Certified Environmental Product Declaration
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ENVIRONMENTAL PRODUCT DECLARATION

In accordance with ISO 14040:2006/AMD 1:2020, ISO 14044:2006, and ISO 21930:2017 for -

Spray Polyurethane Foam Insulation – SKYTITE® Series Closed-cell Roofing System

1 m² of installed insulation material with a thickness that gives an average thermal resistance RSI = 1 m²K/W (R=5.68 hr·ft^{2}·°F/Btu) and with a building service life of 75 years (packaging included).

Owner of the Declaration	**BASF Corporation (www.spf.basf.com)**
EPD Program Operator	NSF Certification, LLC (www.nsf.org)
PCR Program Operator	UL Environment
Declaration number	EPD11123
Issue date	10/24/2025
Validity date	10/24/2030

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at http://info.nsf.org/Certified/Sustain/epd_search.asp

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1.0 Program Information

EPD PROGRAM OPERATOR

NSF Certification LLC
789 N. Dixboro,
Ann Arbor, MI 48105

www.nsf.org

PCR PROGRAM OPERATOR

UL Solutions Inc. (UL)
https://www.ul.com/resources/product-category-rules-pcrs

EPD DECLARATION HOLDER

BASF Corporation
1703 Crosspoint
Houston, TX 77054

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The EPD owner, BASF Corporation, has the sole ownership, liability, and responsibility for the EPD.

LCA CONSULTANT

Sphera Solutions, Inc.
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Chicago, IL 60601

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2.0 General Information

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	NSF Certification LLC, 789 N. Dixboro Road. Ann Arbor Michigan 48105, USA www.nsf.org
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	Part A: Life Cycle Assessment Calculations and Report Requirements, Version 4.0
MANUFACTURER NAME AND ADDRESS	BASF Corporation 1703 Crosspoint Ave. Houston, Texas 77054 USA www.spf.basf.com
DECLARATION NUMBER	EPD11123
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Spray polyurethane foam insulation (SKYTITE closed-cell SPF roofing), 1 m^2 of installed insulation material with a thickness that gives an average thermal resistance of RSI = 1 $m^2 \cdot K/W$ (R = 5.68 $hr \cdot ft^2 \cdot {}^\circ F/Btu$) with a building service life of 75 years (packaging included).
REFERENCE PCR AND VERSION NUMBER	ISO 21930:2017 'Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services' - serves as the core PCR. Part A: Life Cycle Assessment Calculations and Report Requirements, Version 4.0 (2022) Per the ISO 14025 requirements, this Part A was reviewed by the following critical review panel: • Lindita Bushi (Chair), Athena Sustainable Materials Institute, lindita.bushi@athenasmi.org • Hugues Imbeault-Tétreault, Groupe AGÉCO, hugues.i-tetreault@groupeageco.ca • Jack Geibig, Ecoform, jgeibig@ecoform.com Sub-category Part B: Building Envelope Thermal Insulation EPD Requirements, Version 3.0 (2024)
DESCRIPTION OF PRODUCT'S INTENDED APPLICATION AND USE (AS IDENTIFIED WHEN DETERMINING PRODUCT RSL)	SKYTITE spray polyurethane foam insulation used for roofing on buildings, service vessels, tanks and more across the US and Canada
PRODUCT RSL DESCRIPTION (IF APPL.)	The reference service life (RSL) and estimated building service life (ESL) for SPF is the life of the building of 75 years.
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	10/24/2025
PERIOD OF VALIDITY	10/24/2030
EPD TYPE	Product Specific
EPD SCOPE	Cradle to Grave
YEAR(S) OF REPORTED MANUFACTURER PRIMARY DATA	2023
LCA SOFTWARE & VERSION NUMBER	LCA FE 10.9 (formerly GaBi Software)
LCI DATABASE(S) & VERSION NUMBER	Managed LCA Content 2024.2 (formerly GaBi Database, CUP2024.2)
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR6 TRACI 2.1

	CML 2001 Aug 2016
The sub-category PCR review was conducted by	The Part B was reviewed by the following panel: • Thomas Gloria (chair), Industrial Ecology Consultants t.gloria@industrial-ecology.com • Christoph Koffler, Sphera ckoffler@sphera.com • Andre Desjarlais, Oak Ridge National Laboratory desjarlaisa@ornl.go
This declaration was independently verified in accordance with ISO 14025:2006. The UL Environment “Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report,” v4.0 (August 2022), based on ISO 21930:2017, serves as the core PCR, with additional considerations from the USGBC/UL Environment Part A Enhancement (2017) ☐ INTERNAL ☒ EXTERNAL	Jack Geibig, Ecoform
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Sphera Solutions, Inc.
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Jack Geibig, Ecoform

LIMITATIONS:

Environmental declarations from different programs (ISO 14025) may not be comparable.

Comparison of the environmental performance of Building Envelope Thermal Insulation using EPD information shall be based on the product’s use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building energy use phase as instructed under this PCR.

Full conformance with Part B of the PCR for Building Envelope Thermal Insulation allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible”. Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

Environmental declarations from different programs based upon differing PCRs may not be comparable.

This EPD is not intended to make any comparative assertions.

3.0 Company Information

BASF Corporation is a North American manufacturer specializing in high-performance spray polyurethane foam products primarily used for insulation and air sealing, in residential and commercial construction. The company offers a range of spray foam insulation solutions that provide excellent thermal resistance, air sealing, and soundproofing capabilities, contributing to energy efficiency and improved indoor comfort. Overall, BASF's spray foam business plays a crucial role in the company's broader mission to provide sustainable solutions and enhance the performance of buildings while addressing energy efficiency and environmental concerns. Spray polyurethane foam from BASF Corporation is formulated and developed to exceed performance criteria, no matter the climate, the code or the application.

4.0 Product Information

4.1 Product Identification

BASF SKYTITE® SPF product describes a category of high-density, closed-cell spray polyurethane foam (ccSPF) insulation and roofing material used widely in North America. It provides excellent air sealing and thermal insulation, making homes and buildings more energy-efficient, durable and comfortable. SKYTITE is particularly effective at creating a monolithic insulation layer on existing roof surfaces ensuring a seamless seal against air, water and moisture vapor movement (when combined with an elastomeric coating for UV resistance).

TABLE 1 TYPICAL PROPERTIES OF SKYTITE CLOSED-CELL SPRAY POLYURETHANE FOAM

Name	SKYTITE
Density [lb/ft3]	2.8
Thermal resistivity [R/in]	6.5
Air impermeable material	✓
Integral vapor retarder	✓
Water resistant	✓
Cavity insulation	✓
Continuous insulation	✓
Structural improvement	✓

All SPF products must meet numerous performance requirements to comply with building codes. The CSI code for spray foam products is 07 21 19.16 (Polyurethane Foam Insulation). The details of these requirements are described in specific tests listed in consensus standards for material performance and code compliance. Roofing SPF products must follow the following standards:

ASTM Standards:

- C1029 Type III, Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation

International Code Council Standards:

- ICC-ES AC-377 Acceptance Criteria for Spray-Applied Foam Plastic Insulation
- ICC-1100-20xx Standard for Spray-applied Polyurethane Foam Plastic Insulation

Typical material performance requirements per ICC-1100 are provided in Table 2.

TABLE 2 SUMMARY OF TYPICAL MATERIAL PERFORMANCE REQUIREMENTS FOR CCSPF ROOFING IN CONSTRUCTION

Standard Type	ASTM	Closed-cell Roofing
Thermal Performance (R-value)	ASTM C518, C177 or C1363	As reported (typically R_{IP}6.0-7.0/inch / 4.2-4.8/100 mm)
Surface Burning Characteristics	ASTM E84 or UL723	Flame spread index ≤75
Core Density	ASTM D1622	As reported (typically 2.5-4.0 pcf / 40-64 kg/m^3)
Closed-Cell Content	ASTM D2856 or ASTM D6226	>90%
Tensile Strength	ASTM D1623	42 psi min (276 kPa)
Compressive Strength	ASTM D1623	40 psi min (276 kPa)
Dimensional Stability	ASTM D2126	15% max change
Water Vapor Permeance	ASTM E96 (dry cup)	As reported (typically 1 US perm @ 1.5-2" / 0.66 SI perm @ 51 mm)
Air Permeance	ASTM D E283 or D2178	As reported (typically impermeable @ 1.5-2" / 38 mm)
Water Absorption	ASTM D2842	5% max

4.2 Manufacturing Process & Flow Diagram

SKYTITE Series ccSPF insulation and roofing material is made on the jobsite by combining with ELASTOSPRAY 8000A isocyanate (side-A) with the SKYTITE polyol blend (side-B). Sides A and B react and expand at the point of application on the roofing surface to form polyurethane foam. The foamed-in-place SPF provides a seamless insulating air barrier, while also providing moisture resistance and resiliency benefits to the building, along with controlling thermal bridging.

There are various classes of SPF, one of them being the high-density closed-cell spray foam for roofing systems using hydrofluoroolefins (HFO) as the blowing agent. This declaration only covers HFO formulations for roofing products.

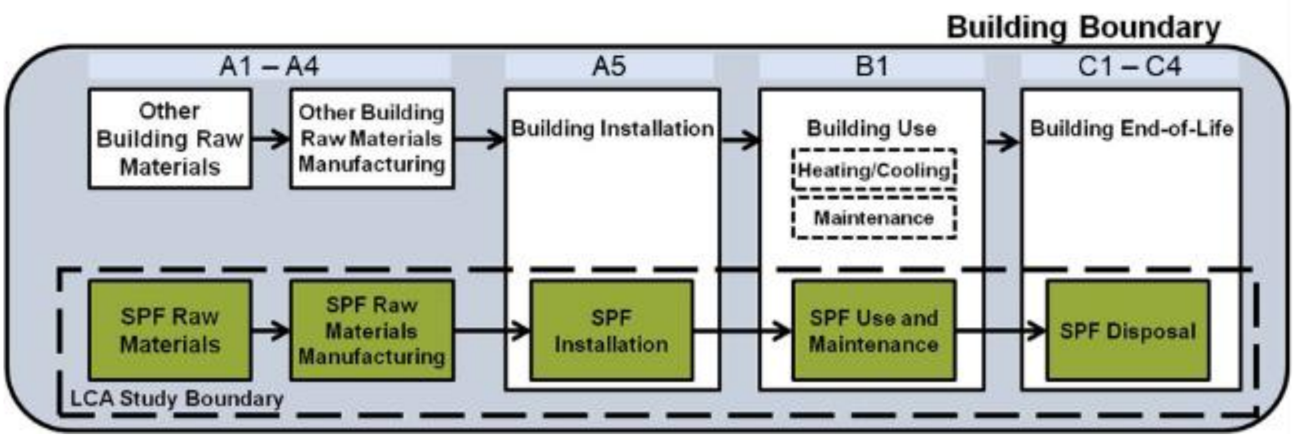

FIGURE 1 FLOW DIAGRAM OF SPRAY FOAM LIFE CYCLE

All the side A is made at Geismar, Louisiana, U.S. All the primary chemicals used in the side-B formulation are processed in a BASF facility in Houston, Texas, U.S.

During the side-B production process, materials are blended together in closed tanks and packaged. Moreover, BASF's facilities employ technology to minimize the release of low boiling point materials, such as blowing agents and catalysts, during material transfers and blending processes. Minimal waste is produced as wash materials are re-blended into the process without the need for additional collection, transport, or processing. Figure 2 below shows the manufacturing process of Sides A and B.

The two chemicals required to produce SPF (side-A and side-B) are delivered as a set to the job site in separate containers. On the job site, 500 lb of side A is mixed with 500 lb of side B to create SKYTITE SPF. A total mass of 0.99 kg (2.19 lb) of SKYTITE product per functional unit (m^2) is used.

4.3 Product Average

This EPD is intended to represent the weighted average results for SKYTITE Series Closed-cell Insulation & Roofing product. The average is calculated based on a weighted-average formulation for side-B, combined with production data collected from BASF. The data were weighted according to the mass produced at BASF's facility in Houston, Texas, U.S. The side A used for this product is ELASTOSPRAY 8000A, which is manufactured by BASF at a single facility located in Geismar, Louisiana, U.S.

4.4 Application

BASF SKYTITE products are specialized spray foam insulation solutions designed for use in commercial roofing applications. They are ideal for both new construction and roof replacement projects, providing exceptional thermal performance and energy efficiency. SKYTITE SPF can be applied to various roofing systems, including flat and low-slope roofs, where they effectively create a seamless, durable, and weather-resistant barrier. Their lightweight nature and superior adhesion properties allow for easy application over existing roofing materials, significantly reducing labor costs and installation time. Additionally, SKYTITE contributes to moisture management and can help extend the lifespan of the roof by preventing issues such as leaks and thermal bridging, making it a preferred choice for enhancing the performance of commercial roofing systems.

4.5 Technical Requirements

Spray foam insulation products must be installed in compliance with building codes. Nearly all jurisdictions have adopted a version of the following building codes:

a) International Code Council (ICC) - International Residential Code (IRC) – For 1 and 2 family dwellings

b) International Code Council (ICC) - International Building Code (IBC) – For multifamily dwellings, as well as commercial, institutional and industrial buildings.

c) International Code Council (ICC) - International Energy Conservation Code (IECC) – Providing envelope energy efficiency requirements for all buildings.

d) American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1- Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

e) American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.2- Energy-Efficient Design of Low-Rise Residential Buildings

To meet code requirements, SKYTITE must meet minimum performance requirements, demonstrated by laboratory testing using approved test methods. These tests are performed by third-party laboratories and test data typically submitted to a certification agency for evaluation of the results and the creation of an independent code compliance report for the product. Certification agencies also perform regular quality control testing from random samples taken from the manufacturer's facilities.

There are two guides that are followed by these certification bodies to collect and evaluate data to generate code compliance reports:

- ICC 1100 Standard for Spray-applied Polyurethane Foam Plastic Insulation (2019)
- IAPMO/ANSI ES1000 Building Code Compliance Spray-Applied Polyurethane Foam (2020)

TABLE 3 TESTING REQUIREMENTS PER ICC 1100 AND IAPMO ES1000 STANDARDS

Testing Requirements per ICC 1100 and IAPMO ES1000 Standards			
Property	Measurement	Test Method	Requirement
Thermal Resistance	R-value at thickness or thermal resistance	ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus, ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, OR ASTM C1363 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	Report
Air Permeance	Thickness where foam is air impermeable	ASTM E283/E283M Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen OR ASTM E2178 Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials	Report minimum thickness where air impermeable
Water Vapor Permeance	Thickness where foam meets Class I, II or III vapor retarder performance	ASTM E96/E96M Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials (Method A)	Report thickness at vapor retarder class I, II or III.

Density	Mass density of foam	ASTM D1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics	Report
Surface Burning Characteristics	Flame Spread Index	ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials	75 or less
	Smoke Developed Index	ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials	450 or less for insulation, unlimited for roofing
Thermal Barrier Testing	Pass fire test with prescriptive thermal barrier for thickness over 4"	NFPA 286, FM 4880, UL 1040 or UL1715	Pass 15 minute criteria
Alternate Thermal Barrier Assembly	Pass fire test with specific covering or coating	NFPA 286, FM 4880, UL 1040 or UL1715	Pass 15 minute criteria
Ignition Barrier Testing	Pass fire test with or without covering or coating	Various special test methods	See standard for details

In addition to these standards, there are also two ASTM material standards for SPF materials.

- ASTM C1029 Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation – Including closed-cell insulation and roofing foams,
- ASTM D7425 Standard Specification for Spray Polyurethane Foam Used for Roofing Applications.

TABLE 4 TESTING REQUIREMENTS PER ASTM C1029 AND ASTM D7425 MATERIAL STANDARDS

Testing Requirements per ASTM C1029 AND D7425 Material Standards				
Property	Measurement	Test Method	ASTM C1029 Requirement	ASTM D7425 Requirement
Thermal Resistance	R-value at thickness or thermal resistance	ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus, ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, OR ASTM C1363 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	R6.2/inch minimum	R5.6/inch minimum
Water Vapor Permeability	perm-inches	ASTM E96/E96M Standard Test Methods for Gravimetric Determination of Water Vapor	3.0 perm-inches	3.0 perm-inches

		Transmission Rate of Materials (Method A)		
Density	Apparent density of foam	ASTM D1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics	Report	2.5 lb/ft^3 minimum
Surface Burning Characteristics	Flame Spread Index	ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials	Report (75 limit in building codes)	Not required
	Smoke Developed Index	ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials	Report (no limit in building codes)	Not required
Closed-cell Content	Percentage of closed cells	ASTM D6226 Standard Test Method for Open Cell Content of Rigid Cellular Plastics	90% or greater	90% or greater
Compressive Strength	psi	ASTM D1621 Standard Test Method for Compressive Properties of Rigid Cellular Plastics	Minimum determined by Type per ASTM C1029: Type I - 15 psi Type II - 25 psi Type III - 40 psi Type IV - 60 psi	40 psi minimum
Tensile Strength	psi	ASTM D1623 Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics	Minimum determined by Type per ASTM C1029: Type I - 20 psi Type II - 32 psi Type III - 42 psi Type IV - 56 psi	40 psi minimum
Response to Thermal/Humid Aging	dimensional stability percent	ASTM D2126 Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging	Maximum determined by Type per ASTM C1029: Type I - 12% Type II - 9% Type III - 6% Type IV - 5&	6% maximum
Water Absorption	Percentage by volume	ASTM D2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics	5% maximum	5% maximum

4.6 Material Composition

The side-A of SKYTITE SPF is comprised of ELASTOSPRAY 8000A, an isocyanate compound manufactured by BASF at their facility located in Geismar, Louisiana, U.S. The side-B is a mixture of polyester and polyether polyols, flame retardants, blowing agents, catalysts, and other additives that, when mixed with side-A, creates a foam that can be applied as insulation. As the precise formulation of the side-B will vary with each BASF facility, this study uses a weighted average formulation (Table 5).

As per the Resource Conservation and Recovery Act (RCRA), Subtitle C, the spray foam product as installed and ultimately disposed of is not classified as a hazardous substance. No substances required to be reported as hazardous are associated with this construction product.

TABLE 5 AVERAGE SKYTITE SIDE-B CHEMICAL COMPOSITION (% MASS)

Chemical Components	Composition (%)
Polyols	77.55%
Fire Retardants	10.49%
Blowing Agents (including water)	9.31%
Catalyst	2.65%
Total	100%

4.7 Environment and Health during Manufacturing

Manufacturing of SPF formulations and upstream chemicals is performed in industrial manufacturing facilities. Like many manufacturing processes, hazardous chemicals and manufacturing procedures may be employed. SPF manufacturers follow all local, state and federal regulations regarding safe use and disposal of all chemicals (United States EPA, 2024) as well as safety requirements required of the generally manufacturing operation of equipment and processes (U.S. and State OSHA-Occupational Safety and Health Standards) (Safety and Health Regulations for Construction) (US Department of Labor, 2024) and safe transport of all materials (US Department of Transportation-DOT) Environment and Health During Installation (US Code of Federal Regulations, November, 2024).

4.8 Packaging

SKYTITE consists of high-pressure SPF chemicals that are packaged in unpressurized containers of varying types, most commonly in 55-gallon (208 L) steel or plastic drums and in some cases, plastic totes. In this study, it is assumed that the empty chemical containers are properly cleaned and taken to a drum recycler. The mass % composition of packaging for both side A and side B components is shown below in Table 6. A total of 1.1 kg of packaging was used per functional unit of the spray foam product.

TABLE 6 PACKAGING COMPOSITION (MASS %)

Components	Packaging Material	Composition (%)
Side-A	Steel drum	96.5%
	Steel strap	3.5%
Side-B	Steel drum	100.0%

Disposal of packaging materials is modeled in accordance with the assumptions outlined in Part A of the PCR for Building related Products (UL Solutions, 2022). Plastic based packaging is disposed in landfill (68%), incineration (17%), and recycled (15%). Metal based packaging is disposed of in landfill (34%), incineration (9%), and recycled (57%).

4.9 Transportation

Final products are distributed via container truck, which is fueled by diesel. These final products are either sent directly to customers, or first to warehouse, prior to being sent to customers. Table 7 details distribution assumptions for the finished SPF product.

4.10 Product Processing/Installation

High-pressure SPF such as SKYTITE is installed by professional applicators by on-site mixing of the side-A and side-B chemicals. The schematic in Figure 2 shows the typical equipment components used to produce high-pressure SPF foam, including unpressurized side-A and side-B liquid drums with transfer pumps, which are connected to the proportioner system for heating and pressurizing the chemicals, and then through a heated hose connected to a spray gun for application.

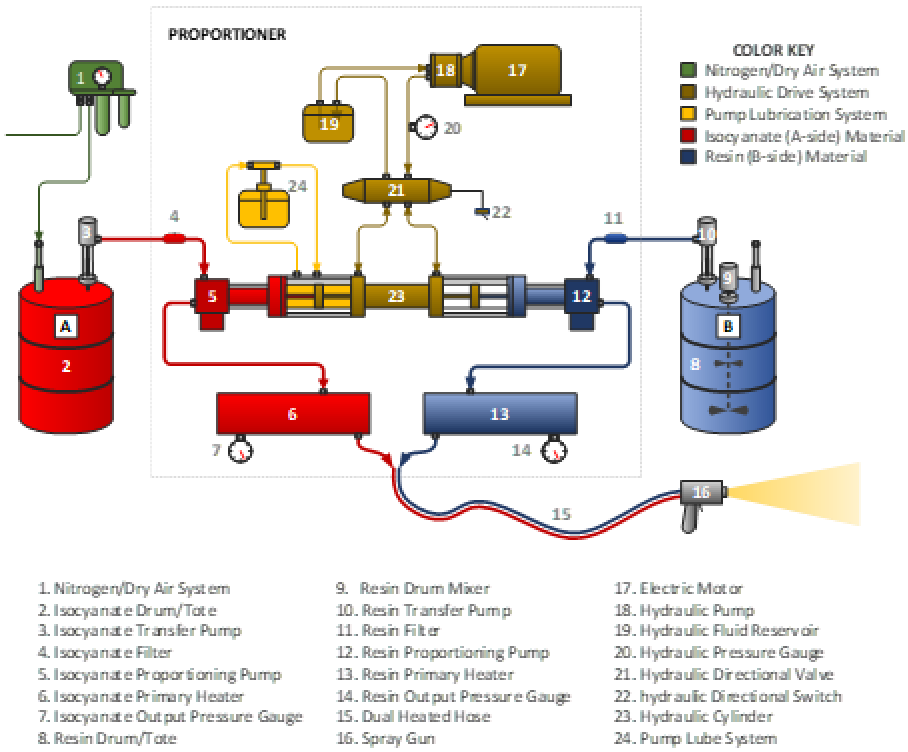

FIGURE 2 SCHEMATIC OF A HIGH-PRESSURE SPF SYSTEM

Installation process includes insulation of the walls, floors and ceilings of entire buildings, or application as an insulated low-slope roofing system. These chemicals are delivered to the jobsite in unpressurized containers (usually 55-gallon / 208 L drums) and heated to approximately 120 to 130 °F (49 to 54 °C) and pressurized to about 1000 psi (6,895 kPa) by specialized equipment. The chemicals are transferred by a heated hose and aerosolized by a spray gun and combined by impingement mixing at the point of application. Personal protective equipment such as goggles, protective suits, and respirator cartridges is required to protect applicators from chemical exposure during installation. Also needed are disposable materials such as masking tape and drop cloths. An estimated 10% of the blowing agent is assumed to be released during installation (Honeywell International) (Kjeldsen & Jensen, 2001).

After the foam cures and expands, any excess that may prevent installation of the interior cladding is cut off and discarded. For SPF with physical blowing agents, this study assumes 10% of the installed blowing agent is released to surrounding air during the installation phase. Discarded foam from installation also experiences blowing agent release while in landfill. Disposal of packaging materials is modeled in accordance to the assumptions outlined in Part A of the

PCR for Building related Products (UL Environment, 2022). All ancillary installation materials are assumed to be sent to landfill.

Installation of SPF involves potential exposure to certain hazardous chemicals that requires risk mitigation through the use of personal protective equipment and on-site actions including ventilation and restricted access. Of greatest concern is the potential exposure to airborne and liquid isocyanates during and immediately after installation of SPF. Isocyanates are known chemical sensitizers and exposure can occur through contact with the skin, eyes and respiratory system. Ventilation of the work zone, coupled with use of proper personal protective equipment is required during and immediately after installation SPF. For more information on health and safety during and immediately after SPF installation, please visit www.spraypolyurethane.org.

4.11 Condition of Use

As this study only looks at the life cycle of spray foam insulation, and not the building, the use phase only contains the emissions of any chemicals off-gassed from the foam. This study assumes 24% of the original chemical blowing agent is off-gassed over a 75-year lifetime (Honeywell International).

4.12 Environment and Health during Use

The use of insulation in a building will provide substantial energy savings. Based on a third-party use phase analysis performed in 2018, the energy savings from SPF will eventually offset the embodied energy of SPF within a few decades, depending on climate zone and amount of insulation installed (Sustainable Solutions Corporation, 2020).

4.13 Reference Service Life

The reference service life (RSL) and estimated building service life (ESL) for SPF, when installed and used as directed is the life of the building which is 75 years.

4.14 Extraordinary Effects

Fire

Spray polyurethane foam, like all foam plastics and many construction materials – including wood - is a combustible material and will emit toxic gases including carbon monoxide during a fire. When used in buildings and other construction applications, foam plastics employ flame retardants to control ignition and spread of fire and development of smoke. In addition, foam plastics may need to be protected with fire-resistant coverings or coatings when used in certain construction applications, as dictated by the building codes. All foam plastic materials and assemblies should meet the fire test requirements of the applicable building codes.

Water

Closed-cell and roofing SPF products meet the FEMA Class 5 requirements[1] for flood-damage resistant insulation materials for floors and walls.

Mechanical Destruction

Should the assembly the SPF is installed in, i.e. the wall or roof, have to be replaced then the SPF will have to be replaced as well.

4.15 Re-use Phase

SPF is typically not reused or recycled following its removal from a building. Thus, reuse, recycling, and energy recovery are not applicable for this product.

4.16 Disposal

When the building is decommissioned, it is assumed that only manual labor is involved to remove the foam. Waste is assumed to be transported 20 miles (32 km) to the disposal site. The spray foam is assumed to be landfilled at end-of-life, as is typical for construction and demolition waste in the US. This study assumes 16% of the original physical blowing agent is emitted at this stage in the life cycle. It is further assumed the spray foam is inert in the landfill and 50% of the blowing agent remains in the product after disposal (Kjeldsen & Jensen, 2001).

4.17 Further Information

Additional information can be found at https://spf.basf.com/.

5.0 LCA Information

5.1 Functional Unit

The product's function is to provide thermal insulation to buildings. Accordingly, the functional unit for the study is 1 m^2 of installed insulation material with a thickness that gives an average thermal resistance of R_{SI} = 1 m^2·K/W (R = 5.68 hr·ft^2·°F/Btu) with a building service life of 75 years (packaging included). The reference flow listed in the table below accounts for installation scrap waste.

TABLE 7 FUNCTIONAL UNIT PROPERTIES

Item	Value	Unit
Functional unit	**1 m^2 of installed insulation material with a thickness that gives an average thermal resistance of RSI = 1 m^2·K/W**	
R-value	6.50	(h·ft^2·°F/Btu)/in
Equivalent Mass	2.19*	lb
	0.99	kg
Reference Flow	2.42*	lb
	1.10	kg
Equivalent Thickness	0.87	In
	0.022*	m

* 0.022, 2.19, and 2.42 are rounded values calculated based on the conversion factors in Table 2 of the Part B PCR, which may lead to minor discrepancies

5.2 System Boundary

The study uses a cradle-to-grave system boundary. As such, it includes upstream processing and production of raw materials (A1), auxiliary material and energy resources needed for the production of SPF (A3), transport of materials (all chemical inputs for production and packaging) to SPF formulation sites (A2), transport of the components to the installation site (A4), installation of insulation (A5), removal and transport of excess insulation loss during installation to disposal site (A5), use phase (B1), transportation to end-of-life (C2), and end-of-life-disposal (C4). Over the RSL no maintenance (B2), repair (B3), replacement (B4), refurbishment (B5), operational energy (B6) or water (B7) use are required. Building energy savings from the use of insulation are excluded from this analysis. Module D has been excluded from this analysis. There are also no biogenic removals or emissions associated with the product across the assessed system boundaries.

5.3 Estimates & Assumptions

The material and energy inputs and outputs were modeled according to data provided by the production facilities, while the electricity grid and natural gas mix were chosen based on the location of each facility. Further granularity of raw material and waste data for additional locations may alter the results of this study.

When possible, energy consumption data on side-B production were collected via sub-metering. However, when not feasible, energy consumption was allocated to the spray polyurethane foam production by mass.

Lastly, this study assumes 50% of blowing agent consumed in the production of the formulation is eventually emitted, with 10% released during installation, 24% released during lifetime in building, and 16% released during end-of-life. The remaining 50% remains in the product (Honeywell International) (Kjeldsen & Jensen, 2001).

5.4 Cut Off Rules

The cut-off criteria for including or excluding materials, energy and emissions data of the study are as follows:

- **Mass** – According to ISO guidelines, if a flow is less than 1% of the cumulative mass of the model it may be excluded, providing its environmental relevance is not a concern. For the purpose of this LCA, all known mass flows are reported, and no known flows were deliberately excluded.
- **Energy** – According to ISO guidelines, if a flow is less than 1% of the cumulative energy of the model it may be excluded, providing its environmental relevance is not a concern. For the purpose of this LCA, all known energy flows are reported, and no known flows were deliberately excluded.
- **Environmental relevance** – If a flow meets the above criteria for exclusion yet is thought to potentially have a significant environmental impact, it was included. Material flows which leave the system (emissions) and whose environmental impact is greater than 1% of the whole impact of an impact category that has been considered in the assessment must be covered. This judgment was made based on experience and documented as necessary.

Packaging of incoming raw materials (e.g. pallets, totes, super-sacks) are excluded as they represent less than 1% of the product mass and are not environmentally relevant.

Capital goods and infrastructure flows were excluded from this analysis due to the minimal extent that it is expected to affect the LCIA results. For the manufacturing of SPF products, capital goods and infrastructure last for 20 to 40 years with periodic re-placement of valves and repair of control systems, with annual production of around 45.5 million lbs of side-B product that are included in this study. During the final stage of manufacturing (Installation) performed by SPF contractors, the life of the most expensive piece of equipment, the proportioner, is around 20 to 25 years. Diesel generators, compressors and spray guns may be around 15 to 20 years.

No known flows are deliberately excluded from this EPD.

5.5 Data Sources

The LCA model was created using the LCA for Experts (LCA FE) v10.9 software system for life cycle engineering, developed by Sphera (Sphera, 2024). Background life cycle inventory data for raw materials and processes were obtained from the Sphera MLC 2024.2 database (CUP 2024.2), except the background dataset for the isocyanate ELASTOSPRAY 8000A, which is not a part of the MLC database but was developed by BASF using MLC DB 2023.2, and shared with Sphera to be used for the purpose of this LCA study. Primary manufacturing data on production (A1-A3) of spray foam products was provided by BASF. Proxy datasets were used where no exact dataset match was found.

5.6 Data Quality

A variety of tests and checks were performed by the LCA practitioner throughout the project to ensure high quality of the completed LCA. Checks included an extensive internal review of the project-specific LCA models developed as well as the background data used. A full data quality assessment is documented in the background report.

Temporal coverage

The data are intended to represent spray polyurethane foam production during the 2023 calendar year. As such, BASF provided primary data for 12 consecutive months during the 2023 calendar year.

Geographical coverage

This LCA represents BASF's products produced in the U.S. Primary data are representative of U.S. Regionally specific datasets were used to represent each manufacturing location's energy consumption. Proxy datasets were used as needed for raw material inputs to address lack of data for a specific material or for a specific geographical region. These proxy datasets were chosen for their technological representativeness of the actual materials.

Technological coverage

Data on material composition, manufacturing data, waste, emissions, and energy use were collected directly from BASF.

5.7 Period Under Review

Primary data collected represent production during the 2023 calendar year. This analysis is intended to represent production in 2023.

5.8 Allocation

Multi-output allocation follows the requirements of ISO 14044, section 4.3.4.2 (ISO, 2006a; ISO, 2006b). When allocation becomes necessary during the data collection phase, the allocation rule most suitable for the respective process step was applied. Energy output was allocated based on engineering knowledge that certain products require more energy to produce. Waste outputs were allocated by mass.

The ELASTOSPRAY 8000A isocyanate dataset created by BASF is based on a "mass + elemental" allocation approach instead of purely mass allocation. This is done to make sure that the isocyanate dataset used in this study is in alignment with the MDI dataset being used in the SPFA industry association EPD. These datasets follow the product category guidance for conducting life cycle assessments for MDI and TDI which was developed by ISOPA (European trade association for producers of diisocyanates and polyols-ISOPA, 2021) and follows the same mass + elemental allocation approach. This approach is also in alignment with the 2022 LCA study conducted by the American Chemistry Council (American Chemistry Council, 2022).

The cut-off allocation approach is adopted in the case of any post-consumer and post-industrial recycled content, which is assumed to enter the system free of burdens from virgin production. Only environmental impacts from the point of recovery and forward (e.g., inbound transport, grinding, processing, etc.) are considered. Additionally, no burdens or credits are applied at end-of-life for recovered materials.

6.0 Scenarios and additional technical information

Transport to the building site uses a weighted average of the various vehicle types used by BASF's different facilities. Table 7 is a summary of the different vehicle types and total transport distance. Liters of fuel and capacity utilization will vary depending on the vehicle type.

The following tables report results per functional unit.

TABLE 8 TRANSPORT TO THE BUILDING SITE (A4) PER FU

Name	Value	Unit
Fuel type	Diesel	
Liters of fuel	2.38E-03	l/100km
Vehicle type	Truck, TL/Dry van	
Transport distance	1403	km

Capacity utilization (including empty runs, mass based)	75	%
Gross density of products transported	45	kg/m^3

TABLE 9 INSTALLATION INTO THE BUILDING (A5) PER FU

Name	Value	Unit
Ancillary materials	0.032	kg
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)	0	m^3
Other resources	N/A	kg
Electricity consumption	0.059	kWh
Other energy carriers	3.90	MJ
Product loss per functional unit	0.037	kg
Waste materials at the construction site before waste processing, generated by product installation	0.0367	kg
Output materials resulting from on-site waste processing (specified by route; e.g. for recycling, energy recovery and/or disposal)	0	kg
Biogenic carbon contained in packaging	0	kg CO_2
Direct emissions to ambient air, soil and water	0.0039	kg
VOC content	0	$\mu g/m^3$

TABLE 10 REFERENCE SERVICE LIFE PER FU

Name	Value	Unit
Direct emissions to ambient air, soil and water	0.00936	kg

TABLE 11 END OF LIFE (C1-C4) PER FU

Name		Value	Unit
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)		Landfill	
Collection process (specified by type)	Collected with mixed construction waste	0.99	kg
Recovery (specified by type)	Landfill	0.99	kg
Disposal (specified by type)	Product or material for final deposition	0.99	kg
Removals of biogenic carbon (excluding packaging)		0	kg CO_2

7.0 Environmental Performance

North American life cycle impact assessment (LCIA) results are declared using TRACI 2.1 (Bare, 2012; EPA, 2012) methodology, with the exception of GWP and ADP_{fossil}. GWP is reported using the IPCC AR6 (IPCC, 2023) methodology, excluding biogenic carbon and including biogenic carbon. ADP_{fossil} is reported using CML 2001, Version 4.8, Aug 2016

(CML, 2001). Primary energy from non-renewable resources (NRPRe) and renewable resources (RPRe) represent the lower heating value (LHV) a.k.a. net calorific value (NCV). These six impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes.

The GWP indicators reported in this study exclude land use change impacts since manufacturing, use, and disposal of SPF products do not have a significant impact on land use, as it does not consume any agricultural products or chemicals that have a direct impact on land use.

Please note that for the sake of readability, only modules with non-zero results have been shown in the tables in the following sections.

Description of the System Boundary (X = Included in LCA; MND = Module not Declared)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MND

7.1 SKYTITE CLOSED-CELL SPRAY FOAM INSULATION AND ROOFING

GWP 100 is calculated using IPCC AR6 2013 methodology. ADP_{fossil} is calculated using CML baseline v4.7 Aug. 2016. All other impact assessment results are calculated using TRACI 2.1 methodology. LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

TABLE 12 NORTH AMERICAN IMPACT ASSESSMENT RESULTS

IMPACT CATEGORY	A1	A2	A3	A4	A5	B1	C2	C4
GWP 100 - INCL BIOGENIC CO_2 [KG CO_2 EQ]	2.87E+00	1.71E-01	1.65E-01	9.48E-02	7.49E-01	4.69E-03	1.60E-03	2.45E-02
GWP 100 - EXCL BIOGENIC CO_2 [KG CO_2 EQ]	2.87E+00	1.71E-01	1.66E-01	9.48E-02	7.48E-01	4.69E-03	1.60E-03	2.46E-02
ODP [KG CFC-11 EQ]	2.91E-08	4.30E-16	2.21E-15	2.41E-16	2.91E-09	0.00E+00	4.06E-18	1.03E-15
AP [KG SO_2 EQ]	4.05E-03	1.41E-03	3.63E-04	3.39E-04	2.41E-03	0.00E+00	6.82E-06	1.11E-04
EP [KG N EQ]	4.90E-04	8.27E-05	1.66E-05	3.26E-05	2.18E-04	0.00E+00	6.21E-07	4.80E-06
SFP [KG O_3 EQ]	8.15E-02	2.88E-02	4.91E-03	7.76E-03	7.31E-02	2.61E-03	1.57E-04	3.74E-03
ADP_{FOSSIL} [MJ, LHV]	6.54E+01	2.20E+00	1.88E+00	1.24E+00	1.34E+01	0.00E+00	2.10E-02	3.16E-01

GWP = global warming potential; ODP = ozone depletion potential; AP = acidification potential; EP = eutrophication potential; SFP = smog formation potential; ADPFossil = abiotic depletion potential for fossil resources

TABLE 13 RESOURCE USE

PARAMETER	A1	A2	A3	A4	A5	B1	C2	C4
RPR_E [MJ, LHV]	4.76E+00	8.52E-02	1.25E-01	5.42E-02	8.91E-01	0.00E+00	9.15E-04	4.04E-02
RPR_M [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-03	0.00E+00	0.00E+00	0.00E+00
RPR_T [MJ, LHV]	4.76E+00	8.52E-02	1.25E-01	5.42E-02	8.93E-01	0.00E+00	9.15E-04	4.04E-02
$NRPR_E$ [MJ, LHV]	4.53E+01	2.22E+00	1.92E+00	1.25E+00	1.09E+01	0.00E+00	2.11E-02	3.26E-01
$NRPR_M$ [MJ, LHV]	2.33E+01	0.00E+00	0.00E+00	0.00E+00	3.05E+00	0.00E+00	0.00E+00	0.00E+00
$NRPR_T$ [MJ, LHV]	6.85E+01	2.22E+00	1.92E+00	1.25E+00	1.39E+01	0.00E+00	2.11E-02	3.26E-01
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW [m^3]	1.95E-02	2.82E-04	1.03E-02	1.83E-04	4.27E-03	0.00E+00	3.09E-06	4.21E-05

RPR_E = use of renewable primary energy excluding renewable primary energy resources used as raw materials; RPR_M = use of renewable primary energy resources as raw materials; RPR_T = total use of renewable primary energy resources; $NRPR_E$ = use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; $NRPR_M$ = use of non-renewable primary energy resources used as raw materials; $NRPR_T$ = total use of non-renewable primary energy resources; SM = use of secondary material; RSF = use of renewable secondary fuels; NRSF = use of non-renewable secondary fuels; RE = use of recovered energy; FW = use of net fresh water; - = Not Applicable

TABLE 14 OUTPUT FLOWS AND WASTE CATEGORIES

PARAMETER	A1	A2	A3	A4	A5	B1	C2	C4
HWD [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.38E-02	0.00E+00	0.00E+00	9.95E-01
HLRW [kg]	1.31E-06	6.90E-09	6.65E-09	3.84E-09	2.31E-07	0.00E+00	6.48E-11	3.88E-09
ILLRW [kg]	1.14E-03	5.81E-06	5.56E-06	3.24E-06	1.97E-04	0.00E+00	5.47E-08	3.46E-06
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-03	0.00E+00	0.00E+00	0.00E+00
EE [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HWD = hazardous waste disposed; NHWD = non-hazardous waste disposed; HLRW = high level radioactive waste; ILLRW = intermediate and low-level radioactive waste; CRU = components for re-use; MR = materials for recycling; MER = materials for energy recovery; EE = exported energy; - = Not Applicable

8.0 Interpretation

In all impact categories, SPF environmental performance is driven primarily by raw materials (A1), in particular ELASTOSPRAY 8000A, polyols, flame retardants, and HFO due to their high mass contribution to the product. Installation tends to be the second highest driver of impact due to the use of on-site diesel generator, as well as waste foam disposal.

As some of the raw materials are transported thousands of miles, the inbound transportation module (A2) is the third largest contributor to the overall impacts. Other transportation modules representing transport to site (A4) and transport to end-of-life (C2), have negligible contribution to life cycle results

It is also important to note the assumptions and limitations to this study. These have been identified as:

- Proxy datasets were used where no exact dataset match was found. The total amount of materials represented by proxies account for less than 5% of the total product by mass and the use of proxies is not expected to have a significant influence on the results.

- This study reports 50% of its blowing agents are released over its lifetime (Honeywell International). However, actual emissions may vary, which will affect the potential environmental impacts.

Results presented in this document do not constitute comparative assertions. Comparison of the environmental performance using EPD information shall be based on the product’s use and impacts at the construction works level. In general, EPDs may not be used for comparability purposes when not considered in a construction works context. Given this PCR ensures products meet the same functional requirements, comparability is permissible provided the information given for such comparison is transparent and the limitations of comparability explained.

8.1 Environmental Activities and Certifications

BASF has certified or tested their insulation products to various VOC standards to measure emissions of volatile or semi-volatile compounds and thus do not emit significant VOCs. These standards include:

- UL Environment GREENGUARD® Certification – The GREENGUARD® Certification Program specifies strict certification criteria for VOC's and indoor air quality. This voluntary program helps consumers identify products that have low chemical emissions for improved indoor air quality.
- California Department of Public Health (CDPH) – Also known as Section 01350, this small-chamber emissions test standard is detailed under: Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers (Standard Methods v1.1-2010 and v1.2-2017).
- Canadian ULC – Required for SPF insulation products, this standard provides a similar VOC emissions test protocol specifically for SPF: CAN/ULC S774 Standard Laboratory Guide for the Determination of Volatile Organic Compound Emissions from Polyurethane Foam
- Currently, an ASTM workgroup is developing a small-chamber emissions test protocol for chemical compounds specific to SPF that include MDI, blowing agents, flame retardants and catalysts.

8.2 Natural Oil Polyols

Natural Oil Polyols, or NOPs, are being used in some spray foam formulations, as some manufacturers are using renewable materials in their formulation to help differentiate their products from conventional petroleum-based materials. NOPs may include vegetable oils such as soy, castor, glycerin and rapeseed. This LCA was based on conventional petroleum-based polyols, as these are the most widely used in the industry and more representative of most current spray foam formulations.

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