Environmental Product Declaration

HEATLOK HFO AND HEATLOK SOYA HP

HUNSTMAN BUILDING SOLUTIONS

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Huntsman Building Solutions is a global leader in the manufacture and supply of open-cell and closed-cell spray polyurethane foam (SPF) insulation and coatings. Formed in May 2020 through the combination of the Demilec and Icynene-Lapolla SPF businesses, Huntsman Building Solutions is a business unit of Huntsman Corporation and has a combined heritage of more than 110 years. Through the application of innovative technology and advanced science,

Huntsman Building Solutions focuses on meeting market demands for more energy-efficient products and serves a range of industries, including residential, commercial, industrial, institutional, and agricultural. For more information, visit www.huntsmanbuildingsolutions.com.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

HUNTSMAN

BUILDING SOLUTIONS

Heatlok HFO and HEATLOK SOYA HP – Spray Polyurethane Foam Insulation

According to ISO 14025, EN 15804, and ISO21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Environment 333 Pfingsten Road Northbrook, IL 60611	https://www.ul.com/ https://spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v.2.5 March 2020	
MANUFACTURER NAME AND ADDRESS	Huntsman Building Solutions | 3315 E. Division Street, Arlington, TX 76011	
DECLARATION NUMBER	4789773836.101.2	
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Heatlok HFO and Heatlok Soya HP-Closed cell spray polyurethane foam insulation with HFO blowing agent, 1 m^2 with a thickness that gives an average thermal resistance of R_{SI}=1m^2·K/W (R_{IP} = 5.68 h·ft²·°F/Btu) with a building service life of 75 years.	
REFERENCE PCR AND VERSION NUMBER	Part A: Calculation Rules for the LCA and Requirements Project Report, (UL Environment, v3.2, 12.12.2018) and Part B: Building Envelope Thermal Insulation EPD Requirements, v2.0 (April 10, 2018)	
DESCRIPTION OF PRODUCT APPLICATION/USE	Building and construction insulation	
PRODUCT RSL DESCRIPTION (IF APPL.)	75 years	
MARKETS OF APPLICABILITY	North America	
DATE OF ISSUE	January 1, 2021	
PERIOD OF VALIDITY	5 years	
EPD TYPE	Product-Specific	
EPD SCOPE	Cradle-to-grave	
YEAR(S) OF REPORTED PRIMARY DATA	2016 & 2023	
LCA SOFTWARE & VERSION NUMBER	GaBi v9.2	
LCI DATABASE(S) & VERSION NUMBER	GaBi 2020 (service pack 40)	
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1	

This PCR review was conducted by:	UL Environment PCR Review Panel epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Grant R. Martin Grant R. Martin, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas S. Gloria Thomas P. Gloria, Industrial Ecology Consultants

LIMITATIONS

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; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR 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.

1. Product Definition and Information

Huntsman Building Solutions operates 3 state of the art manufacturing facilities and has used so far 730 million plastic PET bottles in its products :

- In Arlington, Texas, USA:
  - size of site: 2.4 acres
  - number of employees: 72 associates
- In Boisbriand, QC, Canada:
  - size of site: 80,000 sq. ft.
  - number of employees: 67 associates
  - This site produces its own Polyol made of recycled PET plastic collected from landfills
- In Kings Lynn, UK:
  - size of site: 55,000 sq. ft.

1.1. Product Description

Product Identification

This declaration covers closed-cell medium density spray polyurethane foam (ccSPF) insulation manufactured under the Heatlok HFO & Heatlok Soya HP series brand by HBS. The Heatlok HFO & Heatlok Soya HP series use a hydrofluoroolefin (HFO) blowing agent.

Product Specification

Spray polyurethane foam (SPF) is made on the jobsite by combining polymeric methylene-diphenyl diisocyanate (pMDI/MDI or A-side) with an equal volume of a polyol blend (B-side). Sides A and B react and expand at the point of application in the building envelope to form polyurethane foam. The formed-in-place SPF provides both thermal insulation and air sealing to the building.

The Heatlok HFO & Heatlok Soya HP series provides a water-resistant insulation layer that acts as an air-sealant and provides water vapor control. The product also delivers additional structural performance to the building envelope. Heatlok HFO & Heatlok Soya HP series uses a HFO blowing agent that that transforms into a gas during installation due to the exothermic foam reaction that occurs.

ccSPF products are commonly used in residential, commercial, institutional, and some industrial applications. Typical properties are shown in Table 1.

Table 1. Typical ccSPF properties

PROPERTY	VALUE
Density [lb / ft^3]	2.0 to 2.4
Thermal resistivity [R / in]	5.5 to 7.4
Air impermeable material	✓
Integral vapor retarder	✓
Water resistant	✓
Cavity or exterior insulation	✓
Continuous insulation	✓
Soil Gas Barrier	✓
Rainscreen	✓
Fungi Resistant	✓
Air Quality - Greenguard Gold	✓
Structural improvement	✓

Flow Diagram

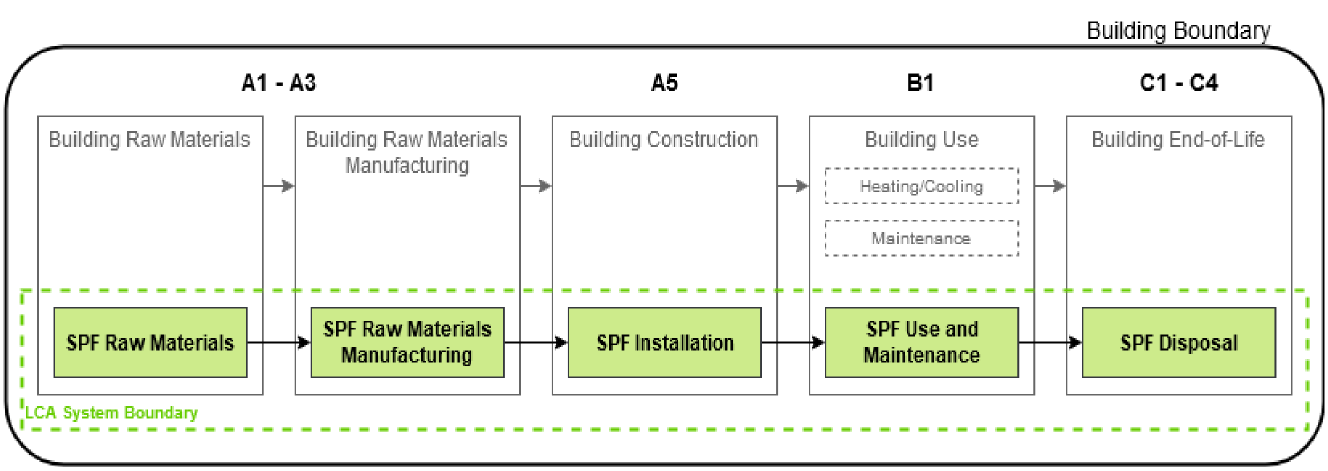

Figure 1. Product flow diagram

1.2. Product Average

The 2016 & 2023 production data used in this EPD consider all Heatlok HFO & Heatlok Soya HP series produced by HBS during the year. The products are manufactured at two facilities in Texas, US and Quebec, CA. Results are weighted according to production totals at the two locations.

1.3. Application

Closed cell products are applied to the interior or exterior side of the building envelope. Due to its water resistance, these can also be used on below grade walls and under slabs.

1.4. Declaration of Methodological Framework

This EPD is declared under a cradle-to-grave system boundary. As such, it includes all life cycle stages including any off-gassing emissions from the blowing agent associated with use of the product.

Per the product category rules (UL Environment, 2018), the assessment was conducted using a building service life of 75 years. Material and energy inputs were allocated on a mass basis. Recycled content and disposal at end-of-life follow the cut-off allocation approach. No inputs or outputs were deliberately excluded from this EPD.

1.5. Technical Requirements

All SPF products must meet numerous performance requirements to comply with building codes. The details of these requirements are described in specific tests listed in consensus standards for material performance and code compliance. A summary of these consensus standards is provided below:

ASTM Standards

- C1029-15 Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation

UL Canada Standards

- S705.1-15 Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density

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

Canadian Construction Materials Centre

- CCMC Evaluation Reports and Listings

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

Table 2: Summary of Typical Material Performance Requirements for SPF in Construction

PERFORMANCE REQUIREMENT	STANDARD	VALUE
Thermal Resistance (R-value)	ASTM C518, C177 or C1363	As reported (typ R6.0-7.0/inch / 4.2-4.8/100 mm)
Surface Burning Characteristics	ASTM E84 or UL723	Flame spread index ≤ 75 Smoke developed ≤ 450
Core Density	ASTM D1622	As reported (typ 1.5-2.5 pcf / 24-40 kg/m^3)
Closed-Cell Content	ASTM D2856 or ASTM D6226	>90%
Tensile Strength	ASTM D1623	15 psi min (100 kPa)
Compressive Strength	ASTM D1623	15 psi min (100 kPa)
Dimensional Stability	ASTM D2126	15% max change

PERFORMANCE REQUIREMENT	STANDARD	VALUE
Water Vapor Permeance	ASTM E96 (dry cup)	As reported (typ 1 US perm @ 2” thk / 60ng @ 51 mm)
Air Permeance	ASTM D E283 or D2178	As reported (typ imperm @ 1.5” thk / 38 mm)
Water Absorption	ASTM D2842	<5% max

Typical material performance requirements per CAN/ULC S705.1-15 are provided in Table 3 below.

Table 3: Summary of Typical Material Performance Requirements for SPF in Construction

PERFORMANCE REQUIREMENT	STANDARD	VALUE
Thermal Performance (R-value)	CAN/ULC S770-09	As reported (min. RSI 1.8/50 mm)
Surface Burning Characteristics	CAN/ULC S102	Flame spread index ≤ 500
Core Density	ASTM D1622	As reported (≥ 1.75 pcf / ≥ 28 kg/m^3)
Closed-Cell Content	ASTM D6226	>90%
Tensile Strength	ASTM D1623	29 psi min (200 kPa)
Compressive Strength	ASTM D1623	25 psi min (170 kPa)
Dimensional Stability	ASTM D2126	-20°C: min -2% max 5% 80°C : min -2% max 8% 70°C, 97±3% RH: min -2% max 14%
Water Vapor Permeance	ASTM E96 (dry cup)	As reported (min. 60ng @ 50 mm)
Air Permeance	ASTM D2178	As reported (max. 0.02 L/s @ 75Pa)
Water Absorption	ASTM D2842	4% max
Fungi Resistance	ASTM C1338	No Growth
Time to Occupancy	CAN/ULC S774	Max. 30 days

1.6. Properties of Declared Product as Delivered

The A-side and B-side are delivered to the job site in separate containers. On the job site, these chemicals are mixed in equal volume proportions to create the Heatlok HFO & Heatlok Soya HP series insulation. The products are seamless, creates no waste on site, provide an Air Barrier System, offer radon protection, remove the need for many other materials to provide air barrier, vapor barrier and insulation, it provide quickness of application (saves time on site), have recycled content, simplify the construction details, add durability, are flood resistance (FEMA) and provide structural strength.

1.7. Material Composition

The A-side of SPF is made from a blend of polymeric methylene diphenyl diisocyanate (MDI). The B-side is a mixture of polyester and polyester polyols, flame retardants, blowing agents, catalysts, and other additives that, when mixed with A-side, creates foam that can be applied for insulation.

One half of the formulation by volume is MDI (A-side). Table 4 focuses on the other multi-component half (B-side).

Huntsman Building Solutions product composition is proprietary, so an approximate composition of chemical components is shown. While some of the ingredients may be classified as hazardous, per the Resource Conservation and Recovery Act (RCRA), Subtitle 3, the product as installed and ultimately disposed of is not classified as a hazardous substance, as hazardous ingredients are rendered chemically inert after installation.

Table 4. Heatlok HFO & Heatlok Soya HP series B-side formulation (mass %)

CHEMICAL		COMPOSITION
Polyols	Polyester	< 55%
	Mannich	< 20%
Fire Retardant	TCPP	< 5%
Blowing Agent	Reactive (H_2O)	< 5%
	HFO, aggregate	< 15%
Catalyst	Amine	< 5%
	Metal	< 5%
Surfactant	Silicone	< 1%

2.1. Manufacturing

During the B-side production process, materials are blended together in tanks and packaged. The blending process utilizes internal scrap from a manufacturer's own operations. Additionally, the facility utilizes technology to minimize release of gaseous materials inputs, such as blowing agents, during material transfer and processing. Waste materials are typically reintegrated into the formulation without additional collection, transport or processing.

Polyester polyol is produced by HBS from post-consumer PET bottles. Since 2006, Huntsman Building Solutions has been manufaturing it's own proprietary polyol and has integrated in its products 730 millions plastic PET bottles collected from landfills all around the world. Each drum of HFO or HP resin contains the equivalent of 3000 plastic PET bottles.

2.2. Packaging

The high-pressure SPF chemicals are packaged in steel drums or plastic totes. Finished packaged products are loaded onto pallets. In this study, it is assumed that the empty chemical containers are properly cleaned and taken to a recycler.

2.3. Transportation

Final products are distributed via container truck either directly to customers, or first to warehouse, prior to being sent to customers. Table 5 details distribution assumptions for the finished SPF product.

2.4. Product Installation

The Heatlok HFO & Heatlok Soya HP series is installed by trained/certified professional applicators by on-site mixing of the A-side and B- side chemicals.

Installation includes insulation of the walls, floors and ceilings of entire buildings. These chemicals are delivered to the jobsite in unpressurized containers and heated to approximately 120-130 °F (49-54 °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. The schematic in Figure 2 shows the typical equipment components used to produce high-pressure SPF foam, including unpressurized A-side and B-side 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.

This study assumes 10% of the installed blowing agent is released to surrounding air during the installation phase. Disposal of packaging materials is modeled in accordance to the assumptions outlined in Part A of the PCR (UL Environment, 2018). All ancillary installation materials are assumed to be sent to landfill.

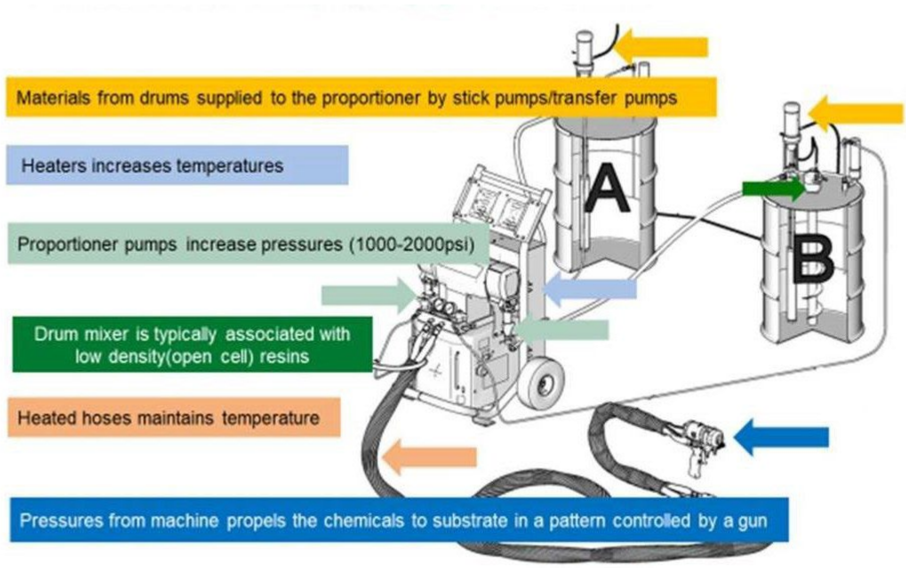

Figure 2. Schematic of a High-Pressure SPF system

2.5. 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).

2.6. Reference Service Life and Estimated Building Service Life

The reference service life (RSL) for SPF is the life of the building or 75 years. Additional information is provided in Table 7.

2.7. Reuse, Recycling, and Energy Recovery

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. There is not a huge market for recycling SPF, but it exists. Because of its durability, SPF from construction is not commonly recycled.

2.8. Disposal

When the building is decommissioned, it is assumed that only manual labor is involved to remove the foam. Wastes are assumed to be transported 30 miles (48 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).

3. LCA Calculation Rules

3.1. Functional Unit

The product function is providing insulation to buildings. Accordingly, the functional unit for the study is 1 m² of installed insulation material with a thickness that gives an average thermal resistance of R_{SI}=1m^2·K/W (In imperial units, R_{SI}=1 is equivalent to R = 5.68 h·ft²·°F/Btu) with a building service life of 75 years (packaging included).

3.2. System Boundary

The study uses a cradle-to-grave system boundary. As such, it includes upstream processing and production of materials and energy resources needed for the production of SPF, transport of materials (all chemical inputs for production and packaging) to SPF formulation sites, formulation of SPF components, transport of the components to the installation site, installation of insulation, removal and transport of insulation to disposal site, and end-of-life-disposal. Building energy savings from the use of insulation are excluded from this analysis.

3.3. Cut-off Rules

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

- **Mass** – 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.
- **Energy** – 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.
- **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 total 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 required to produce and install SPF (e.g. batch mixers, spraying equipment) are presumed to produce millions of units over the course of their life, so impact of a single functional unit attributed to this equipment is negligible; therefore, capital goods and infrastructure were excluded from this study. No known flows are deliberately excluded from this EPD.

3.4. Data Sources

The LCA model was created using the GaBi software system for life cycle engineering, developed by Sphera Solutions, Inc. (Sphera, 2020). Background life cycle inventory data for raw materials and processes were obtained from the GaBi 2020 database (service pack 40). Primary manufacturing data were provided by HBS.

3.5. Data Quality

A variety of tests and checks were performed by Sphera throughout the project to ensure high quality of the completed LCA. Checks included an extensive review of the product-specific LCA models as well as the background data used.

Temporal coverage

The data are intended to represent spray polyurethane foam production during the 2016 calendar year. As such, Huntsman Building Solutions provided primary data for 12 consecutive months during the 2016 calendar year.

Geographical coverage

This background LCA represents HBS's product produced in the United States and Canada. Primary data are representative of these countries. 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 were collected directly from HBS. Manufacturing data were provided by HBS for the Heatlok HFO & Heatlok Soya HP series product. Waste, emissions, and energy use are calculated from reported annual production during the reference year.

3.6. Period under Review

Primary data collected represent production during the 2016 calendar year. This analysis is intended to represent production in 2016.

3.7. Allocation

Multi-output allocation generally follows the requirements of ISO 14044, section 4.3.4.2. When allocation becomes necessary during the data collection phase, the allocation rule most suitable for the respective process step was applied.

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 burden-free. Only environmental impacts from the point of recovery and forward (e.g., inbound transports, grinding, processing, etc.) are considered.

3.8. Estimates and Assumptions

This EPD is based on primary data collected at HBS's facilities. As such, the datasets selected to represent the production of raw materials by upstream suppliers are based on regional or global averages rather than on primary data collected from the supply chain.

This EPD 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).

Lastly, the underlying study was conducted in accordance with the PCR. While this EPD has been developed by industry experts to best represent the product system, real life environmental impacts of closed-cell HFO SPF may extend beyond those defined in this document.

4. LCA Scenarios and Additional Technical Information

Table 5. Transport to the building site (A4)

Name	Value	Unit
Fuel type	Diesel	
Fuel economy, outbound transport Large truck Small truck Refrigerated truck	 0.000111 0.000111 0.000127	l/100km
Fuel economy, jobsite transport (light truck)	0.000492	l/100km
Outbound distance Large truck Small truck Refrigerated truck	 790 195 341	km
Jobsite distance	0.410	km
Weight of products transported	0.793	kg

Table 6. Installation into the building (A5)

Name	Value	Unit
Ancillary materials Chemical proof gloves Chemical suits Cloth gloves Duct tape Goggles Lubricating oil Masking tape Polyethylene Respirator cartridges	 0.000117 0.00205 6.90E-05 0.000423 0.000597 1.34E-05 0.000107 0.0213 1.66E-05	kg
Electricity consumption	0.0444	kWh
Diesel	0.0685	kg
Product loss per functional unit	0.0275	kg
Waste materials at the construction site before waste processing, generated by product installation	0.00349	kg
Biogenic carbon contained in packaging	0.00717	kg CO_2
Direct emissions to ambient air, soil and water	0.00480	kg

Table 7. Reference Service Life

NAME	VALUE	UNIT
RSL	75	years
Declared product properties (at the gate) and finishes, etc.	1	m^2
	1	R_{SI}

Table 8. End of life (C1-C4)

NAME	VALUE	UNIT
Collected as mixed construction waste	1	kg
Landfill	1	kg
Removals of biogenic carbon (excluding packaging)	0	kg CO_2

Table 9. Reuse, recovery and/or recycling potentials (D), relevant scenario information

NAME	VALUE	UNIT
Net energy benefit from steam recovery from waste treatment declared as exported energy in D	0.00353	MJ
Net energy benefit from electricity recovery from waste treatment declared as exported energy in D	0.00750	MJ

* No applicable data is present for modules B2-B7.

5. LCA Results

As this is a cradle-to-grave declaration, all modules are declared, as seen in Table 10. However, modules B2 to B7, C1, and C3 do not contribute to impact and are therefore declared as zero.

Table 10. Description of the system boundary modules. X = included in EPD scope; MND = module not declared (i.e., excluded from EPD scope)

	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During	Building Operational Water Use During	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
Cradle to Grave	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Impact assessment and other results are shown for a cradle-to-gate system boundary. Module D accounts for energy recovered from landfill gas generated due to the disposal of production waste.

5.1. Life Cycle Impact Assessment Results

North American LCIA results are declared using TRACI 2.1 methodology. Note that the IPCC AR5 GWP (IPCC, 2006) results are also presented as they are more current than the TRACI 2.1 GWP results. The TRACI 2.1 methodology refers to an earlier version of the IPCC report.

LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Table 11. LCIA results

TRACI v2.1	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP 100 [kg CO_2 eq]	1.92E+00	6.30E-02	5.09E-01	0.00E+00	-	-	-	-	-	-	-	2.07E-03	-	3.20E-02	-1.40E-03
GWP 100, IPCC AR5 [kg CO_2 eq]	1.94E+00	6.32E-02	4.89E-01	1.04E-02	-	-	-	-	-	-	-	2.07E-03	-	3.93E-02	-1.41E-03
ODP [kg CFC-11 eq]	5.49E-08	8.53E-18	1.57E-13	0.00E+00	-	-	-	-	-	-	-	2.81E-19	-	1.05E-16	-5.51E-18
AP [kg SO_2 eq]	6.51E-03	3.05E-04	2.80E-03	0.00E+00	-	-	-	-	-	-	-	6.58E-06	-	1.41E-04	-1.96E-06
EP [kg N eq]	8.06E-04	2.99E-05	2.48E-04	0.00E+00	-	-	-	-	-	-	-	7.62E-07	-	7.97E-06	-1.45E-07
POCP [kg O_3 eq]	9.03E-02	6.97E-03	9.38E-02	3.22E-03	-	-	-	-	-	-	-	1.48E-04	-	4.64E-03	-3.15E-05
ADP_{fossil} [MJ, LHV]	5.53E+00	1.26E-01	6.68E-01	0.00E+00	-	-	-	-	-	-	-	4.14E-03	-	6.33E-02	-1.86E-03

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.

5.2. Life Cycle Inventory Results

Table 12. Resource use results

PARAMETER	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPR_E [MJ, LHV]	2.40E+00	3.99E-02	2.49E-01	0.00E+00	-	-	-	-	-	-	-	1.31E-03	-	4.04E-02	-3.00E-03
RPR_M [MJ, LHV]	1.71E-01	0.00E+00	1.69E-03	0.00E+00	-	-	-	-	-	-	-	0.00E+00	-	0.00E+00	0.00E+00
RPR_T [MJ, LHV]	2.57E+00	3.99E-02	2.51E-01	0.00E+00	-	-	-	-	-	-	-	1.31E-03	-	4.04E-02	-3.00E-03
$NRPR_E$ [MJ, LHV]	4.55E+01	9.46E-01	5.24E+00	0.00E+00	-	-	-	-	-	-	-	3.11E-02	-	4.99E-01	-2.35E-02
$NRPR_M$ [MJ, LHV]	2.46E+01	0.00E+00	5.90E-01	0.00E+00	-	-	-	-	-	-	-	0.00E+00	-	0.00E+00	0.00E+00
$NRPR_T$ [MJ, LHV]	7.02E+01	9.46E-01	5.83E+00	0.00E+00	-	-	-	-	-	-	-	3.11E-02	-	4.99E-01	-2.35E-02
SM [kg]	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

PARAMETER	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
NRSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-	-	-	-	-	-	-	0.00E+00	-	0.00E+00	0.00E+00
RE [MJ, LHV]	2.40E+00	3.99E-02	2.49E-01	0.00E+00	-	-	-	-	-	-	-	1.31E-03	-	4.04E-02	-3.00E-03
FW [m^3]	1.71E-01	0.00E+00	1.69E-03	0.00E+00	-	-	-	-	-	-	-	0.00E+00	-	0.00E+00	0.00E+00

Table 13. Waste categories and output flows results

PARAMETER	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD [kg]	-1.27E-06	1.62E-08	6.24E-08	0.00E+00	-	-	-	-	-	-	-	5.33E-10	-	3.33E-09	-8.89E-12
NHWD [kg]	2.58E-02	6.78E-05	4.47E-02	0.00E+00	-	-	-	-	-	-	-	2.23E-06	-	7.47E-01	-6.88E-06
HLRW [kg]	1.43E-06	2.57E-09	7.14E-08	0.00E+00	-	-	-	-	-	-	-	8.46E-11	-	4.92E-09	-2.02E-09
ILLRW [kg]	1.68E-05	6.91E-08	1.96E-06	0.00E+00	-	-	-	-	-	-	-	2.28E-09	-	1.30E-07	-5.58E-08
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-	-	-	-	-	-	-	0.00E+00	-	0.00E+00	0.00E+00
R [kg]	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	-	-	-	-	-	-	-	0.00E+00	-	0.00E+00	0.00E+00
EE [MJ, LHV]	3.35E-04	0.00E+00	3.20E-03	0.00E+00	-	-	-	-	-	-	-	0.00E+00	-	0.00E+00	-3.53E-03

6. LCA Interpretation

The results in Section 5 represent the cradle-to-grave environmental performance of 1 m^2 of installed SPF at R_{SI}=1 over a 75-year RSL. These results are consistent with SPF blowing agent characteristics and previous studies of SPF life cycle impacts. Across impact categories, the environmental profile of the product is driven primarily by raw materials (A1), in particular by production of polyols and the HFO blowing agent. After manufacturing, installation is the second-largest contributor to impacts due to waste foam disposal and the use of on-site diesel generators.

Though some raw materials are transported vast distances, the inbound transportation module (A2) has a modest contribution to overall impact. Other transportation modules representing transport to site (A4) and transport to end-of-life (C2) have negligible contributions to impact categories

7. Additional Environmental Information

7.1. Environment and Health During Manufacturing and Installation

Manufacturing of SPF formulations and upstream chemicals are performed in an industrial manufacturing facility. Like many manufacturing processes, hazardous chemicals and manufacturing procedures may be employed. These manufacturers follow all local, state and federal regulations regarding safe use and disposal of all chemicals (US EPA), as well as safety requirements required of the generally manufacturing operation of equipment and processes (US and State OSHA) and safe transport of all materials (US DOT) Environment and Health During Installation

Polyester polyol is produced by HBS from post-consumer PET bottles. Since 2006, Huntsman Building Solutions has been manufaturing it's own proprietary polyol and has integrated in its products 730 millions plastic PET bottles collected from landfills all around the world. Each drum of HFO or HP resin contains the equivalent of 3000 plastic PET bottles.

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.

7.2. 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 the 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 plastics materials and assemblies should meet the fire test requirements of the applicable building codes.

Water

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

Radon

The Heatlok HFO & Heatlok Soya HP series products act as a radon barrier in accordance with K124/02/95.

Mechanical Destruction

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

[1] "Flood Damage-Resistant Materials Requirements", FEMA Technical Bulletin 2, 2008, Table 2.

7.3. Environmental Activities and Certifications

Huntsman Building Solutions has certified or tested their insulation products to various VOC standards to measure emissions of volatile or semi-volatile compounds. 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 Health Services – Also known as Section 01350, this small-chamber emissions test standard is detailed under: Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers (CA/DHS/EHLB/Standard Method v1.1-2010).
- Canadian ULC – Required for SPF insulation products, this standard provides a similar VOC emissions test protocol specifically for SPF: CAN/ULC S774-09 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.

7.4. Low-GWP Blowing Agents

This EPD is based on an LCA of SPF products that use HFOs as blowing agents. Because of the low global warming potential factor of HFOs (~1.0 g CO_2-eq./kg) the emissions of these blowing agents account for a small percentage of the global warming potential life cycle results for HFO containing foams.

8. References

EPA. (2012). *Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI) - User's Manual.* Washington, D.C.: US EPA.

Honeywell International. (n.d.). *Predictive Model for Polyurethane Blowing Agent Emissions into a House.* Buffalo.

IPCC. (2006). *Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste; IPCC Waste Model.* Retrieved from http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html

ISO. (2006). *ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines.*

ISO. (2009). *ISO 14040: Environmental management - Life cycle assessment - principles and frameworks.*

ISO. (2017). *ISO 21930 Sustainability in building construction - Environmental declaration of building products.*

Kjeldsen, P., & Jensen, M. (2001). Release of CFC-11 from Disposal of Polyurethane Foam Waste. *ENVIRONMENTAL SCIENCE & TECHNOLOGY*, 3055-3063.

Sphera. (2020). *GaBi LCA Database Documentation*. Retrieved from Sphera Solutions, Inc.: http://www.gabi-software.com/america/support/gabi/

UL Environment. (2018). *Product Category Rules (PCR) Guidance for Building-Related Products and Services Part B: Building Envelope Thermal Insulation EPD Requirements, UL 10010–1 (v2.0).*

UL Environment. (2018). *Product Category Rules for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements, v3.2.*

UL Environment. (2020). *Program Operator Rules v 2.5.*

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