.70×10^{-12}	**9.77×10^{-10}**
SFP [kg O_3-eq]					
EPDM (R) 60 mils	0.270	0.0316	0.00256	0.0125	**0.317**
EPDM (R) 75 mils	0.325	0.0391	0.00309	0.0154	**0.383**

Waste Generation

The waste generation associated with the 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 reinforced EPDM, per declared unit

Indicator	Production A1-A3	Transport to Site A4	Installation A5	EoL C1-C4	Total
Waste generated [kg]					
EPDM (R) 60 mils	0.443	9.59×10^{-5}	0.230	1.97	**2.64**
EPDM (R) 75 mils	0.472	1.18×10^{-4}	0.286	2.43	**3.19**

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.

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