

ENVIRONMENTAL PRODUCT DECLARATION

LOW-VOC ADHESIVE

FOR INSTALLATION OF NON-REINFORCED EPDM MEMBRANES



Low-VOC adhesive for installing non-reinforced EPDM roofing membranes



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 leaving each member to work 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.



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According to ISO 14025

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	
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 <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL	UL Provided
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	
	UL Provided

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Participating Members

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



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Carlisle, PA 17013
www.carlislesyntec.com



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Firestone Building Products
250 West 96th Street
Indianapolis, IN 46260
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Product Definition

Description of Product

The product system evaluated in this report is a solvent-based (<250 g/L) low-VOC (volatile organic compound) adhesive used in the installation of single ply, non-reinforced ethylene propylene diene monomer (EPDM) roofing membrane.

Base Materials/ Ancillary Materials

There are no common identification criteria used for hazardous materials and waste streams across the participating member companies. In some cases, toluene has been identified as a Resource Conservation and Recovery Act (RCRA) listed hazardous constituent (Appendix VIII) and identified in multiple waste streams (e.g., F005, F024, F025). Alternatively, toluene has also been identified as reportable under Superfund Amendments and Reauthorization Act (SARA Section 313) that requires certain facilities to report both routine and accidental chemical releases.

Technical Data

No industry standard dictates the technical requirements for adhesives of membranes, such as peel strength or tensile strength. The only technical requirement is that the larger assembly meets the required wind testing for a particular project. Section 1504.3.1 of the International Building Code describes the test procedures that must be used to evaluate the wind uplift resistance of single ply roofing assemblies: "504.3.1 Other roof systems. Built-up, modified bitumen, fully adhered or mechanically attached single-ply roof systems, metal panel roof systems applied to a solid or closely fitted deck and other types of membrane roof coverings shall be tested in accordance with FM 4474, UL 580 or UL 1897."

Application and Uses

Non-reinforced EPDM single ply roofing membranes are used for both new construction and replacement roofing projects, primarily in low slope roofs (slope < 2:12). Since non-reinforced roofing membranes cannot be mechanically fastened, they are adhered in place using a solvent-based low-VOC adhesive. Roofing systems are glued on to underlying layers, that is, insulation and cover boards.



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Conditions of Use

The product contains solvents (volatile organic compounds) that are dangerous and could produce fire and explosion hazards when exposed to heat, flame or sparks.

Extraordinary Effects

Fire/Flammability

The low-VOC membrane adhesives manufactured by participating SPRI member companies are all classified as Category 2, Flammable liquids under the Globally Harmonized System of Classification (GHS) which is an internationally agreed upon system for classifying and labelling chemicals.

Product Life Cycle Description

Material Content

Table 1 shows the input materials for low-VOC adhesive and their material percentages for adhesive production.

Table 1: Average low-VOC adhesive composition

Function	Material	Mass %
Additive	Antioxidizing agent	0.6%
	Magnesium Oxide	0.4%
	Zinc Oxide	0.6%
	Other additives	1.7%
Binder	Chloroprene	8.6%
	Resin (phenol formaldehyde/phenolic)	4.1%
	Other binders	7.3%
Solvent	Acetone	1.9%
	Tertiary Butyl Acetate	39.4%
	Toluene	16.4%
	Other solvents	19.2%
Other	Water	0.04%

* Compositions based on annual input to adhesive manufacturing

Manufacturing Process

The various raw material inputs, such as binders and solvents, each undergo individual preparation, processing, and purification steps either in laboratory or industrial environments. Raw materials are then transported, using intermediate packaging (steel pails) to the final adhesive manufacturing plant where they undergo additional processing to form the final product. Figure 1 shows an overview of the stages involved in low-VOC adhesive production.



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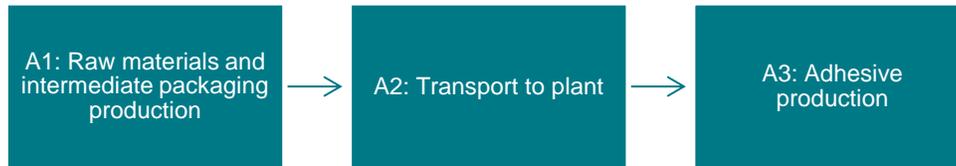


Figure 1: Low-VOC production system

Life Cycle Assessment – Product System and Modeling

Declared Unit

The declared unit being evaluated is 1 kg of low-VOC adhesive. As the use stage is excluded from the study, no service life is defined for the product.

Life Cycle Stages Assessed

The life cycle assessment (LCA) conducted includes the production of raw materials, transport to manufacturing plant, and adhesive manufacturing (cradle-to-gate).

System Boundaries

System boundaries are summarized in Figure 2 for the analysis scope of “cradle-to-gate”. Excluded modules are indicated by “MND” or “module not declared”. 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	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

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.



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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 2010-2014.

Manufacturing Locations

This study represents three SPRI member companies with facilities. 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 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 to be considered for the exclusion of inputs and outputs are listed below:

- All inputs and outputs to a (unit) process shall be included in the calculation for which data is available. Data gaps may be filled by conservative assumptions with average or generic data. Any assumptions for such choices shall be documented;
- In case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1% of renewable and non-renewable primary energy usage and 1% of the total mass of that unit process. The total neglected input flows shall be a maximum of 5% of the energy use and mass;
- Particular care was taken to include material and energy flows known to have the potential to cause significant emissions into air and water or soil related to the environmental indicators of this standard

No cut-off criteria were applied for this study. For the processes within the system boundary, all available energy and material flow data have been included in the model.

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.

Since the system boundary for this study is cradle-to-gate, a net scrap allocation approach is applied only for the intermediate packaging (steel pail) of raw materials that go into manufacturing. Open scrap inputs into the manufacturing stage are subtracted from scrap to be recycled to give the net scrap output from manufacturing.



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Life Cycle Assessment – Results and Analysis

Use of Material Resources

The material resource consumption associated with manufacturing of low-VOC adhesive is presented below in Table 2 (A1-A3 stages).

Table 2: Resource use by life cycle stage, per kg of low-VOC adhesive

	A1	A2	A3	Total
Renewable primary energy as energy carrier [MJ]	2.81	0.0175	0.116	2.94
Renewable primary energy resources as material utilization [MJ]	-	-	0.208	0.208
Total use of renewable primary energy resources [MJ]	2.81	0.0175	0.324	3.15
Non-renewable primary energy as energy carrier [MJ]	62.3	1.34	8.03	71.7
Non-renewable primary energy as material utilization [MJ]	9.14	-	1.25	10.4
Total use of non-renewable primary energy resources [MJ]	71.4	1.34	9.28	82.1
Use of secondary material [MJ]	-	-	-	-
Use of renewable energy secondary fuels [MJ]	-	-	-	-
Use of non-renewable energy secondary fuels [MJ]	-	-	-	-
Use of net fresh water [m ³]	0.178	2.16E-04	9.90E-04	0.179

Life Cycle Impact Assessment

The environmental impacts associated with low-VOC adhesive are presented below in Table 3 and Table 4 for the production (A1-A3) stage.

Table 3: Life cycle impact category (TRACI 2.1) results for low-VOC adhesive, per declared unit

Impact assessment method: TRACI 2.1				
Impact category	A1	A2	A3	Total
Global warming potential [kg CO ₂ -Equiv.]	2.61	0.0971	0.541	3.25
Ozone depletion potential [kg CFC 11-Equiv.]	1.55E-10	7.65E-13	5.46E-11	2.10E-10
Acidification Potential [kg SO ₂ Equiv.]	6.74E-03	1.04E-03	8.57E-04	8.65E-03
Eutrophication potential [kg N-Equiv.]	6.46E-04	5.83E-05	5.21E-05	7.57E-04
Smog formation potential [kg O ₃ Eq.]	0.0954	0.0255	0.0232	0.144



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Table 4: Life cycle impact category (CML) results for low-VOC adhesive, per declared unit

Impact assessment method: CML 2001 – April 2013				
Impact category	A1	A2	A3	Total
Global warming potential [kg CO ₂ -Equiv.]	2.61	0.097	0.541	3.25
Ozone depletion potential [kg CFC 11-Equiv.]	1.46E-10	7.19E-13	5.04E-11	1.97E-10
Acidification potential [kg SO ₂ Equiv.]	6.52E-03	9.04E-04	7.85E-04	8.21E-03
Eutrophication potential [kg (PO ₄) ³⁻ -Equiv.]	8.43E-04	1.45E-04	1.02E-04	1.09E-03
Photochemical ozone creation potential [kg Ethene-Equiv.]	8.33E-04	7.74E-05	9.53E-04	1.86E-03
Abiotic depletion potential, non-fossil resources [MJ]	1.66E-05	1.25E-08	2.19E-07	1.68E-05
Abiotic depletion potential, fossil resources [kg Sb. Equiv.]	69.7	1.33	9.16	80.2

Waste Generation

The waste generation associated with low-VOC adhesive is presented below in Table 5 for the production (A1-A3) stage.

Table 5: Output flows and waste categories, per kg of low-VOC adhesive

	A1	A2	A3	Total
Hazardous waste disposal [kg]	1.63E-05	1.74E-07	1.93E-06	1.84E-05
Non-hazardous waste disposal [kg]	0.0213	4.12E-05	0.00627	0.0276
Radioactive waste disposal [kg]	6.93E-04	2.63E-06	4.68E-05	7.42E-04
Components for re-use	-	-	-	-
Materials for recycling	-	-	-	-
Materials for energy recovery	-	-	-	-



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LCA: Interpretation

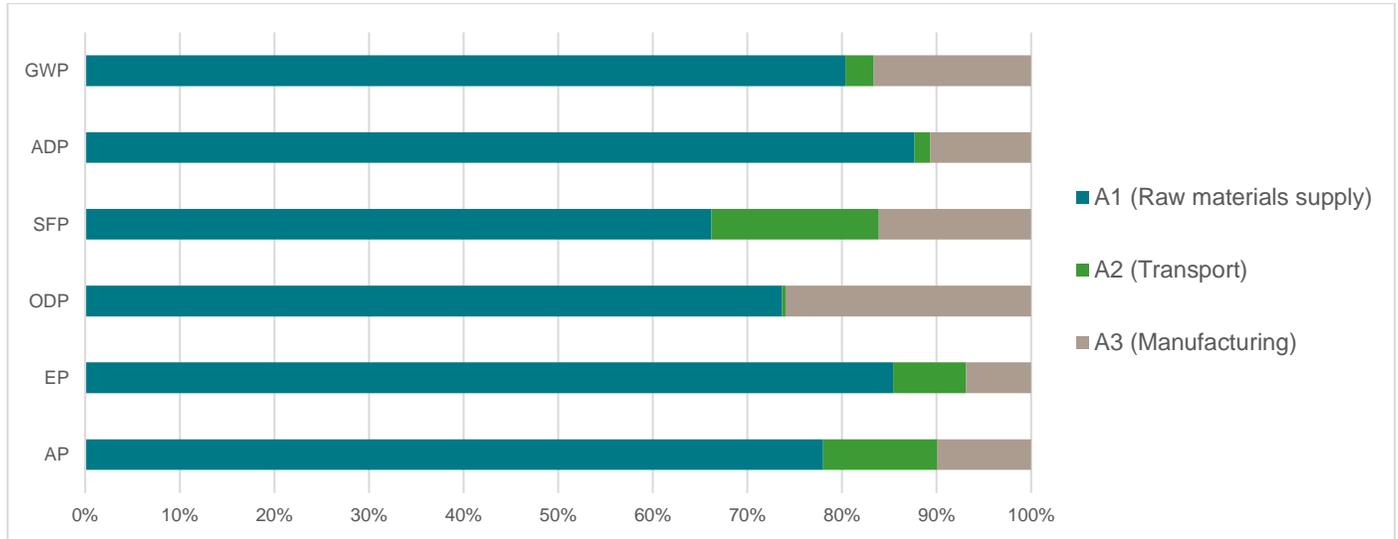


Figure 3: Relative contribution of modules to TRACI 2.1 environmental impacts

The supply of raw materials (A1) for adhesive manufacturing is the largest contributor to the total environmental burden of low-VOC adhesive. Within raw materials, manufacturing of VOC-based solvent (toluene) and VOC-free solvents such as butyl acetate are the main potential impact contributors.

Solvent manufacturing contributes heavily to GWP and abiotic resources depletion potential. This can be attributed to the energy intensive distillation and processing involving a wide variety of solvents and additives. Similarly, solvent production contributes the most to the smog formation potential due to the potential for production related emissions to form tropospheric ozone. In this impact category, transport and production of binders are also important contributors due to associated emissions.

Requisite Evidence

Participating member companies of SPRI follow specific testing methods, classifications and institutes as part of quantifying VOC emissions, exposure limits and component carcinogenicity. Table 6 lists the common classifications found across member companies.

Table 6: Measured values; Test institute - Association advancing Occupational and Environmental Health (ACGIH)

Measured Value	Components	Value	Unit
VOC exposure limit - TWA	Toluene	20	ppm
	tert-butyl acetate	200	ppm
Carcinogenic substances	No components classified as human carcinogen	-	-

All member company's products, at minimum, comply with OTC standards for single-ply roofing membrane adhesive VOC emissions limit of 250 g/L. There is no one single testing method across member companies. VOC testing methods used include EPA Method 24 and SCAQMD Method 34.



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All member companies' products, at minimum, comply with OTC standards (per Rule 1168) for single-ply roofing membrane adhesive VOC emissions limit, as shown in Table 7. There is no one single testing method across member companies. VOC testing methods used include EPA Method 24 and SCAQMD Method 34.

Table 7: VOC limit and content, per Rule 1168

Name	Sealant Category (per Rule 1168 Category)	Calculated Value	Category Limit (per Rule 1168 Category)	Unit
VOC content	Single-Ply Roof Membrane Installation/Repair Adhesive	< 250	250	g/L

References

- IBU. (2016). PCR Guidance for Building-Related Products and Services : Part A and Part B (Dispersion adhesives and primers for floor).
- thinkstep. (2014). GaBi LCA Database Documentation. Retrieved from thinkstep AG: <http://database-documentation.gabi-software.com>

LCA Development



thinkstep

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

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