On behalf of Spray Polyurethane Foam Alliance

Spray Polyurethane Foam Insulation Products

EPD Background Report

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On behalf of Sphera Solutions, Inc. and its subsidiaries

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List of Acronyms

ADP	Abiotic Depletion Potential
AP	Acidification Potential
ASTM	American Society for Testing and Materials
CML	Centre of Environmental Science at Leiden
EoL	End-of-Life
EP	Eutrophication Potential
GaBi	Ganzheitliche Bilanzierung (German for holistic balancing)
GHG	Greenhouse Gas
GWP100	Global Warming Potential
HFC	Hydrofluorocarbons
HFO	Hydrofluoroolefins
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
NMVOC	Non-Methane Volatile Organic Compound
MDI	Methylene diphenyl diisocyanate
ODP	Ozone Depletion Potential
SFP	Smog Formation Potential
SPF	Spray Polyurethane Foam
SPFA	Spray Polyurethane Alliance
PCR	Product Category Rule
RSL	Reference Service Life
TRACI	Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts
TCPP	Tris(2-chloroisopropyl)phosphate
TDCP	Tris(1,3-dichloro-2-propyl)phosphate
VOC	Volatile Organic Compound

Glossary

Life Cycle

A view of a product system as "consecutive and interlinked stages … from raw material acquisition or generation from natural resources to final disposal" (ISO 14040:2006, section 3.1). This includes all material and energy inputs as well as emissions to air, land and water.

Life Cycle Assessment (LCA)

"Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle" (ISO 14040:2006, section 3.2)

Life Cycle Inventory (LCI)

"Phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle" (ISO 14040:2006, section 3.3)

Life Cycle Impact Assessment (LCIA)

"Phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product" (ISO 14040:2006, section 3.4)

Life Cycle Interpretation

"Phase of life cycle assessment in which the findings of either the inventory analysis or the impact assessment, or both, are evaluated in relation to the defined goal and scope in order to reach conclusions and recommendations" (ISO 14040:2006, section 3.5)

Functional Unit

"Quantified performance of a product system for use as a reference unit" (ISO 14040:2006, section 3.20)

Allocation

"Partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems" (ISO 14040:2006, section 3.17)

Closed-loop and Open-loop Allocation of Recycled Material

"An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties."

"A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials."

(ISO 14044:2006, section 4.3.4.3.3)

Foreground System

"Those processes of the system that are specific to it … and/or directly affected by decisions analyzed in the study." (JRC 2010, p. 97) This typically includes first-tier suppliers, the manufacturer itself and any downstream life cycle stages where the manufacturer can exert significant influence. As a general rule, specific (primary) data should be used for the foreground system.

Background System

"Those processes, where due to the averaging effect across the suppliers, a homogenous market with average (or equivalent, generic data) can be assumed to appropriately represent the respective process … and/or those processes that are operated as part of the system but that are not under direct control or decisive influence of the producer of the good…." (JRC 2010, pp. 97-98) As a general rule, secondary data are appropriate for the background system, particularly where primary data are difficult to collect.

Critical Review

"Process intended to ensure consistency between a life cycle assessment and the principles and requirements of the International Standards on life cycle assessment" (ISO 14044:2006, section 3.45).

Executive Summary

The Spray Polyurethane Foam Alliance (SPFA) is recognized as the leading advocate for the spray polyurethane foam industry. In addition to representing companies who manufacture spray polyurethane foam (SPF), SPFA develops tools designed to educate and influence the construction industry with the positive benefits of SPF roofing, insulation, coatings, and specialty installations. Aware of the increasing interest in transparent reporting of products' environmental performance, SPFA seeks to demonstrate their sustainability leadership and leverage business value through evaluating the environmental profiles of member companies' SPF products and communicating the results via industry average Environmental Product Declarations (EPDs).

The study consists of a cradle-to-grave life cycle assessment (LCA) of five SPF formulations produced in North America:

- One open cell formulation with reactive blowing agent
- Two formulations with hydrofluorocarbon (HFC) blowing agents
- Two formulations with hydrofluoroolefin (HFO) blowing agents

The intended audience for this report includes the program operator, American Society for Testing and Materials (ASTM) International, the reviewer who will be assessing the life cycle assessment (LCA) for conformance to the Product Category Rule (PCR), and SPFA member companies. In addition, Sphera recommends making this report available upon request to all third parties to whom the EPD is communicated for conformance with ISO 14044, Section 5.2 (ISO, 2006). The resulting EPDs are intended to support business-to-business communication.

This study was commissioned by SPFA and performed by Sphera. The analyses were conducted according to ULE's Product Category Rule: "Part B: Building Envelope Thermal Insulation EPD Requirements" (UL Environment, 2024) and in accordance with the International Standard ISO 14044 (ISO, 2006). Conformance of the background LCA study as well as the final EPD with the guiding PCRs and ISO 14025 (ISO, 2007), ISO 21930 (ISO, 2017), and ISO 14044 (ISO, 2006) were verified through ASTM's EPD program. Note that this study is an update to the SPFA's Spray Polyurethane Foam Insulation EPD issued in 2018 (SPFA, 2018), which was an update from the EPD issued in 2012 (SPFA, 2012).

There was an improvement in data collection for the five SPF formulations since the 2018 study. Changes in this update include:

- Updated primary data from member companies
- Updated side-B formulation to use weighted averages instead of generic formulations
- Additional chemicals in side-B formulations were incorporated into the model
- Updated densities and R-values of each formulation

The life cycle impact assessment (LCIA) results represent the cradle-to-grave environmental performance of 1 m^2 of installed SPF with an average thermal resistance of R_{SI} = 1 m^2K/W over a reference service life (RSL) of 75 years. The results indicate that SPF products with an HFC based blowing agent generally have a higher environmental impact than its SPF counterpart with an HFO based blowing agent, and open cell products with a reactive blowing agent (i.e., water) have the lowest environmental impact.

The high global warming potential (GWP100) for HFC based SPF products are primarily driven by the emissions released over its lifetime. The GWP100 for closed cell SPF with HFC and roofing SPF with HFC are 18.1 kg CO_2/ m^2 of installed SPF and 18.6 kg CO_2 eq./ m^2 of installed SPF, respectively, where 81 – 87% is contributed by the

HFC emissions. Based on the study done by Honeywell on a predictive model of SPF emissions, it is assumed a total of 50% of blowing agent is released over the product lifetime – 10% during installation (A5), 24% during use phase (B1), and 14% during end of life (C4) (Honeywell International). The same assumption was used for HFO based SPF products and open cell products, but the released HFOs have approximately 0.1% of the GWP100 of HFCs, and the water used in the open cell products has no associated GWP100.

For GWP100 of open cell and HFO based SPF products, raw materials (A1) are the most dominant contributor. The burden from the upstream production of methylene diphenyl diisocyanate (MDI) which makes up side-A (35 - 37% of overall GWP100), and the raw materials in side-B such as polyols (21 - 26% of overall GWP100) and TCPP (7 - 17% of overall GWP100) were main contributors due to high mass contribution to the final product.

In AP, EP, and SFP, installation (A5) contributed 19% to 35% of the impact for all five products due to the onsite diesel generator used for installation as well as emissions from foam waste disposal.

For ODP, the dominant contributor was the cardboard used in module A5 (material for installation) (76 – 99%) and module A3 (packaging material for manufacturing) (0 – 23%). For HFO based products, the dominant contributor was the HFO upstream production.

Although some raw materials are transported over long distances, the inbound transportation (A2) and transportation to site (A4) have modest contributions to the overall impact. Inbound transportation (A2) ranged from 0% to 11% of the overall impact, and transportation to site (A4) ranged from 0 to 5%. Other transportation modules such as the transportation to end-of-life (C2) have negligible impacts.

As side-B formulation varies from product to product, a sensitivity analysis was performed to test the sensitivity of the results to changes in blowing agent composition in the side-B formulation. The composition of the blowing agent was varied by 5%. Results showed small changes (3% or less) in all impact categories considered for open cell product because the reactive blowing agent is water-based. For HFO-based products, the composition of the blowing agent affected the ODP category with changes of 57 – 65% due to the upstream production of HFO. Other impact categories varied by 5% or less. For HFC-based products, the composition of blowing agents greatly affected the GWP100 category due to the emissions of HFC-245fa. A 5% variation in blowing agent composition resulted in GWP100 changes of 45% to 65%. Other impact categories showed small changes (≤5%). It is also worth noting that ODP impacts did not change with varying blowing agent compositions for HFC based products

A Monte Carlo uncertainty analysis was also done by varying the R-value and density of each SPF product by 10% and running 500 simulations. Results from the uncertainty test showed that the GWP100 results were within 1% to 13% of the baseline scenario, and standard deviation was around 5% to 12% for all five formulations.

As evident in the results, raw materials (A1) are a dominant contributor across the various environmental impact categories, it is recommended that SPFA continue to investigate alternative formulations that use fewer intensive components. The industry should explore alternative options for MDI for side A or low-carbon MDI, as well as for blowing agents, polyols, and flame retardants. SPFA member companies should also work together with their manufacturers in their supply chain to reduce environmental impact in their upstream production. As insulation requirements for buildings can vary across the different regions and climates, SPFA member companies can also investigate more region-specific formulations to reduce certain raw materials in the side-B formulation.

Onsite installation, specifically the use of diesel generators, showed significant contribution in GWP100, AP, EP, and SFP. SPFA member companies can encourage spray foam installers use lower impact electricity sources such as batteries or mobile generators using biodiesel

It is recommended that SPFA and its member companies continue their efforts in understanding the environmental impact of their products and update EPDs in effort to track progress and continuously identify opportunities for improvement.

1. Goal of the Study

The Spray Polyurethane Foam Alliance (SPFA) is recognized as the leading advocate for the spray polyurethane foam industry. In addition to representing companies who manufacture spray polyurethane foam (SPF), SPFA develops tools designed to educate and influence the construction industry with the positive benefits of SPF roofing, insulation, coatings, and specialty installations. Aware of the increasing interest in transparent reporting of products' environmental performance, SPFA seeks to demonstrate their sustainability leadership and leverage business value through evaluating the environmental profiles of member companies' SPF products and communicating the results via industry average Environmental Product Declarations (EPDs).

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This study was commissioned by SPFA and performed by Sphera. The analyses were conducted according to ULE's Product Category Rule: "Part B: Building Envelope Thermal Insulation EPD Requirements" (UL Environment, 2024) and in accordance with the International Standard ISO 14044 (ISO, 2006). Conformance of the background LCA study as well as the final EPD with the guiding PCRs and ISO 14025 (ISO, 2007), ISO 21930 (ISO, 2017), and ISO 14044 (ISO, 2006) were verified through American Society for Testing and Materials (ASTM) EPD program. Note that this study is an update to the SPFA's Spray Polyurethane Foam Insulation EPD issued in 2018 (SPFA, 2018).

The intended audience for this report includes the program operator, ASTM International, the reviewer who will be assessing the life cycle assessment (LCA) for conformance to the Product Category Rules (PCRs), and SPFA member companies. In addition, Sphera recommends making this report available upon request to all third parties to whom the EPD is communicated for conformance with ISO 14044, Section 5.2 (ISO, 2006). The resulting EPDs are intended to support business-to-business communication.

Results presented in this document do not constitute comparative assertions. However, these results will be disclosed to the public in EPDs, which architects and builders can potentially use to compare SPFA member companies' products with similar products presented in other EPDs that follow the same PCR. Prior to publication by a program operator, the EPDs will undergo a verification process for conformance to the PCRs.

2. Scope of the Study

The following sections describe the general scope of the project to achieve the stated goals. This includes, but is not limited to, the identification of specific product systems to be assessed, the product function, functional unit and reference flows, the system boundary, allocation procedures, and cut-off criteria of the study.

2.1. Product Systems

SPF products are commonly used in commercial, light commercial, institutional, and residential insulation applications. A two-component mixture composed of isocyanate (side-A) and polyol resin (side-B) is sprayed onto a surface in an equal volumetric ratio that reacts to form an expanding polyurethane foam that has thermally insulating properties. SPF performance characteristics are predominantly determined by the side-B formulation.

Five specific side-B formulations, which are considered representative of common SPF products manufactured by SPFA member companies, as seen in Table 2-1, are evaluated in this study.

This declaration covers a range of spray polyurethane foam manufactured at 19 different facilities by participating SPFA members, representing a significant majority of annual production in the US and Canada. Only the following participating companies may claim to be represented by the resulting EPDs:

- BASF (4 sites)
- Creative Polymers (1 site)
- Elastochem (1 site)
- General Coatings (2 sites)
- Holcim Building Solutions (2 sites)
- Huntsman Building Solutions (3 sites)
- Johns Manville (1 site)
- Natural Polymers (1 site)
- NCFI (2 sites)
- Soprema (1 site)
- SWD (1 site)

Table 2-1: SPF products under study

Product	Blowing Agent			Relevant Standards		
	HFC	HFO	Reactive	ASTM	CAN/ULC	ICC
Open Cell			X	WK30150	S712.1	ICC 1100; ICC-ES AC377
Closed Cell	X	X		C1029 Type I and II	S705.1	ICC 1100; ICC-ES AC377
Roofing	X	X		C1029 Type III and IV; D7245		

ASTM Standards

- C1029-15 Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
- D7425-13 Standard Specification for Spray Polyurethane Foam Used for Roofing Applications
- WK30150 (under development) Standard Specification for Spray-Applied Open Cellular Polyurethane Thermal Insulation

UL Canada Standards

- S705.1 Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density
- S712.1 Standard for Thermal Insulation - Light Density, Open Cell Spray Applied Semi-Rigid Polyurethane Foam
- 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

2.2. Product Function and Functional Unit

The product's function is to provide thermal insulation to buildings. Accordingly, the functional unit (FU) for the study, as defined by the UL Environment's Product Category Rule (PCR) for Building Envelope Thermal Insulation, Product Category Rule Number UL 10010-1 (UL Environment, 2024), is: 1 m^2 of installed insulation material with a thickness that gives an average thermal resistance of 1 $m^2 \cdot K/W$ (5.68 $hr \cdot ft^2 \cdot °F/Btu$) with a building service life of 75 years (packaging included). The thickness of insulation required to fulfill the functional unit can be calculated using Equation 1.

$$FU\ [kg \text{ or } lb] = R_{SI} \cdot \lambda \cdot \rho \cdot A \tag{1}$$

Where,

- R_{SI} = thermal resistance [m^2K/W *or* $ft^2 \cdot °F \cdot hr/Btu$]
- λ = thermal conductivity [W/mK *or* Btu-in./hr· $ft^2 \cdot °F$]
- ρ = density of insulation product [kg/m^3 *or* lb/ft^3]
- A = area [m^2 *or* ft^2] (here, 1 m^2 *or* 10.763 ft^3)

The thickness required to satisfy the functional unit is calculated as follows in Equation 2:

$$thickness\ [m \text{ or } in] = R_{SI} \cdot \lambda = \frac{RSI}{R_{value}} \tag{2}$$

Where,

- R_{value} = thermal resistance of the spray foam per unit thickness [m^2K/W per m *or* $ft^2 \cdot °F \cdot hr/Btu$ per in]
- RSI = 1 $m^2 \cdot K/W$ (5.68 $hr \cdot ft^2 \cdot °F/Btu$)

To calculate the reference flow, the required thickness is used to calculate the volume of installed insulation material, and finally with the density of the material, the mass required to satisfy the functional unit can be calculated, as follows in Equation 3.

$$Reference\ flow\ [lb] = thickness \cdot A \cdot \rho = \frac{RSI}{R_{value}} \cdot \frac{1\ ft}{12\ in} \cdot A \cdot \rho \tag{3}$$

The products assessed fall under UNSPSC code 301415 Insulation and 301515 Roofing Material, and CSI/CSC code 07 21 19 Foam-in-Place Insulation.

The reference flows for which life cycle inventory (LCI) information will be reported in this study are shown in Table 2-2. Nominal densities and R-values for a thickness of 3-inches were collected from participating companies and a production average was calculated for each SPF formulation.

The minimum and maximum ranges of the R-value and nominal densities have also been included in Table 2-2.

Table 2-2: Insulation properties and the associated reference flows

	Unit	Open cell	Closed Cell		Roofing	
			HFC	HFO	HFC	HFO
R-Value per inch	(hr·ft²·°F/Btu)/ in	3.74 [3.69-3.80]	6.80 [6.50-7.10]	7.08 [5.31-7.61]	6.52 [6.25-7.10]	6.43 [5.70-6.70]
Density	lbs/ft³	0.47 [0.43-0.64]	2.00 [2.00-2.10]	1.98 [1.84-2.18]	2.89 [2.73-3.15]	2.79 [2.73-3.05]
Thickness to achieve functional unit	in	1.52	0.84	0.80	0.87	0.88
	mm	38.6	21.2	20.4	22.1	22.4
Reference flow	lbs	0.64	1.50	1.42	2.25	2.20
	kg	0.29	0.68	0.65	1.02	1.00

2.3. System Boundary

SPF is created by mixing equal volumes of two batches of chemicals, commonly referred to as side-A and side-B. “side-A” is the industry term for the isocyanate component of foam; in this case methylene diphenyl diisocyanate (MDI).

With SPF, “side-B” is a mixture of polyols, fire retardants, blowing agents, catalysts, and other additives that, when mixed with “side-A,” creates foam used for insulation. The formulations of these side-B mixtures for each company are proprietary. However, the main ingredients do not vary significantly. The five formulations based on industry average are used to represent the side-B products evaluated in this study. The compositions of each of these formulations can be found in Table 3-1 in Section 3.

Figure 2-1 shows the life cycle stages associated with the study. This LCA study only focuses on the spray foam portion of a building. It excludes all other building materials as well as building use and the effects the spray foam may have on the thermal resistance of the building envelope.

Capital goods and infrastructure flows were excluded from this analysis due to the minimal extent that it affects the LCIA results. For the manufacturing of SPF products, capital goods and infrastructure last for 30 to 40 years with periodic replacement of valves and repair of control systems, with an annual production of around 60 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.

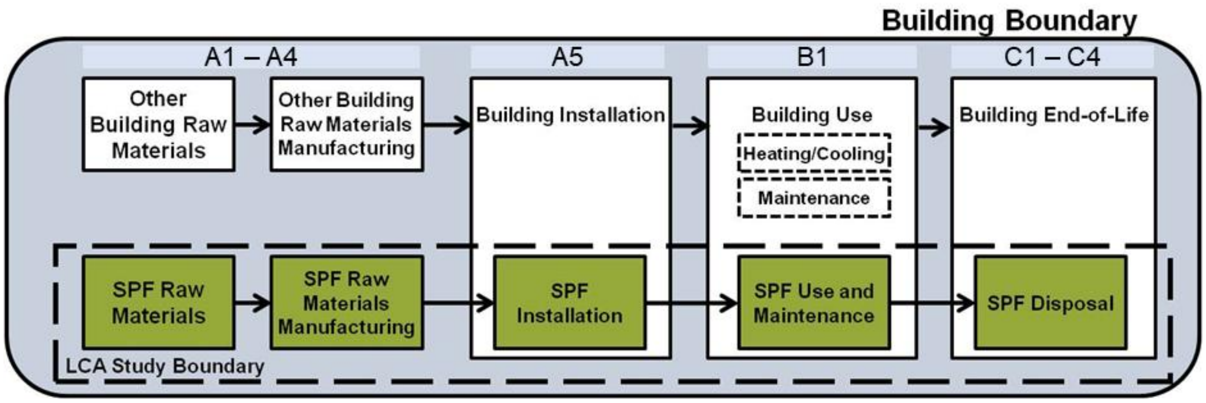


Figure 2-1: Life cycle flow diagram of SPF products

Table 2-3: System boundaries

Included	Excluded
✓ Extraction of raw materials (A1) ✓ Production and manufacturing of spray foam and upstream production of packaging materials (A3) ✓ Spray foam formulation (A3) ✓ Spray foam installation (A5) ✓ End-of-life of packaging material (A5) ✓ End-of-life of insulation foam (C4) ✓ Transportation between all life cycle stages (A2, A4, C2)	× Construction of capital equipment and infrastructure × Maintenance of support equipment × Human labor and employee commute × Energy savings from product use

2.3.1. Time Coverage

The data are intended to represent spray polyurethane foam production during the 2022 calendar year. As such, each participating SPFA member company provided primary data for 12 consecutive months during the 2022 calendar year. These data were then used to calculate average production values for each company.

Results are valid until significant technological changes occur.

2.3.2. Technology Coverage

This LCA is intended to represent current technology used by participating SPFA members' products produced in the United States and Canada.

2.3.3. Geographical Coverage

This background LCA represents SPFA members' products 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.

2.4. Allocation

2.4.1. Multi-output Allocation

Multi-output allocation 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 is applied and documented along with the process in Chapter 3.

Upon discussions with primary data providers participating in this LCA study, it was determined that mass allocation should be used to allocate the inputs and outputs of SPF manufacturing process between the different SPF co-products manufactured at a given facility. This allocation approach was also confirmed with the participants of the LCA study.

However, the background MDI dataset used in the LCA study, which was developed by the European diisocyanates and polyols producers' association known as ISOPA is based on a combination of mass and elemental allocation approach (European Diisocyanate and Polyol Producers Association (ISOPA), 2021).

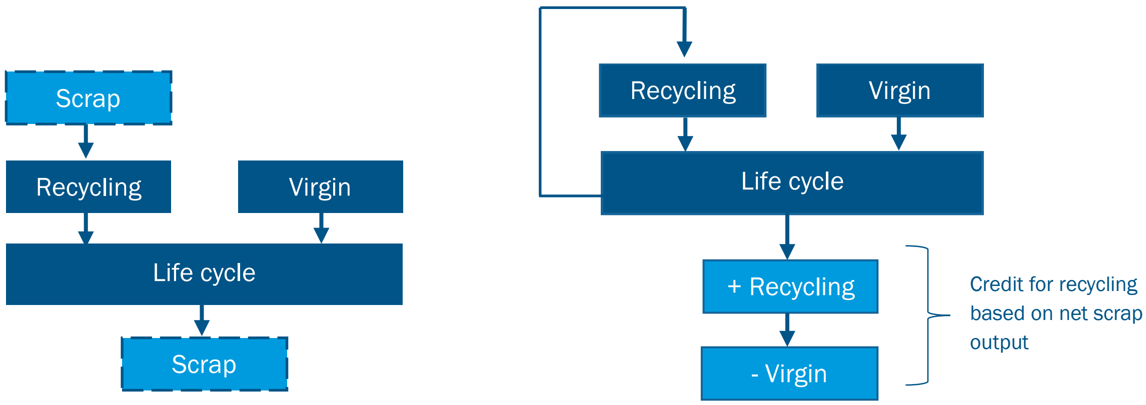
Allocation of other background data (energy and materials) taken from the Sphera MLC 2024.2 databases is documented online at https://lcadatabase.sphera.com/ .

2.4.2. End-of-Life Allocation

End-of-Life allocation generally follows the requirements of ISO 14044, section 4.3.4.3. Such allocation approaches address the question of how to assign impacts from virgin production processes to material that is recycled and used in future product systems.

Two main approaches are commonly used in LCA studies to account for end-of-life recycling and recycled content.

- Substitution approach (also known as 0:100, closed-loop approximation, recyclability substitution or end of life approach) – this approach is based on the perspective that material that is recycled into secondary material at end of life is technically able to substitute an equivalent amount of virgin material. Hence, a credit is given to account for this substitutability. To avoid double-counting the benefits of recycled content, waste materials collected for recycling in EoL are first used to satisfy the scrap demand of the manufacturing phase before being sent to recycling and crediting in EoL. This 'net scrap' approach rewards both end of life recycling as well as the use of recycled content.
- Cut-off approach (also known as 100:0 or recycled content approach) – burdens or credits associated with material from previous or subsequent life cycles are not considered i.e., are "cut-off". Therefore, scrap input to the production process is considered to be free of upstream virgin material burdens but, equally, no credit is received for scrap available for recycling at end of life. This approach rewards the use of recycled content but does not reward end of life recycling.



(i) Cut-off approach (scrap inputs and outputs are not considered)

(ii) Substitution approach (credit given for net scrap arising)

Figure 2-2: Schematic representations of the cut-off and substitution approaches

The cut-off allocation approach is adopted in the case for 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.

Any open scrap inputs into manufacturing remain unconnected. The system boundary includes waste incineration and landfilling processes following the polluter-pays-principle. In cases where materials are sent to waste incineration, they are linked to an inventory that accounts for waste composition and heating value as well as for regional efficiencies and heat-to-power output ratios. In cases where materials are sent to landfills, they are linked to an inventory that accounts for waste composition, regional leakage rates, landfill gas capture as well as utilization rates (flaring vs. power production). No credits for power or heat production are assigned.

Per the UL PCR Part A, the product is modeled to be disposed in a landfill. Plastic and other construction waste is assumed to be inert in landfills so no landfill gas is produced from it. In the case of bio-based packaging installation waste, it is sent to landfill with inventories that account for the waste composition.

2.5. Cut-off Criteria

The cut-off criteria for including or excluding materials, energy, and emission data 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.

The 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 assumed to be negligible; therefore, capital goods and infrastructure were excluded from this study.

In cases where no matching life cycle inventories are available to represent a flow, proxy data have been applied based on conservative assumptions regarding environmental impacts. The choice of proxy data is documented in Chapter 3. The influence of these proxy data on the results of the assessment has been carefully analyzed and is discussed in Chapter 5.

2.6. Selection of LCIA Methodology and Impact Categories

The impact assessment categories and other metrics considered to be of high relevance to the goals of the project and are as required by ISO 21930 and the PCR are shown in Table 2-4 and in Table 2-5 (ISO, 2017) (UL Environment, 2024). TRACI 2.1 has been selected as it is currently the only impact assessment methodology framework that incorporates US average conditions to establish characterization factors (Bare, 2012) (EPA, 2012). For impact categories where TRACI characterization factors are not available (e.g., water footprinting) or where they are not considered to be the most current (e.g., global warming potential), alternative methods have been used and are described in more detail below.

Global Warming Potential and Non-Renewable Primary Energy Demand were chosen because of their relevance to climate change and energy efficiency, both of which are strongly interlinked, of high public and institutional interest, and deemed to be one of the most pressing environmental issues of our time. The global warming potential impact category is assessed based on the current IPCC characterization factors taken from the 6th Assessment Report (IPCC, 2021) for a 100-year timeframe (GWP100) as this is currently the most used metric.

The GWP100 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.

Eutrophication, Acidification, and Photochemical Ozone Creation Potentials were chosen because they are closely connected to air, soil, and water quality and capture the environmental burden associated with commonly regulated emissions such as NO_x, SO_2, VOC, and others.

Ozone depletion potential was chosen because of its high political relevance, which eventually led to the worldwide ban of more active ozone-depleting substances; the phase-out of less active substances is due to be completed by 2030. Current exceptions to this ban include the application of ozone depleting chemicals in nuclear fuel production. The indicator is therefore included for reasons of completeness.

Table 2-4: North American LCIA Descriptions

Impact Category	Description	Unit	Reference
Global Warming Potential (GWP100)	A measure of greenhouse gas emissions, such as CO_2 and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, increasing the natural greenhouse effect. This may in turn have adverse impacts on ecosystem health, human health and material welfare.	kg CO_2 equivalent	(IPCC, 2021)

Impact Category	Description	Unit	Reference
Eutrophication Potential (EP)	Eutrophication covers all potential impacts of excessively high levels of macronutrients, the most important of which nitrogen (N) and phosphorus (P). Nutrient enrichment may cause an undesirable shift in species composition and elevated biomass production in both aquatic and terrestrial ecosystems. In aquatic ecosystems increased biomass production may lead to depressed oxygen levels, because of the additional consumption of oxygen in biomass decomposition.	kg N equivalent	(Bare, 2012) (EPA, 2012)
Acidification Potential (AP)	A measure of emissions that cause acidifying effects to the environment. The acidification potential is a measure of a molecule's capacity to increase the hydrogen ion (H^+) concentration in the presence of water, thus decreasing the pH value. Potential effects include fish mortality, forest decline and the deterioration of building materials.	kg SO_2 equivalent	
Smog Formation Potential (SFP)	A measure of emissions of precursors that contribute to ground level smog formation (mainly ozone O_3), produced by the reaction of VOC and carbon monoxide in the presence of nitrogen oxides under the influence of UV light. Ground level ozone may be injurious to human health and ecosystems and may also damage crops.	kg O_3 equivalent	
Ozone Depletion Potential (ODP)	A measure of air emissions that contribute to the depletion of the stratospheric ozone layer. Depletion of the ozone leads to higher levels of UVB ultraviolet rays reaching the earth's surface with detrimental effects on humans and plants.	kg CFC-11 equivalent	
Abiotic resource depletion potential of non-renewable (fossil) energy resources (ADPfossil)	A measure of the removal of abiotic resources from the earth, or the depletion of non-renewable (fossil) energy resources.	MJ	CML 2001 (CML, 2001)

Table 2-5: Resource Use Indicators

Indicator	Description	Unit	Reference
RPR_E	Renewable primary energy as energy carrier	MJ, LHV	(Sphera, 2024)
RPR_M	Renewable primary energy resources as material utilization	MJ, LHV	
$NRPR_E$	Non-renewable primary energy as energy carrier	MJ, LHV	
$NRPR_M$	Non-renewable primary energy as material utilization	MJ, LHV	
SM	Use of secondary material	kg	
RSF	Use of renewable secondary fuels	MJ, LHV	
NRSF	Use of non-renewable secondary fuels	MJ, LHV	
RE	Recovered Energy	MJ, LHV	
FW	Use of net fresh water	m^3	

Table 2-6: Output Flows and Waste Categories

Indicator	Description	Unit	Reference
HWD	Hazardous waste disposed	kg	(Sphera, 2024)
NHWD	Non-hazardous waste disposed	kg	
HLRW	High-level radioactive waste, conditioned, to final repository	kg	
ILLRW	Intermediate- and low-level radioactive waste, conditioned, to final repository	kg	
CRU	Components for re-use	kg	
MR	Materials for recycling	kg	
MER	Materials for energy recovery	kg	
EE	Exported energy	MJ	

It shall be noted that the above impact categories represent impact *potentials*, i.e., they are approximations of environmental impacts that could occur if the emissions would (a) actually follow the underlying impact pathway and (b) meet certain conditions in the receiving environment while doing so. In addition, the inventory only captures that fraction of the total environmental load that corresponds to the functional unit (relative approach). LCIA results are therefore relative expressions only and do not predict actual impacts, the exceeding of thresholds, safety margins, or risks.

The study applies normalization to yearly US emissions to establish the order of magnitude in which each product system would contribute to the average environmental burden of a given year. The chosen geographic reference represents the region where the majority of the life cycle environmental burdens occur and corresponds to the scope of the chosen impact assessment methodologies.

As this study intends to support comparative assertions to be disclosed to third parties, no grouping or further quantitative cross-category weighting has been applied. Instead, each impact is discussed in isolation, without reference to other impact categories, before final conclusions and recommendations are made.

2.7. Interpretation to be Used

The results of the LCI and LCIA were interpreted according to the Goal and Scope. The interpretation addresses the following topics:

- Identification of significant findings, such as the main process step(s), material(s), and/or emission(s) contributing to the overall results
- Evaluation of completeness, sensitivity, and consistency to justify the exclusion of data from the system boundaries as well as the use of proxy data.
- Conclusions, limitations and recommendations

Note that in situations where no product outperforms all of its alternatives in each of the impact categories, some form of cross-category evaluation is necessary to draw conclusions regarding the environmental superiority of one product over the other. Since ISO 14044 rules out the use of quantitative weighting factors in comparative assertions to be disclosed to the public, this evaluation will take place qualitatively and the defensibility of the results therefore depend on the authors' expertise and ability to convey the underlying line of reasoning that led to the final conclusion.

2.8. Data Quality Requirements

The data used to create the inventory model shall be as precise, complete, consistent, and representative as possible with regards to the goal and scope of the study under given time and budget constraints.

- Measured primary data are considered to be of the highest precision, followed by calculated data, literature data, and estimated data. The goal is to model all relevant foreground processes using measured or calculated primary data.
- Completeness is judged based on the completeness of the inputs and outputs per unit process and the completeness of the unit processes themselves. The goal is to capture all relevant data in this regard.
- Consistency refers to modeling choices and data sources. The goal is to ensure that differences in results reflect actual differences between product systems and are not due to inconsistencies in modeling choices, data sources, emission factors, or other artefacts.
- Reproducibility expresses the degree to which third parties would be able to reproduce the results of the study based on the information contained in this report. The goal is to provide enough transparency with this report so that third parties are able to approximate the reported results. This ability may be limited by the exclusion of confidential primary data and access to the same background data sources
- Representativeness expresses the degree to which the data matches the geographical, temporal, and technological requirements defined in the study's goal and scope. The goal is to use the most representative primary data for all foreground processes and the most representative industry-average data for all background processes. Whenever such data were not available (e.g., no industry-average data available for a certain country), best-available proxy data were employed.

An evaluation of the data quality with regard to these requirements is provided in section 5 of this report.

2.9. Type and Format of the Report

In accordance with the ISO requirements (ISO, 2006) this document aims to report the results and conclusions of the LCA completely, accurately and without bias to the intended audience. The results, data, methods, assumptions and limitations are presented in a transparent manner and in sufficient detail to convey the complexities, limitations, and trade-offs inherent in the LCA to the reader. This allows the results to be interpreted and used in a manner consistent with the goals of the study.

2.10. Software and Database

The LCA model was created using the Sphera LCA for Expert (LCA FE) Software version 10.9 system for life cycle engineering, developed by Sphera Solutions, Inc. Sphera's Managed LCA Content (MLC) 2024.2 LCI database provides the life cycle inventory data for several of the raw and process materials obtained from the background system.

2.11. Verification

The background LCA report and EPDs must be verified before publication. Report verification was conducted by Thomas Gloria, Ph.D., on behalf of ASTM International. This verification was performed against ISO 14044 (ISO, 2006a; ISO, 2006b), ISO 21930 (ISO, 2017), and the selected PCRs for insulation (UL Environment, 2022) (UL Environment, 2024).

3. Life Cycle Inventory Analysis

3.1. Data Collection Procedure

All primary data were collected using customized data collection templates, which were sent out by email to the respective data providers in the participating companies. Upon receipt, each questionnaire was cross-checked for completeness and plausibility using mass balance, stoichiometry, as well as internal and external benchmarking. If gaps, outliers, or other inconsistencies occurred, Sphera engaged with the data provider to resolve any open issues.

The energy inputs and outputs were modeled according to data provided by each site, while the electricity grid was chosen based on the locations of each manufacturer's production facilities.

When possible, electricity and fuel consumption data on side-B production were collected via sub-metering. However, when not feasible, energy outputs were allocated based on engineering knowledge that certain products require more energy to produce. Comparative consumption data between different products (for example, open cell products consume ~30% less energy than HFC/HFO products) were obtained from participating companies producing multiple products and used to appropriately allocate energy outputs.

Material inbound transport distances, product outbound distances, packaging details, and installation details, are calculated based on primary data or estimates from participating SPFA companies.

The project was further subjected to a comprehensive quality assurance process at every major milestone in the project to analyze and ensure model integrity, data accounting and consistency with the goal and scope.

3.2. Spray Polyurethane Foam

3.2.1. Overview of Product System

SPF is a chemical product produced from the reaction of MDI (side-A) and a polyol resin mixture (side-B). SPF expands over thirty-fold its original liquid volume when applied by spraying onto a substrate. As the foam expands, it adheres and contours to the surface, filling in cracks and crevices that can cause air and water infiltration. SPF provides durability, structural strength, water resistance, and thermal insulation.

SPF formulators typically only produce side-B, as side-A is a relatively simple mixture consisting of either purely MDI or MDI with a small fraction of blowing agent. Side-B, a mixture of polyols, fire retardants, blowing agents, catalysts, and other additives, is blended by formulators. The blended side-B is packaged along with side-A to form a "set". The packaged set is then shipped to a consumer, installed, and used before disposal. The SPF life cycle and system boundaries of this study can be found in Section 2.3 in Figure 2-1 and Table 2-1.

There are no toxic materials or hazardous wastes directly associated with either the manufacturing of these components or the installation of the spray foam systems.

3.2.2. Product Composition

In this study, side-A is purely MDI, which is represented using a background dataset developed by ISOPA (European Diisocyanate and Polyol Producers Association (ISOPA), 2021). Side-B formulations were developed using weighted averages based on formulation data provided by participating SPF companies. Five side-B formulations are evaluated in this study, each of which have their own distinctive characteristics, lending themselves to unique applications. The chemical compositions of each formulation are shown in Table 3-1.

While some of the ingredients may be classified as hazardous, per EPA's Resource Conservation and Recovery Act (RCRA), Subtitle C, Title 40 Code of Federal Regulations, Part 261 (Code of Federal Regulations , 2023), the product as installed and ultimately disposed of is not classified as a hazardous substance, as hazardous ingredients are rendered chemically inert after installation.

The complete SPF product set includes an equal volumetric ratio of side-A and side-B. For this study, the mass of side-A in a set is 474 lb and side-B is 500 lb.

Table 3-1: Side-B Compositions (%)

Chemical Composition (%)		Open Cell	Closed Cell		Roofing	
			HFC	HFO	HFC	HFO
Polyol	Polyester	0	45	41	41	34
	Polyether	32	13	25	12	14
	Mannich	0	12	4	20	24
	Compatibilizer	13	1	0	2	4
Fire Retardant	Tris(2-chloroisopropyl)phosphate (TCPP)	25	10	13	11	10
	Tris(1,3-dichloro-2-propyl)phosphate (TDCP)	0	2	0	0	0
	Brominated	0	0	0	1	0
Blowing Agent	Reactive (H2O)	20	3	3	3	2
	HFO-1233zd or HFO-1336mzzZ	0	0	9	0	8
	HFC-245fa	0	9	0	6	0
Catalyst	Catalyst, amine	9	4	2	3	1
	Catalyst, aggregate	0	0	2	0	2
Surfactant	Silicone	1	1	1	1	1

Variation of the side-B composition amongst formulation collected can be found in Table 3-2, below. HFC closed and HFC roofing products have been grouped together, as well as HFO closed and HFO roofing products.

Table 3-2: Minimum and Maximum compositions in Side-B Compositions

Chemical Type	Open Cell	HFC based products	HFO based product
Polyol	38 – 47	65 – 80	65 – 80
Fire Retardant	15 – 40	8 – 16	8 – 17
Blowing Agent	9 – 22	4 – 16	8 – 15
Catalyst	7 – 16	2 – 13	2 – 6

Chemical Type	Open Cell	HFC based products	HFO based product
Surfactant	1 – 13	0.5 – 1.3	0 - 2

3.2.3. Manufacturing

Side A and B material inputs are transported to the producer's facility by a combination of ship, rail, and container and tanker truck. Table 3-3 provides a summary of the inbound transportation requirements for the production of the five SPF products.

Table 3-3: Average inbound transportation distances for SPF raw materials in miles

Material	Transportation Mode	Open Cell	Closed Cell		Roofing	
			HFO	HFC	HFO	HFC
Polyester Polyol	Rail	31	80	75	118	0
	Semi-truck, 12t – 30t	0	0	0	0	0
	Semi-truck, >30t	27	18	58	0	74
	Tanker truck	436	508	600	213	768
Polyether Polyol	Semi-truck, >30t	0	1	0	0	0
	Tanker truck	441	690	447	424	458
	Container ship	0	16	0	0	0
Mannich Polyol	Semi-truck, >30t	80	53	174	0	222
	Tanker truck	591	350	163	779	191
Compatibilizer Polyol	Semi-truck, 12t – 30t	87	56	190	0	242
	Semi-truck, >30t	0	2	0	0	0
	Tanker truck	456	527	291	757	208
TCPP	Rail	0	13	0	0	0
	Semi-truck, 12t – 30t	11	39	173	0	0
	Semi-truck, >30t	78	358	57	0	73
	Tanker truck	1083	1922	1347	694	1985
	Container ship	2661	3009	1110	3567	149
TDPP	Semi-truck, 12t – 30t	430	235	0	498	0
	Semi-truck, >30t	26	17	57	0	73
	Refrigerated truck	15	21	48	7	120
Brominated FR	Rail	87	56	190	0	242
	Tanker truck	1990	1196	1110	80	149
HFO-1233zd or HFO-1336mzzZ	Semi-truck, 12t – 30t	63	6	113	88	41
	Semi-truck, >30t	4	8	6	0	48
	Tanker truck	906	961	560	852	367
HFC-245fa	Tanker truck	305	291	755	171	664
Catalyst, amine	Semi-truck, 12t – 30t	100	156	209	215	125
	Semi-truck, >30t	86	37	100	26	28

Material	Transportation Mode	Open Cell	Closed Cell		Roofing	
	Tanker truck	20	73	35	0	65
Catalyst, metal	Semi-truck, 12t – 30t	591	1135	392	2287	304
	Semi-truck, >30t	118	68	245	0	242
	Tanker truck	261	886	0	0	0
			HFO	HFC	HFO	HFC
Catalyst, aggregate	Semi-truck, 12t – 30t	59	25	126	68	149
	Semi-truck, >30t	4	0	6	0	48
	Tanker truck	17	69	88	0	162
Surfactant	Semi-truck, 12t – 30t	269	361	472	797	384
	Semi-truck, >30t	457	297	248	92	28
	Tanker truck	17	69	88	0	162

During the side-B production process, materials are blended together in tanks and packaged in containers of varying types, most commonly steel drums and plastic totes. Since each member company utilizes different package types and sizes, packaging data was aggregated by type (i.e. steel or plastic) and function (i.e. side-A or side-B). Finished packaged products are loaded onto pallets, where additional shipping materials, such as strapping, cardboard, and plastic wrap, are applied.

In the case of facilities that have outputs other than the products considered in this study, waste outputs were allocated to the SPF products by mass. Energy outputs were allocated based on engineering knowledge that certain products require more energy to produce. Comparative consumption data between different products (for example, open cell products consume ~30% less energy than HFC/HFO products) were obtained from participating companies producing multiple products and used to appropriately allocate energy outputs.

The side-B blending process utilizes internal scrap from its own operations. Additionally, many facilities utilize technology to minimize the release of gaseous material inputs, such as blowing agents, during material transfer and processing. Waste materials are typically reintegrated into the formulation without additional collection, transport, or processing. Packaging materials that are associated with inbound transportation of raw materials have been excluded.

After data were collected from the formulation locations, the values were normalized to a per-pound of side-B formulation, and then a production volume weighted average was calculated. Manufacturing data for all five SPF products is confidential and can be found in Annex B1 . Please note that process emissions of HFO and HFC-245fa are only present if they are used in those particular formulations.

3.2.4. Distribution

Final products are distributed via container truck and refrigerated truck, either directly to customers, or first to a warehouse then to customers. Table 3-4 details weighted-average outbound transportation considering both production sent to warehouse first as well as production sent directly to customers.

Table 3-4: Outbound transportation distances in miles

	Open Cell	Closed Cell		Roofing	
		HFO	HFC	HFO	HFC
Semi-truck, 12t – 30t	154	226	62	678	39
Semi-truck, >30t	613	669	752	118	844
Refrigerated truck	170	120	117	191	0

3.2.5. Installation

During the installation step, sides A and B are mixed and heated in a one-to-one ratio by volume. During the installation, the applicators use various safety equipment such as goggles, Tyvek® protective suits, and respirator cartridges, as well as other disposable materials such as masking tape and plastic drop cloths. After the foam dries and expands, the excess is cut off and discarded. Discarded from installation also experiences blowing agent release while in landfill. Disposal of packaging materials is modeled in accordance with the assumptions outlined in Part A of the PCR, as seen in Table 3-5. Given that the US represents the majority of production compared to Canada, US assumptions were used. Additionally, they represent more conservative values.

Table 3-5: Packaging disposal assumptions

	Recycling Rate (%)	Landfill Rate (%)	Incineration Rate (%)
Plastics	15	68	17
Metals	57	34	9
Pulp (cardboard, paper)	75	20	5

Based on a predictive modelling on SPF emissions, this study assumes 10%[1] of the installed blowing agent is released to surrounding air during the installation phase (Honeywell International).

Within the context of the model, the installation step includes all the energy and materials used, waste out, and transportation to the installation site. All installation materials are assumed to be sent to landfill. Table 3-6 lists these materials required in a representative installation job.

Primary installation data collected from the 2012 study (SPFA, 2012) were applied in this study as no significant changes have occurred in installation technology or methodology since 2010. However, a 20% increase in respirator cartridges was assumed to account for increased use of air purifying respirators in place of supplied air respirators for indoor installation.

[1] It is assumed that 50% of the total blowing agent is emitted eventually (Kjeldsen & Jensen, 2001). 10% is assumed to be released during installation. As global warming potential looks at emissions on a 100-year scale, and as the lifetime of the spray foam is 75 years, it is assumed that of the remaining 40% to be emitted, 60% is emitted over the lifetime of the product, and 40% is emitted at end-of-life. This results in the following life cycle of the blowing agent:

- 10% emitted during installation
- 24% emitted during lifetime in building
- 16% emitted during end-of-life
- 50% remains in product

Table 3-6: Weighted average values of installation contractors normalized to 1 pound of foam

		Units	Value
Energy	Diesel	gal	1.32E-02
	Electricity	BTU	2.71E-02
Materials	Chemical suits	piece	5.50E-04
	Respirator cartridges	piece	2.51E-03
	Goggles	piece	8.90E-04
	Duct tape	piece	1.80E-04
	Polyethylene rolls	piece	2.80E-04
	Chemical proof gloves	piece	1.65E-03
	Lubricants	lb	1.00E-05
	Masking tape rolls	piece	8.00E-05
	Cloth gloves	piece	1.10E-04
Waste	Waste foam	lb	3.68E-02
	Waste material	lb	4.68E-03

3.2.6. 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).

Several SPF manufacturers have 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 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.

For open cell SPF products, since the blowing agent is water, this results in no impact during the use phase (module B1).

3.2.7. End-of-Life

SPF is assumed to endure the entire building RSL of 75 years without any need for replacement. When the building is decommissioned, it is assumed that only manual labor is involved, and no environmental impact is associated with this module (C1). Waste is then transported 30 miles to disposal (C2). The spray foam is assumed to be collected with mixed construction waste and landfilled at end-of-life, as is typical for construction and demolition waste in the US and Canada. SPF cannot be recycled like other plastics and therefore the 'Other materials' recycling rate for Canada specified in PCR Part A does not apply. No biogenic carbon is removed from the environment as a result of the disposal of the products after use.

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.

3.3. Background Data

This section details the Sphera Managed LCA Content (MLC) 2024.2 datasets used in the SPF LCA model. Datasets are grouped by energy, materials, transportation, and disposal. Documentation for all Sphera MLC datasets can be found at https://lcadatabase.sphera.com/ .

3.3.1. Fuels and Energy

National averages for fuel inputs and electricity grid mixes were obtained from the MLC 2024.2 databases. Table 3-7 shows the most relevant LCI datasets used in modeling the product systems. Electricity consumption was modeled using regional grid mixes that account for imports from neighboring regions.

Documentation for all MLC datasets can be found at https://lcadatabase.sphera.com/ .

Table 3-7: Key energy datasets used in inventory analysis

Energy	Geo.	Dataset	Data Provider	Reference Year	Proxy?
Diesel	US	Diesel mix at refinery	Sphera	2019	No
Electricity	US	Electricity grid mix	Sphera	2019	No
Electricity	CA	Electricity grid mix	Sphera	2019	No
Electricity	US	Electricity grid mix – CAMX	Sphera	2020	No
Electricity	US	Electricity grid mix – ERCT	Sphera	2020	No
Electricity	US	Electricity grid mix – NWPP	Sphera	2020	No
Electricity	US	Electricity grid mix – RFCW	Sphera	2020	No
Electricity	US	Electricity grid mix – SRMW	Sphera	2020	No
Electricity	US	Electricity grid mix – SRSO	Sphera	2020	No
Electricity	US	Electricity grid mix – SRVC	Sphera	2020	No
Heavy fuel oil	US	Heavy fuel oil at refinery (2.5wt.% S)	Sphera	2019	No
Kerosene	US	Kerosene / Jet A1 at refinery	Sphera	2019	No
Light fuel oil	US	Light fuel oil at refinery	Sphera	2019	No
Propane	US	Liquefied Petroleum Gas (LPG) (70% propane; 30% butane)	Sphera	2019	No
Natural gas	US	Natural gas mix	Sphera	2019	No
Steam	US	Process steam from natural gas 85%	Sphera	2019	No
Steam	US	Process steam from natural gas 95%	Sphera	2019	No

Energy	Geo.	Dataset	Data Provider	Reference Year	Proxy?
Thermal energy	US	Thermal energy from heavy fuel oil (HFO)	Sphera	2019	No
Thermal energy	US	Thermal energy from natural gas	Sphera	2019	No

3.3.2. Raw Materials and Processes

Data for upstream and downstream raw materials and unit processes were obtained from the MLC 2024.2 database. Table A-1 in Annex A1 shows the most relevant LCI datasets used in modeling the product systems. Documentation for all MLC datasets can be found at https://lcadatabase.sphera.com/ .

It should be noted that the previous SPFA LCA study incorporated the use of MDI dataset that was developed by Polyisocyanurate Insulation Manufacturers Association (PIMA) as an outcome of the LCA study conducted by the American Chemistry Council (ACC) in 2011 (American Chemistry Council, 2011). This study was updated in 2022 and the allocation approach was changed from mass allocation in 2011 study to mass + elemental allocation in the 2022 study (American Chemistry Council, 2022). However, due to the unavailability of an updated dataset for MDI based on the 2022 ACC report, the MDI dataset developed by ISOPA has been used as the best-available proxy for the purpose of this LCA study as it is based on the same allocation approach as the 2022 LCA study conducted by ACC.

3.3.3. Transportation

Average transportation distances and modes of transport are included for the transport of the raw materials, operating materials, and auxiliary materials to production and assembly facilities.

Sphera's MLC databases (CUP 2024.2) were used to model transportation. Truck transportation within the United States was modeled using US truck transportation datasets based on data from EPA's SmartWay program (U.S. EPA, 2022). SmartWay collects fleet data -- including truck class, fuel consumption, miles driven, etc. -- from various US carriers and aggregates the data to generate average carbon dioxide (CO_2) emissions for each carrier. Emissions for this dataset are then calculated by averaging emissions for all carriers classified under the given SmartWay vehicle category.

Other emissions are calculated based on EPA MOVES v3 data (U.S. EPA, 2022). An appropriate MOVES truck type is identified and the corresponding emission factors in grams per mile is obtained from the model. Emission factors are separated for short (less than 200 miles) and long haul (above 200 miles) as the latter accounts for "hoteling", i.e., the hours spent in idle mode during breaks.

Diesel consumption is back calculated from SmartWay CO_2 emissions while factoring in biodiesel content from the US Energy Information Administration (EIA) Annual Energy Review (U.S. EIA, 2021) under the assumption that diesel is the primary fuel consumed by SmartWay carriers. The fraction of biodiesel calculated from EIA data is also used to split SmartWay CO_2 emissions into fossil and biogenic CO_2.

Table 3-8: Transportation and road fuel datasets

Mode / fuels	Geo.	Dataset	Data Provider	Reference Year	Proxy?
Diesel	US	Diesel mix at refinery	Sphera	2019	no
Heavy fuel oil	US	Heavy fuel oil at refinery (2.5wt.% S)	Sphera	2019	no

Mode / fuels	Geo.	Dataset	Data Provider	Reference Year	Proxy?
Rail	GLO	Rail transport cargo - Diesel, average train, gross tonne weight 1,000t / 726t payload capacity	Sphera	2022	no
Ship	GLO	Container ship, 5.000 to 200.000 dwt pay-load capacity, deep sea	Sphera	2022	no
Truck, flatbed	US	Truck - flatbed (EPA SmartWay)	Sphera	2023	no
Truck, heavy/bulk	US	Truck - heavy/bulk (EPA SmartWay)	Sphera	2023	no
Truck, refrigerated	US	Truck - refrigerated (EPA SmartWay)	Sphera	2023	no
Truck, tanker	US	Truck - tanker (EPA SmartWay)	Sphera	2023	no
Truck, TL/dry van	US	Truck - TL/dry van (EPA SmartWay)	Sphera	2023	no

3.3.4. End-of-Life

The end-of-life stage is modeled primarily using landfill datasets, and both side-A and side-B are classified non-hazardous according to the EPA's Resource Conservation and Recovery Act (RCRA), Subtitle C, Title 40 Code of Federal Regulations, Part 261 (Code of Federal Regulations , 2023). Recycled material is modeled as leaving the system boundary burden free. Table 3-9 shows datasets used into model the end-of-life stage.

Table 3-9: End-of-life datasets

Mode / fuels	Geo.	Dataset	Data Provider	Reference Year	Proxy?
Incineration, metals	US	Ferro metals in waste incineration plant	Sphera	2022	No
Incineration, pulp	US	Paper waste (water 0%) in waste incinera-tion plant	Sphera	2022	No
Incineration, plastics	US	Plastics wastes in waste incineration plant	Sphera	2022	No
Landfill, inert	US	Inert matter (Glass) on landfill	Sphera	2022	No
Landfill, metals	US	Ferro metals on landfill, post-consumer	Sphera	2022	No
Landfill, municipal	US	Municipal Solid Waste on landfill	Sphera	2022	No
Landfill, pulp	US	Paper waste on landfill, post-consumer	Sphera	2022	No
Landfill, plastics	US	Plastic waste on landfill, post-consumer	Sphera	2022	No
Landfill, wood	US	Wood products (OSB, particle board) on landfill, post-consumer	Sphera	2022	No
Wastewater	US	Municipal wastewater treatment (EPA data, US average, cut off approach)	Sphera	2023	No

4. Results

This chapter contains the results for the impact categories and additional metrics defined in section 2.6. It shall be reiterated at this point that the reported impact categories represent impact potentials, i.e., they are approximations of environmental impacts that could occur if the emissions would (a) follow the underlying impact pathway and (b) meet certain conditions in the receiving environment while doing so. In addition, the inventory only captures that fraction of the total environmental load that corresponds to the chosen functional unit (relative approach).

LCIA results are therefore relative expressions only and do not predict actual impacts, the exceeding of thresholds, safety margins, or risks.

4.1. Overall Results

Life cycle impact assessment and inventory results per functional unit are summarized in this section. Tabulated results are followed by contribution analyses of the five SPF products, to provide a sense of which modules are driving environmental burden. Per Part A of the PCR, module D is optional and not reported; totals reported in the subsequent sections only represent the sum of modules A1 through C4.

The GWP100 indicator reported in this report is for excluding biogenic carbon. For better readability, zero values are represented by a dash ("–") in the following tables.

4.1.1. Open cell

Figure 4-1 and Table 4-1 to Table 4-3, show life cycle results for the open cell product. Module A1 (raw materials) contributes the most to every impact category, except ODP, with a contribution of 48% to 88%. Module A5 (installation) follows with a contribution ranging from 7% to 76% across every impact category. Raw materials such as MDI, polyether polyol, and TCPP contribute the most within the A1 module, more details on raw material contribution can be found in Section 4.2. Installation of SPF uses onsite diesel generators, which contribute to the overall AP, EP, and SFP due to the VOCs and nitrogen containing compounds released.

Open cell SPF uses a reactive blowing agent (water) and while it is released at the same rate during manufacturing, use, and end-of-life phases as other SPF blowing agents, there is no associated environmental impact.

Within ODP, module A5 (material for installation) (76%) and module A3 (manufacturing) (23%) are the main contributors due to the cardboard dataset used to model the packaging material and installation material (duct tape and masking tape).

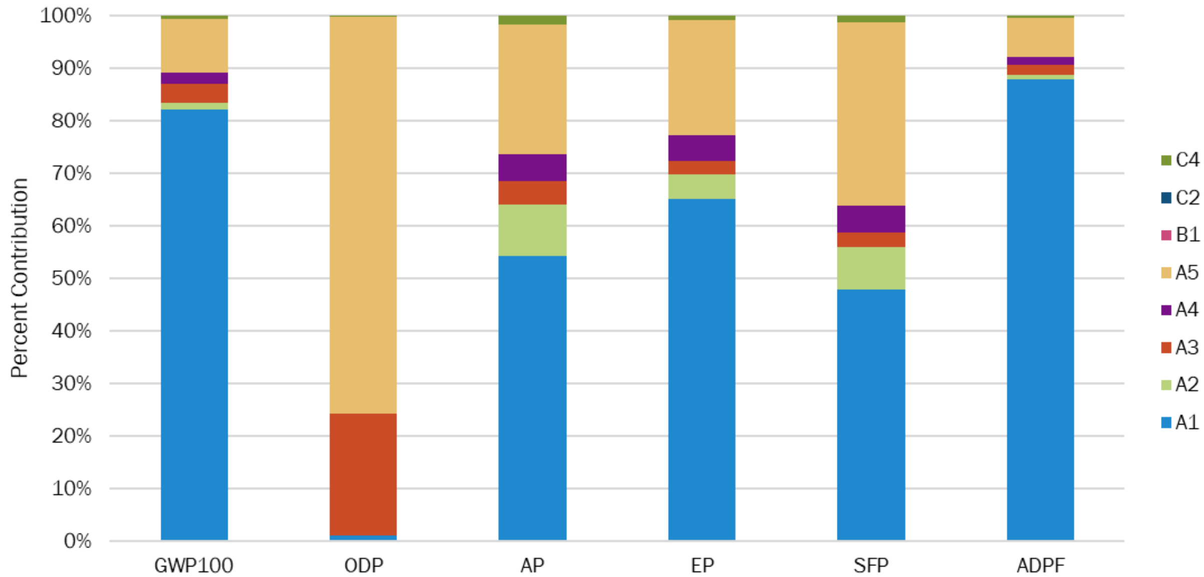


Figure 4-1: A1 to C4 contribution analysis – Open Cell SPF

Table 4-1: Open Cell North American LCIA Results as per Functional Unit

Impact Assessment									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
GWP100 [kg CO_2 eq.] [IPCC AR6]	1.21E+00	9.91E-01	1.75E-02	4.25E-02	2.68E-02	1.22E-01	0.00E+00	4.66E-04	6.27E-03
ODP [kg CFC-11eq.]	2.33E-12	2.42E-14	4.36E-17	5.40E-13	6.81E-17	1.77E-12	0.00E+00	1.19E-18	3.01E-16
AP [kg SO_2 eq.]	2.15E-03	1.17E-03	2.12E-04	9.38E-05	1.11E-04	5.30E-04	0.00E+00	1.99E-06	3.25E-05
EP [kg N eq.]	2.09E-04	1.37E-04	9.92E-06	5.10E-06	1.02E-05	4.61E-05	0.00E+00	1.81E-07	1.40E-06
SFP [kg O_3 eq.]	5.05E-02	2.42E-02	4.10E-03	1.44E-03	2.54E-03	1.76E-02	0.00E+00	4.57E-05	5.82E-04
ADPF [MJ]	2.49E+01	2.19E+01	2.22E-01	4.97E-01	3.51E-01	1.86E+00	0.00E+00	6.12E-03	9.23E-02

Table 4-2: Open Cell Resource Use Indicators as per Functional Unit

Resource Use									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
RPR_E [MJ, LHV]	1.31E+00	1.11E+00	7.40E-03	5.75E-02	1.53E-02	1.14E-01	0.00E+00	2.67E-04	1.18E-02
RPR_M [MJ, LHV]	4.68E-03	0.00E+00	0.00E+00	3.45E-03	0.00E+00	1.23E-03	0.00E+00	0.00E+00	0.00E+00
RPR_t [MJ, LHV]	1.32E+00	1.11E+00	7.40E-03	6.10E-02	1.53E-02	1.15E-01	0.00E+00	2.67E-04	1.18E-02
$NRPR_E$ [MJ, LHV]	1.97E+01	1.68E+01	2.23E-01	5.20E-01	3.54E-01	1.69E+00	0.00E+00	6.16E-03	9.51E-02
$NRPR_M$ [MJ,LHV]	6.17E+00	5.93E+00	0.00E+00	1.11E-02	0.00E+00	2.30E-01	0.00E+00	0.00E+00	0.00E+00
$NRPR_t$ [MJ,LHV]	2.59E+01	2.28E+01	2.23E-01	5.31E-01	3.54E-01	1.92E+00	0.00E+00	6.16E-03	9.51E-02
SM [kg]	-	-	-	-	-	-	-	-	-
RSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
NRSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
RE [m^3]	-	-	-	-	-	-	-	-	-
FW [m^3]	7.33E-03	4.66E-03	2.39E-05	2.22E-03	5.17E-05	3.65E-04	0.00E+00	9.00E-07	1.23E-05

Table 4-3: Open Cell Output Flows and Waste as per Functional Unit

Output Flows and Waste Categories									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
HWD [kg]	-	-	-	-	-	-	-	-	-
NHWD [kg]	3.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-02	0.00E+00	0.00E+00	2.90E-01
HLRW [kg]	4.29E-07	3.88E-07	7.03E-10	9.08E-09	1.09E-09	2.93E-08	0.00E+00	1.89E-11	1.13E-09
ILLRW [kg]	3.71E-04	3.36E-04	5.92E-07	7.60E-06	9.16E-07	2.45E-05	0.00E+00	1.60E-08	1.01E-06
CRU [kg]	-	-	-	-	-	-	-	-	-
MR [kg]	-	-	-	-	-	-	-	-	-
MER [kg]	1.20E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-03	0.00E+00	0.00E+00	0.00E+00
EE [MJ, LHV]	-	-	-	-	-	-	-	-	-

4.1.2. Closed cell, HFC

Figure 4-2 and Table 4-4 to Table 4-6, show life cycle results for the closed cell, HFC SPF product. The majority of the burden for all impact categories except GWP100 and ODP is from module A1 (raw materials), ranging from 48% to 86%. For GWP100, A5 (installation) (20%), B1 (use) (40%), and C4 (end-of-life) (27%) are the dominant modules, specifically the impact is driven by the emissions of its blowing agent, R-245fa. As mentioned in Section 3, 50% of blowing agents are assumed to be emitted over the course of the product's life.

Installation of SPF uses onsite diesel generators, which also contribute to the overall GWP100, AP, EP, and SFP due to the associated combustion emissions.

Within ODP, module A5 (material for installation) (89%) and module A3 (manufacturing) (10%) are the main contributors due to the cardboard dataset used to model the packaging material and installation material (duct tape and masking tape).

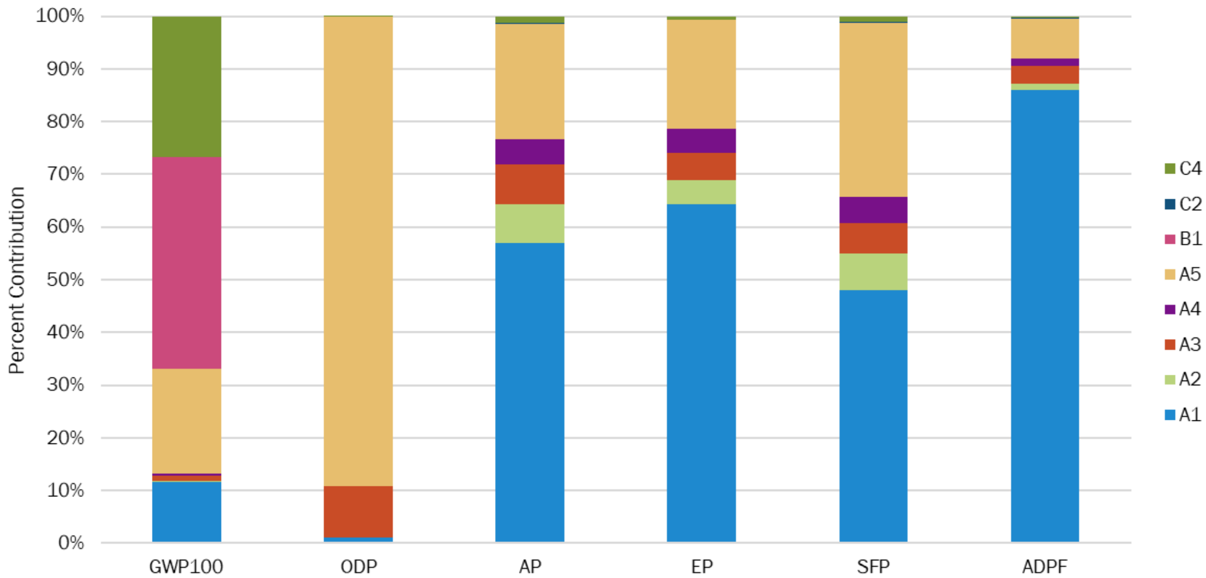


Figure 4-2: A1 to C4 contribution analysis – Closed Cell, HFC SPF

Table 4-4: Closed cell, HFC North American LCIA Results as per Functional Unit

Impact Assessment									
Parameter	**Total**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**C2**	**C4**
GWP100 [kg CO_2 eq.] [IPCC AR6]	1.81E+01	2.10E+00	5.01E-02	1.75E-01	6.15E-02	3.61E+00	7.28E+00	1.09E-03	4.87E+00
ODP [kg CFC-11eq.]	4.64E-12	5.32E-14	1.26E-16	4.47E-13	1.57E-16	4.14E-12	0.00E+00	2.78E-18	7.04E-16
AP [kg SO_2 eq.]	5.68E-03	3.24E-03	4.19E-04	4.34E-04	2.69E-04	1.24E-03	0.00E+00	4.65E-06	7.61E-05
EP [kg N eq.]	5.24E-04	3.37E-04	2.46E-05	2.64E-05	2.43E-05	1.08E-04	0.00E+00	4.24E-07	3.28E-06
SFP [kg O_3 eq.]	1.25E-01	5.99E-02	8.76E-03	7.10E-03	6.18E-03	4.12E-02	5.69E-06	1.07E-04	1.36E-03
ADPF [MJ]	5.74E+01	4.94E+01	6.48E-01	2.00E+00	8.07E-01	4.35E+00	0.00E+00	1.43E-02	2.16E-01

Table 4-5: Closed cell, HFC Resource Use Indicators as per Functional Unit

Resource Use									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
RPR_E [MJ, LHV]	3.08E+00	2.59E+00	2.50E-02	1.32E-01	3.52E-02	2.67E-01	0.00E+00	6.25E-04	2.76E-02
RPR_M [MJ, LHV]	1.71E-02	0.00E+00	0.00E+00	1.42E-02	0.00E+00	2.87E-03	0.00E+00	0.00E+00	0.00E+00
RPR_t [MJ, LHV]	3.10E+00	2.59E+00	2.50E-02	1.47E-01	3.52E-02	2.70E-01	0.00E+00	6.25E-04	2.76E-02
$NRPR_E$ [MJ, LHV]	4.23E+01	3.46E+01	6.52E-01	2.05E+00	8.13E-01	3.97E+00	0.00E+00	1.44E-02	2.23E-01
$NRPR_M$ [MJ,LHV]	1.75E+01	1.69E+01	0.00E+00	1.37E-02	0.00E+00	5.38E-01	0.00E+00	0.00E+00	0.00E+00
$NRPR_t$ [MJ,LHV]	5.98E+01	5.15E+01	6.52E-01	2.06E+00	8.13E-01	4.51E+00	0.00E+00	1.44E-02	2.23E-01
SM [kg]	-	-	-	-	-	-	-	-	-
RSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
NRSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
RE [m³]	-	-	-	-	-	-	-	-	-
FW [m³]	2.27E-02	1.19E-02	8.29E-05	9.76E-03	1.19E-04	8.58E-04	0.00E+00	2.11E-06	2.88E-05

Table 4-6: Closed cell, HFC Output Flows and Waste as per Functional Unit

Output Flows and Waste Categories									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
HWD [kg]	-	-	-	-	-	-	-	-	-
NHWD [kg]	7.28E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.84E-02	0.00E+00	0.00E+00	6.80E-01
HLRW [kg]	9.44E-07	8.52E-07	2.03E-09	1.67E-08	2.50E-09	6.88E-08	0.00E+00	4.43E-11	2.65E-09
ILLRW [kg]	8.53E-04	7.76E-04	1.71E-06	1.40E-05	2.11E-06	5.76E-05	0.00E+00	3.73E-08	2.36E-06
CRU [kg]	-	-	-	-	-	-	-	-	-
MR [kg]	-	-	-	-	-	-	-	-	-
MER [kg]	5.17E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.17E-03	0.00E+00	0.00E+00	0.00E+00
EE [MJ, LHV]	-	-	-	-	-	-	-	-	-

4.1.3. Closed cell, HFO

Figure 4-3 and Table 4-7 to Table 4-9, show life cycle results for the closed cell, HFO product. Modules A1 (raw material) (46% to 100%), followed by module A5 (installation) (0% to 30%) contribute the most to all the impact categories due to impacts associated with raw material supply and manufacturing. Raw materials such as MDI (side-A), polyether polyol, and TCPP contribute most dominantly within the A1 module. While in installation, the use of onsite diesel generators contributes to the overall AP, EP, and SFP due to the VOCs, and NO_x released.

Note that unlike its HFC counterpart, the GWP100 for the closed cell, HFO product is consolidated to primarily raw materials (A1) and is not distributed amongst downstream modules such as modules A5 (installation), B1 (use), and C4 (end of life). While released at the same rate over the course of the life of the product as HFCs, HFO-1233zd or HFO-1336mzzZ have a substantially lower contribution to GWP100 due to their GWP100 characterization factor being less than 1 kg CO_2-eq., while the GWP100 characterization factor for HFC is 962 to 1549 kg CO_2-eq.

Within the ODP category, A1 (raw materials) is the main contributor where the burden is mainly from HFO upstream production.

Figure 4-3: A1 to C4 contribution analysis – Closed Cell, HFO SPF

Table 4-7: Closed cell, HFO North American LCIA Results as per Functional Unit

Impact Assessment									
Parameter	**Total**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**C2**	**C4**
GWP100 [kg CO_2 eq.] [IPCC AR6]	2.71E+00	2.17E+00	6.01E-02	1.28E-01	6.52E-02	2.74E-01	3.33E-03	1.04E-03	1.62E-02
ODP [kg CFC-11 eq.]	1.27E-08	1.27E-08	1.50E-16	1.20E-12	1.66E-16	3.94E-12	0.00E+00	2.64E-18	6.69E-16
AP [kg SO_2 eq.]	5.81E-03	3.27E-03	6.54E-04	3.51E-04	2.74E-04	1.18E-03	0.00E+00	4.42E-06	7.24E-05
EP [kg N eq.]	5.42E-04	3.57E-04	3.27E-05	2.05E-05	2.51E-05	1.03E-04	0.00E+00	4.03E-07	3.11E-06
SFP [kg O_3 eq.]	1.31E-01	6.07E-02	1.29E-02	7.04E-03	6.31E-03	4.00E-02	1.86E-03	1.02E-04	2.53E-03
ADPF [MJ]	5.64E+01	4.89E+01	7.67E-01	1.50E+00	8.55E-01	4.13E+00	0.00E+00	1.36E-02	2.05E-01

Table 4-8: Closed cell, HFO Resource Use Indicators as per Functional Unit

Resource Use									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
RPR_E [MJ, LHV]	3.86E+00	3.36E+00	2.70E-02	1.55E-01	3.73E-02	2.54E-01	0.00E+00	5.94E-04	2.62E-02
RPR_M [MJ, LHV]	2.77E-02	1.69E-02	0.00E+00	8.07E-03	0.00E+00	2.73E-03	0.00E+00	0.00E+00	0.00E+00
RPR_T [MJ, LHV]	3.89E+00	3.38E+00	2.70E-02	1.63E-01	3.73E-02	2.56E-01	0.00E+00	5.94E-04	2.62E-02
$NRPR_E$ [MJ, LHV]	4.23E+01	3.51E+01	7.73E-01	1.55E+00	8.61E-01	3.77E+00	0.00E+00	1.37E-02	2.12E-01
$NRPR_M$ [MJ,LHV]	1.65E+01	1.60E+01	0.00E+00	3.14E-02	0.00E+00	5.12E-01	0.00E+00	0.00E+00	0.00E+00
$NRPR_T$ [MJ,LHV]	5.88E+01	5.11E+01	7.73E-01	1.58E+00	8.61E-01	4.28E+00	0.00E+00	1.37E-02	2.12E-01
SM [kg]	-	-	-	-	-	-	-	-	-
RSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
NRSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
RE [m³]	-	-	-	-	-	-	-	-	-
FW [m³]	1.84E-02	1.11E-02	8.79E-05	6.24E-03	1.26E-04	8.13E-04	0.00E+00	2.00E-06	2.74E-05

Table 4-9: Closed cell, HFO Output Flows and Waste as per Functional Unit

Output Flows and Waste Categories									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
HWD [kg]	-	-	-	-	-	-	-	-	-
NHWD [kg]	6.86E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.98E-02	0.00E+00	0.00E+00	6.46E-01
HLRW [kg]	9.81E-07	8.81E-07	2.42E-09	2.72E-08	2.64E-09	6.52E-08	0.00E+00	4.21E-11	2.52E-09
ILLRW [kg]	8.57E-04	7.73E-04	2.04E-06	2.27E-05	2.23E-06	5.46E-05	0.00E+00	3.55E-08	2.25E-06
CRU [kg]	-	-	-	-	-	-	-	-	-
MR [kg]	-	-	-	-	-	-	-	-	-
MER [kg]	3.33E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.33E-03	0.00E+00	0.00E+00	0.00E+00
EE [MJ, LHV]	-	-	-	-	-	-	-	-	-

4.1.4. Roofing, HFC

Figure 4-4 and Table 4-10 to Table 4-12, show life cycle results for the Roofing HFC product. The majority of burdens for all impact categories, except GWP100 and ODP, are due to module A1 (raw material) ranging from 48% to 86%.

For GWP100, the impact is distributed among installation (A5) (19%), use (B1) (37%), and end-of-life (C4) (25%), all of which are driven by the emission of R-245fa. As mentioned in section 3, 50% of blowing agent is assumed to be emitted over the course of the product's life. Most of the emissions take place during use in the building, giving way to the use phase (B1) having the highest GWP100 contribution.

Similar to the other spray foam products, due to the use of diesel generators during installation, contributions from module A5 (installation) contribute greatly to AP, EP, and SFP due to the emissions of VOCs and nitrogen containing compounds.

Within ODP, module A5 (material for installation) (99%) is the main contributor due to the cardboard dataset used to model the packaging material and installation material (duct tape and masking tape).

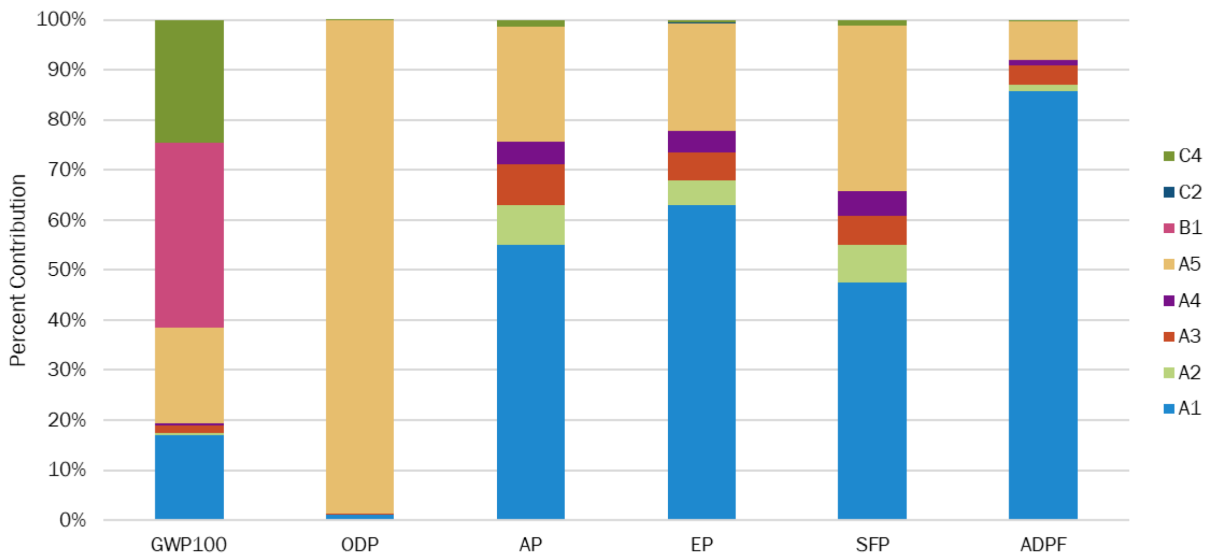


Figure 4-4: A1 to C4 contribution analysis – Roofing, HFC SPF

Table 4-10: Roofing, HFC North American LCIA Results as per Functional Unit

Impact Assessment									
Parameter	**Total**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**C2**	**C4**
GWP100 [kg CO_2 eq.] [IPCC AR6]	1.88E+01	3.19E+00	8.10E-02	2.88E-01	8.38E-02	3.60E+00	6.93E+00	1.65E-03	4.64E+00
ODP [kg CFC-11eq.]	6.33E-12	7.18E-14	2.04E-16	1.48E-14	2.13E-16	6.24E-12	0.00E+00	4.18E-18	1.06E-15
AP [kg SO_2 eq.]	8.42E-03	4.62E-03	6.73E-04	6.88E-04	3.86E-04	1.93E-03	0.00E+00	7.01E-06	1.15E-04
EP [kg N eq.]	8.14E-04	5.13E-04	4.01E-05	4.57E-05	3.44E-05	1.75E-04	0.00E+00	6.39E-07	4.94E-06
SFP [kg O_3 eq.]	1.88E-01	8.92E-02	1.39E-02	1.12E-02	8.90E-03	6.22E-02	5.42E-06	1.61E-04	2.05E-03
ADPF [MJ]	8.68E+01	7.44E+01	1.05E+00	3.36E+00	1.10E+00	6.56E+00	0.00E+00	2.16E-02	3.25E-01

Table 4-11: Roofing, HFC Resource Use Indicators as per Functional Unit

Resource Use									
Parameter	**Total**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**C2**	**C4**
RPR_E [MJ, LHV]	4.32E+00	3.57E+00	4.07E-02	2.13E-01	4.80E-02	4.03E-01	0.00E+00	9.42E-04	4.16E-02
RPR_M [MJ, LHV]	2.31E-01	0.00E+00	0.00E+00	2.27E-01	0.00E+00	4.33E-03	0.00E+00	0.00E+00	0.00E+00
RPR_T [MJ, LHV]	4.55E+00	3.57E+00	4.07E-02	4.40E-01	4.80E-02	4.08E-01	0.00E+00	9.42E-04	4.16E-02
$NRPR_E$ [MJ, LHV]	6.22E+01	5.03E+01	1.05E+00	3.45E+00	1.11E+00	5.99E+00	0.00E+00	2.17E-02	3.36E-01
$NRPR_M$ [MJ,LHV]	2.80E+01	2.71E+01	0.00E+00	8.44E-02	0.00E+00	8.11E-01	0.00E+00	0.00E+00	0.00E+00
$NRPR_T$ [MJ,LHV]	9.02E+01	7.74E+01	1.05E+00	3.54E+00	1.11E+00	6.80E+00	0.00E+00	2.17E-02	3.36E-01
SM [kg]	-	-	-	-	-	-	-	-	-
RSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
NRSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
RE [m^3]	-	-	-	-	-	-	-	-	-
FW [m^3]	3.40E-02	1.76E-02	1.35E-04	1.48E-02	1.62E-04	1.30E-03	0.00E+00	3.17E-06	4.34E-05

Table 4-12: Roofing, HFC Output Flows and Waste as per Functional Unit

Output Flows and Waste Categories									
Parameter	**Total**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**C2**	**C4**
HWD [kg]	-	-	-	-	-	-	-	-	-
NHWD [kg]	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.33E-02	0.00E+00	0.00E+00	1.02E+00
HLRW [kg]	1.42E-06	1.24E-06	3.27E-09	5.73E-08	3.40E-09	1.04E-07	0.00E+00	6.67E-11	3.99E-09
ILLRW [kg]	1.26E-03	1.11E-03	2.76E-06	4.83E-05	2.87E-06	8.68E-05	0.00E+00	5.63E-08	3.56E-06
CRU [kg]	-	-	-	-	-	-	-	-	-
MR [kg]	-	-	-	-	-	-	-	-	-
MER [kg]	8.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.00E-03	0.00E+00	0.00E+00	0.00E+00
EE [MJ, LHV]	-	-	-	-	-	-	-	-	-

4.1.5. Roofing, HFO

Figure 4-5 and Table 4-13 to Table 4-15, below, show life cycle results for the Roofing HFO product. Module A1 (raw material) (50% to 100%), followed by module A5 (installation) (0% to 34%) contribute the most to all the impact categories due to impacts associated with raw material supply and manufacturing. Raw materials such as MDI (side-A), polyester polyol, polyether polyol, and TCPP contribute the most within the A1 module. While in installation, the use of onsite diesel generators contributes to the overall GWP100, AP, EP, and SFP due to associated combustion emissions.

Note that unlike its HFC counterpart, the GWP100 for the Roofing HFO product is consolidated to primarily raw materials (A1) and is not distributed amongst downstream modules. While released at the same rate over the course of the life of the product as HFCs, HFO-1233zd or HFO-1336mzzZ have a substantially lower contribution to GWP100 due to their GWP100 characterization factor being less than 1 kg CO_2-eq., while the GWP100 characterization factor for HFC-245a is 962 to 1549 kg CO_2-eq.

Within the ODP category, module A1 (raw materials) is the main contributor where the burden is mainly from HFO upstream production.

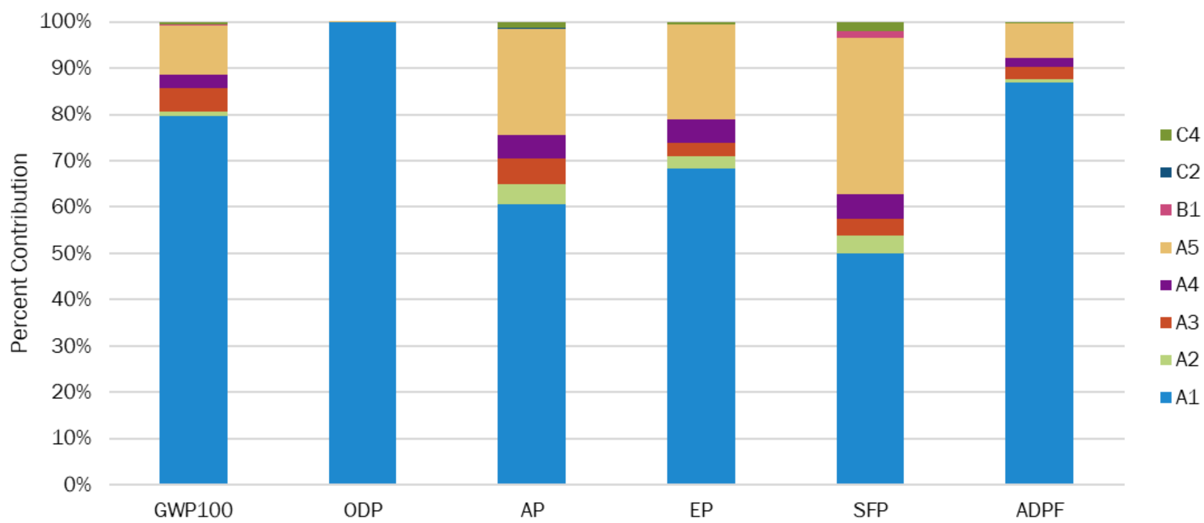


Figure 4-5: A1 to C4 contribution analysis – Roofing, HFO

Table 4-13: Roofing, HFO North American LCIA Results as per Functional Unit

Impact Assessment									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
GWP100 [kg CO_2 eq.] [IPCC AR6]	4.02E+00	3.20E+00	4.62E-02	2.02E-01	1.16E-01	4.25E-01	4.52E-03	1.61E-03	2.47E-02
ODP [kg CFC-11eq.]	1.72E-08	1.72E-08	1.17E-16	7.31E-15	2.96E-16	6.11E-12	0.00E+00	4.09E-18	1.04E-15
AP [kg SO_2 eq.]	8.03E-03	4.86E-03	3.47E-04	4.53E-04	4.20E-04	1.83E-03	0.00E+00	6.87E-06	1.12E-04
EP [kg N eq.]	7.89E-04	5.39E-04	2.14E-05	2.34E-05	4.03E-05	1.59E-04	0.00E+00	6.25E-07	4.83E-06
SFP [kg O_3 eq.]	1.84E-01	9.17E-02	7.21E-03	6.71E-03	9.61E-03	6.19E-02	2.52E-03	1.58E-04	3.69E-03
ADPF [MJ]	8.58E+01	7.46E+01	5.98E-01	2.38E+00	1.53E+00	6.41E+00	0.00E+00	2.11E-02	3.19E-01

Table 4-14: Roofing, HFO Resource Use Indicators as per Functional Unit

Resource Use									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
RPR_E [MJ, LHV]	5.46E+00	4.71E+00	2.36E-02	2.27E-01	6.66E-02	3.94E-01	0.00E+00	9.22E-04	4.07E-02
RPR_M [MJ, LHV]	1.99E-02	0.00E+00	0.00E+00	1.56E-02	0.00E+00	4.24E-03	0.00E+00	0.00E+00	0.00E+00
RPR_T [MJ, LHV]	5.48E+00	4.71E+00	2.36E-02	2.43E-01	6.66E-02	3.98E-01	0.00E+00	9.22E-04	4.07E-02
$NRPR_E$ [MJ, LHV]	6.15E+01	5.07E+01	6.03E-01	2.39E+00	1.54E+00	5.86E+00	0.00E+00	2.13E-02	3.28E-01
$NRPR_M$ [MJ,LHV]	2.77E+01	2.69E+01	0.00E+00	6.92E-02	0.00E+00	7.94E-01	0.00E+00	0.00E+00	0.00E+00
$NRPR_T$ [MJ,LHV]	8.92E+01	7.76E+01	6.03E-01	2.46E+00	1.54E+00	6.65E+00	0.00E+00	2.13E-02	3.28E-01
SM [kg]	-	-	-	-	-	-	-	-	-
RSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
NRSF [MJ, LHV]	-	-	-	-	-	-	-	-	-
RE [m³]	-	-	-	-	-	-	-	-	-
FW [m³]	2.96E-02	1.66E-02	7.85E-05	1.14E-02	2.24E-04	1.26E-03	0.00E+00	3.11E-06	4.24E-05

Table 4-15: Roofing, HFO Output Flows and Waste as per Functional Unit

Output Flows and Waste Categories									
Parameter	Total	A1	A2	A3	A4	A5	B1	C2	C4
HWD [kg]	-	-	-	-	-	-	-	-	-
NHWD [kg]	1.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.60E-02	0.00E+00	0.00E+00	1.00E+00
HLRW [kg]	1.41E-06	1.27E-06	1.87E-09	2.31E-08	4.72E-09	1.01E-07	0.00E+00	6.53E-11	3.90E-09
ILLRW [kg]	1.23E-03	1.12E-03	1.57E-06	1.94E-05	3.98E-06	8.48E-05	0.00E+00	5.51E-08	3.49E-06
CRU [kg]	-	-	-	-	-	-	-	-	-
MR [kg]	-	-	-	-	-	-	-	-	-
MER [kg]	6.24E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.24E-03	0.00E+00	0.00E+00	0.00E+00
EE [MJ, LHV]	-	-	-	-	-	-	-	-	-

4.2. Detailed Results

To better understand the difference between different products, the following graphs show how each SPF product compares to each other.

The total GWP100 results are presented in Figure 4-6 (IPCC AR6). For GWP100, the emissions of HFC during installation (A5), use (B1), and end of life (C4) drive the difference between HFC spray foam products and other spray foam products leading to a factor of ~5 to 7 times increase when compared to HFO closed cell or roofing products.

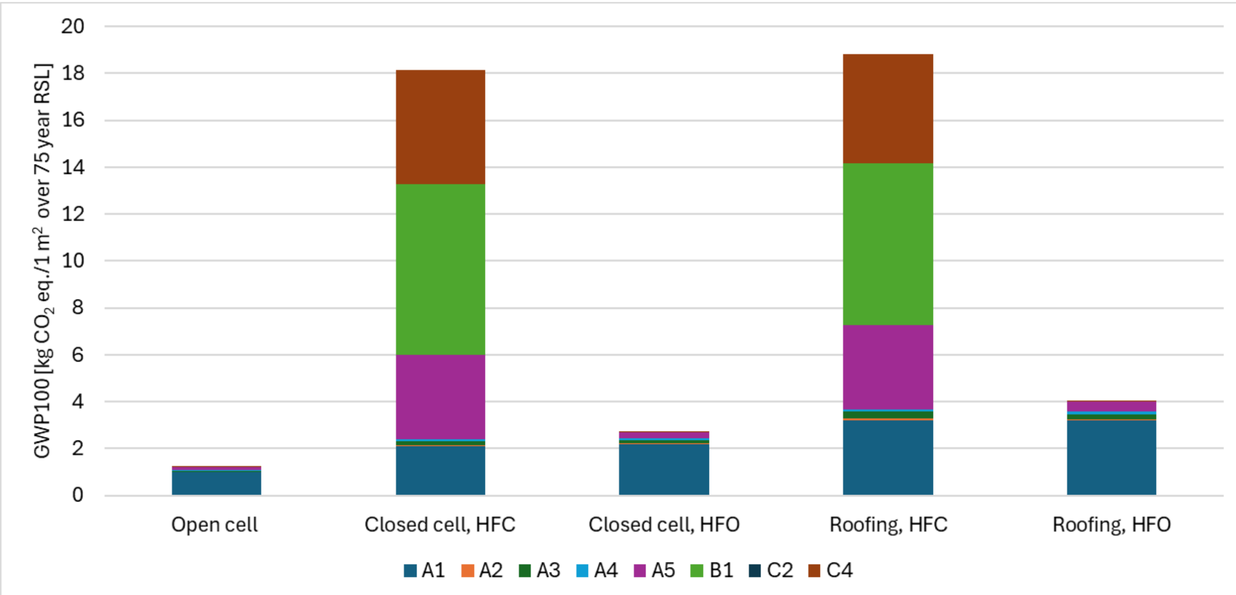


Figure 4-6: Total cradle-to-grave GWP100 [IPCC AR6] as per Functional Unit for all SPF products

Figure 4-7 shows the total ODP results for all five formulations. It is important to note the uncertainty around the ODP impact category and the magnitude of the ODP results. Due to their overall small magnitude of emissions and large characterization factors for associated emissions, there is higher variability in ODP compared to other impact categories.

For open cell and HFC based SPF, the main contributor is module A5 (materials for installation), contributing around 76 – 99%. This is contributed mainly by paper products for installation such as masking tape and duct tape. The ODP of HFO-based SPF comes from module A1 (raw materials), where ~100% of the contribution is from HFO upstream production. Due to this, the HFO-based products have a higher ODP than their HFC counterparts.

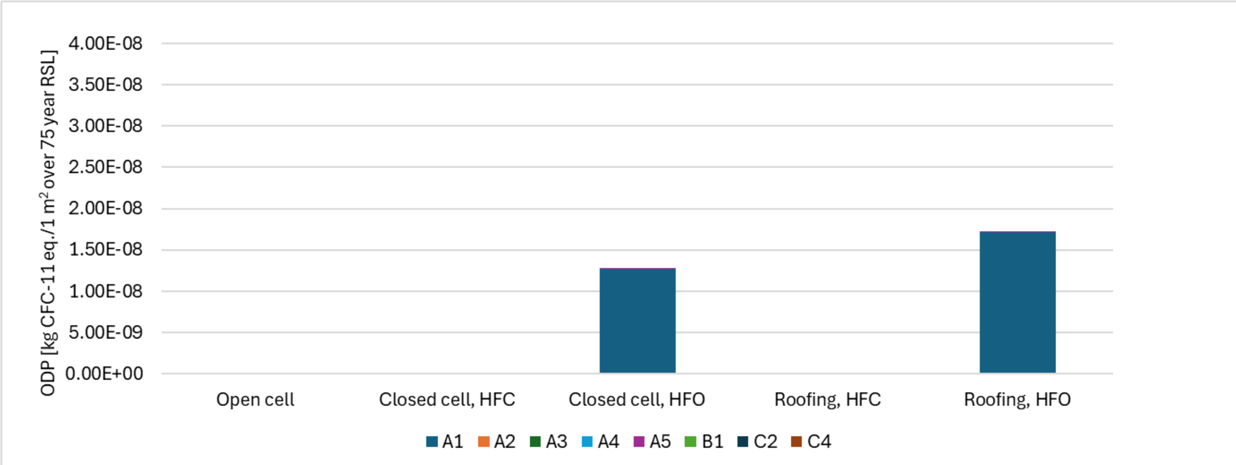


Figure 4-7: Total cradle-to-grave ODP as per Functional Unit for all SPF products

Figure 4-8, Figure 4-9, and Figure 4-10 shows the AP, EP, and SFP results for all five formulations. The burden from installation (A5) is larger for AP, EP, and SFP compared to other categories for all SPF products due to the onsite diesel generator used during installation.

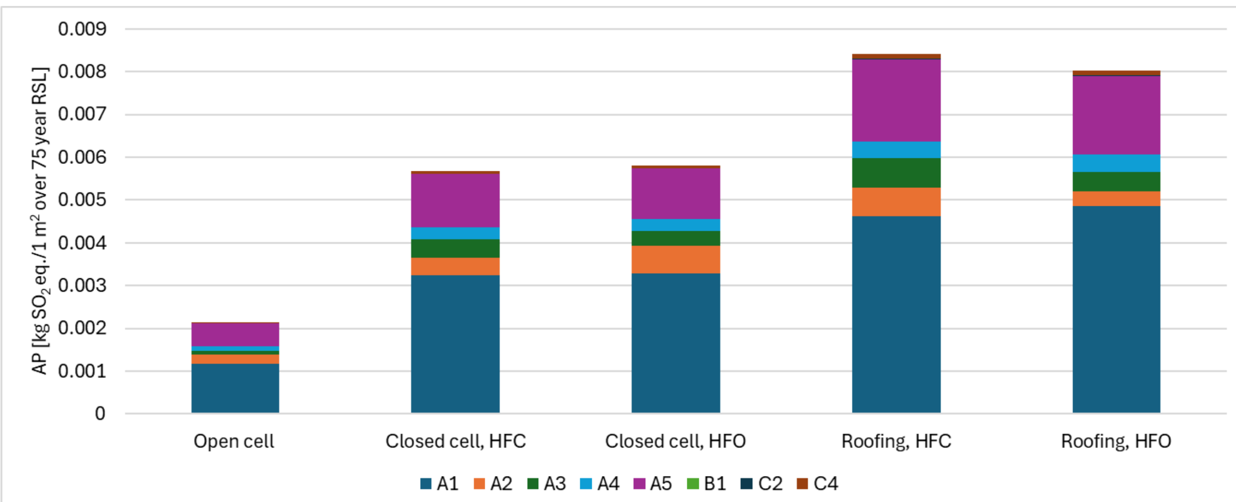


Figure 4-8: Total cradle-to- grave AP as per Functional Unit for all SPF products

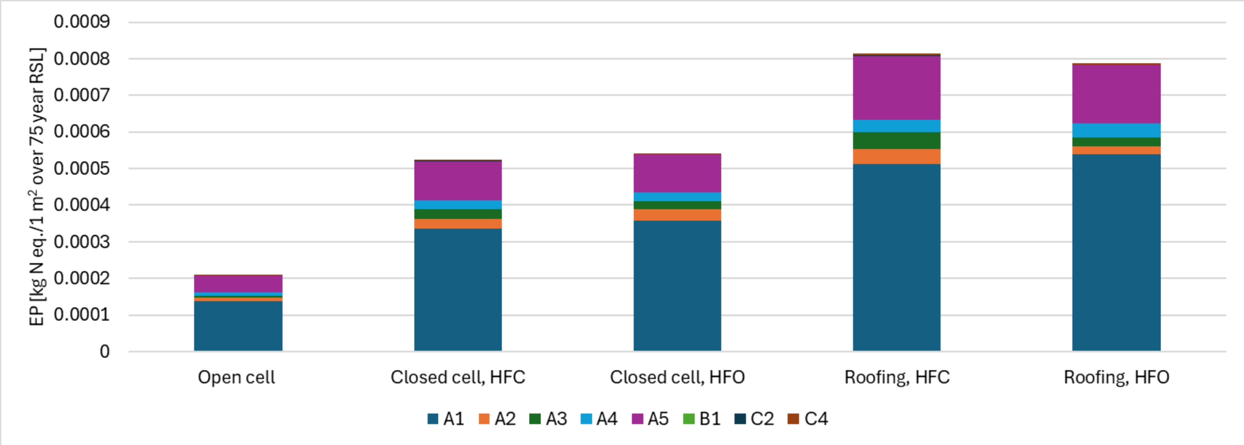


Figure 4-9: Total cradle-to- grave EP as per Functional Unit for all SPF products

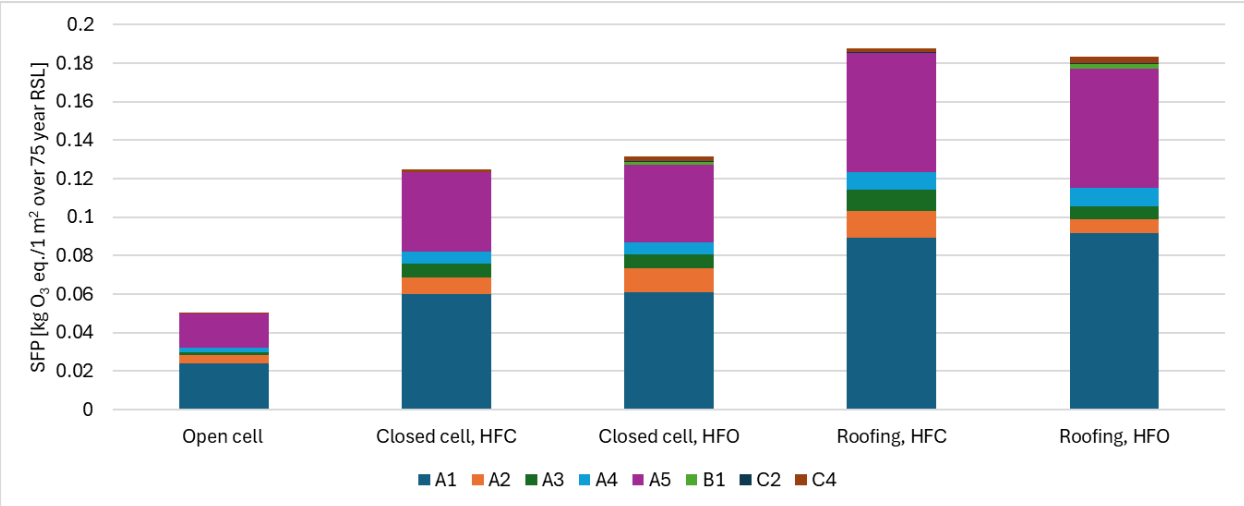


Figure 4-10: Total cradle-to- grave SFP as per Functional Unit for all SPF products

Figure 4-11 shows the ADP fossil results for all five formulations. The main contributor is raw materials (A1) due to the upstream production burden.

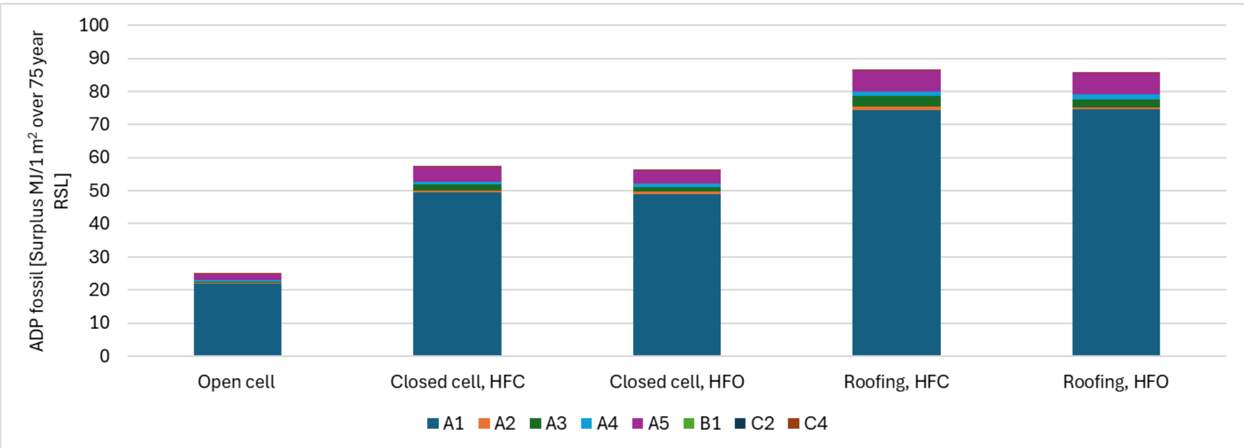


Figure 4-11: Total cradle-to-grave ADP, fossil as per Functional Unit for all SPF products

4.3. Raw Materials Analysis

As module A1 (raw material) is a significant contributor, an analysis was done to see which raw material is the dominant contributor. As shown in Figure 4-12, MDI (side-A) is the main contributor (43% to 48% of module A1 GWP100) due to its mass contribution to each product. This is followed by polyols (in blues) with a contribution of 25% to 33% to module A1 GWP100. The contribution of blowing agents (HFCs and HFOs) is around 6% to 9%.

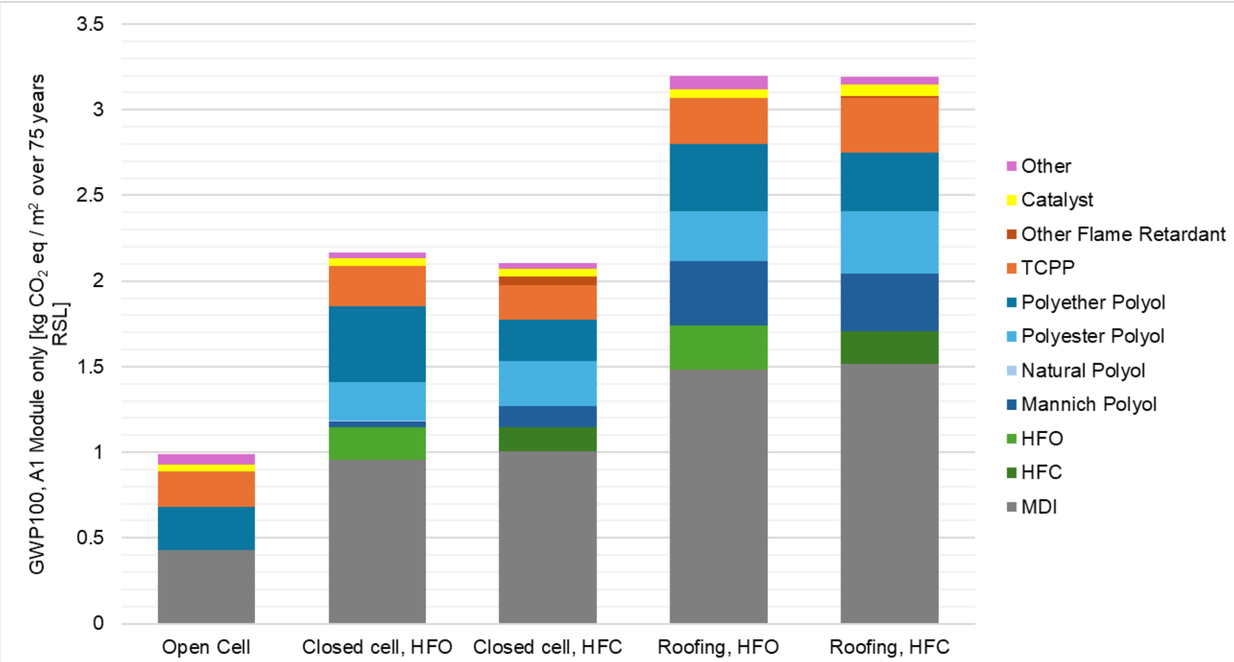


Figure 4-12: GWP100 of Module A1 only for all SPF products

4.4. Sensitivity Analysis

A sensitivity analysis was done to understand the effects of blowing agents in the SPF side-B formulations to its overall impact. The blowing agents used in each SPF product were varied by five percentage points, and the difference was allocated proportionally to the remaining raw materials within the side-B formulation.

Figure 4-13 shows the sensitivity analysis for open cell. Reactive blowing agent (water) was varied by five percentage points (i.e., from 20% to 15% and 25%) and overall impact was varied by 3% or less of the baseline scenario. This is as expected as there is little impact that comes from this blowing agent during the full life cycle of open cell SPF product.

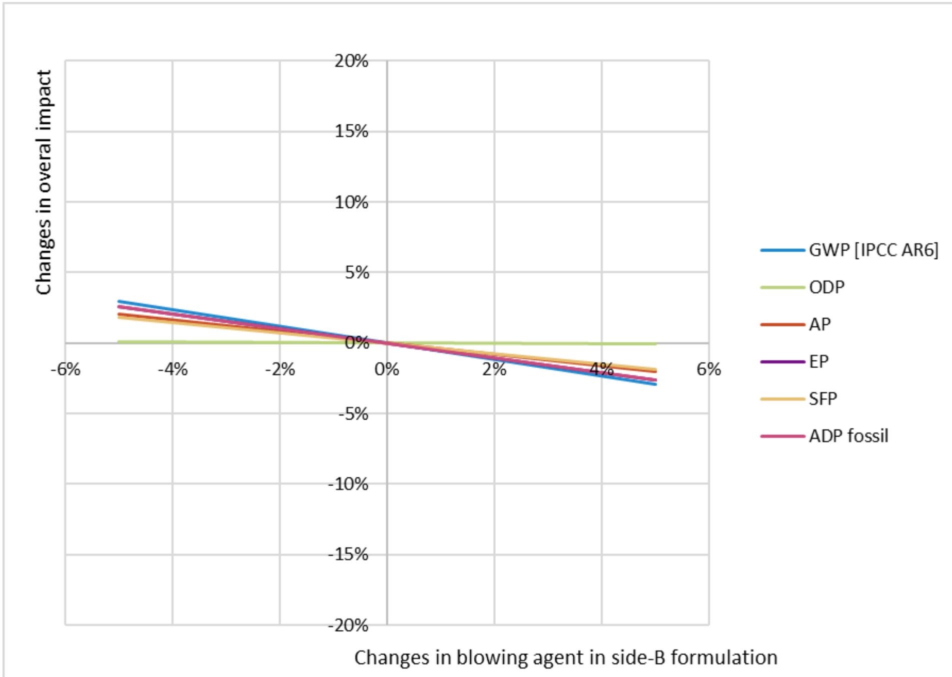


Figure 4-13: Blowing agent sensitivity analysis – Open Cell

Figure 4-14 shows the sensitivity analysis for closed cell, HFO SPF product. The HFO blowing agent was varied by five percentage points (i.e., from 9% to 4% and 14%) and the impact to GWP100, AP, EP, SFP, and ADP varied by 6% or less of the baseline scenario. However, due to the nature and magnitude of the ODP impact category, as well as the high contribution of HFO upstream burdens to the ODP results, ODP is sensitive to the HFO composition and varied by 57% from the baseline scenario.

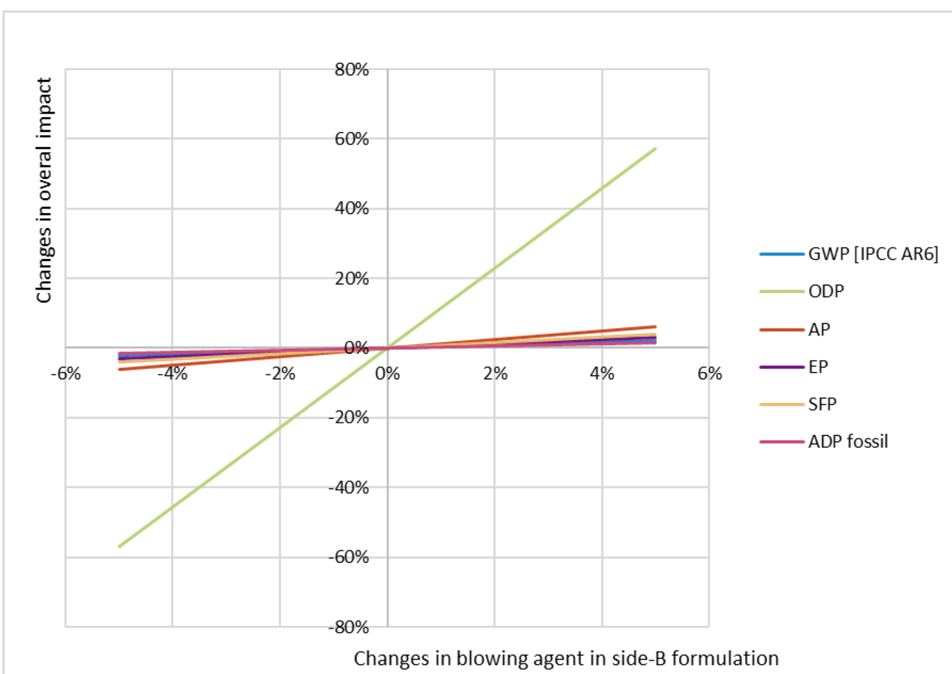


Figure 4-14: Blowing agent sensitivity analysis – Closed Cell, HFO

Figure 4-15 shows the sensitivity analysis for closed cell, HFC SPF product. The HFC blowing agent was varied by five percentage points (i.e., from 9% to 4% and 14%) and the overall impact in AP, SFP, and ADP were affected by 5% or less of the baseline scenario. As emissions of HFCs were a main contributor in overall GWP100, GWP100 was more sensitive to HFC composition in side-B formulation as more HFC in side-B also results in more off-gasses emitted during installation, use phase, and end-of-life. This resulted in a 45% variation from the baseline scenario.

It is also worth noting that ODP and EP were not affected by the HFC composition in side-B formulation as a five-percentage point variation showed no changes from the baseline scenario.

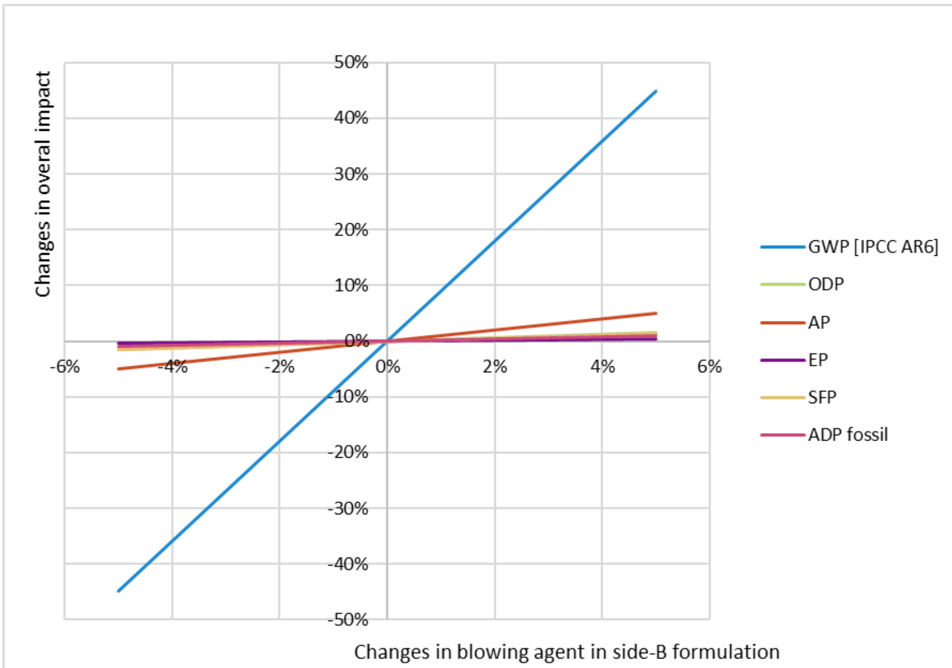


Figure 4-15: Blowing agent sensitivity analysis – Closed Cell, HFC

Figure 4-16 shows the sensitivity analysis for HFO roofing SPF. HFO blowing agent was varied by five percentage points (i.e., from 8% to 3% and 13%). Similar to the HFO closed cell SPF product, the changes in HFO blowing agent results in little impact to GWP100, AP, EP, SFP, and ADP. Results varied by 2 – 7% of the baseline scenario.

However, due to the nature and magnitude of the ODP impact category, as well as the high contribution of HFO upstream burdens to the ODP results, ODP is sensitive to the HFO composition and varies by 65% from the baseline scenario.

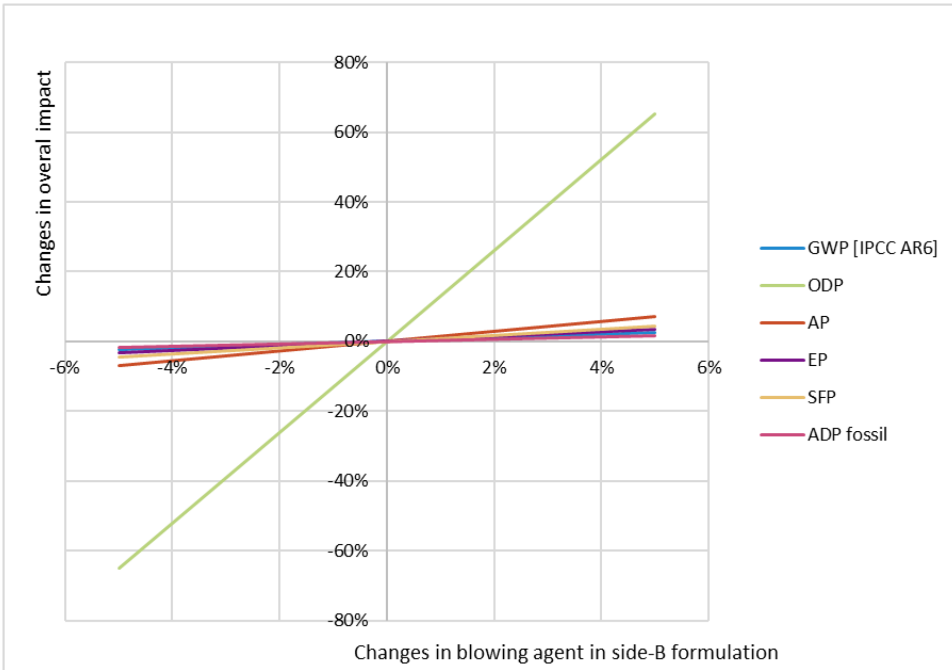


Figure 4-16: Blowing agent sensitivity analysis – Roofing, HFO

Figure 4-17 shows the sensitivity analysis for roofing, HFC SPF product. The HFC blowing agent varied by five percentage points (i.e., from 6% to 1% to 11%) and the overall impact in AP, SFP, and ADP were varied by 5% or less of the baseline scenario. Similar to closed cell, HFC, it is also worth noting that ODP and EP were not affected by the HFC composition in side-B formulation as 5% variation showed no changes from the baseline scenario.

As emissions of HFCs were a main contributor in overall GWP100, GWP100 was more sensitive to HFC composition in side-B formulation as more HFC in side-B also results in more off-gasses emitted during installation, use phase, and end-of-life. This resulted in a ~65% variation from the baseline scenario. The difference in variation compared to the HFC closed cell sensitivity analysis is due to there being only 6% HFC in the baseline scenario for HFC Roofing, therefore sensitivity for HFC composition ranged from 1% to 11%, while there is 9% HFC in the baseline scenario for HFC closed cell products and HFC composition ranged from 4% to 14%. Thus, there is a bigger relative change. In addition, there is more mass in the functional unit for HFC closed cell products than there is for HFC roofing products, and therefore more HFC mass per functional unit.

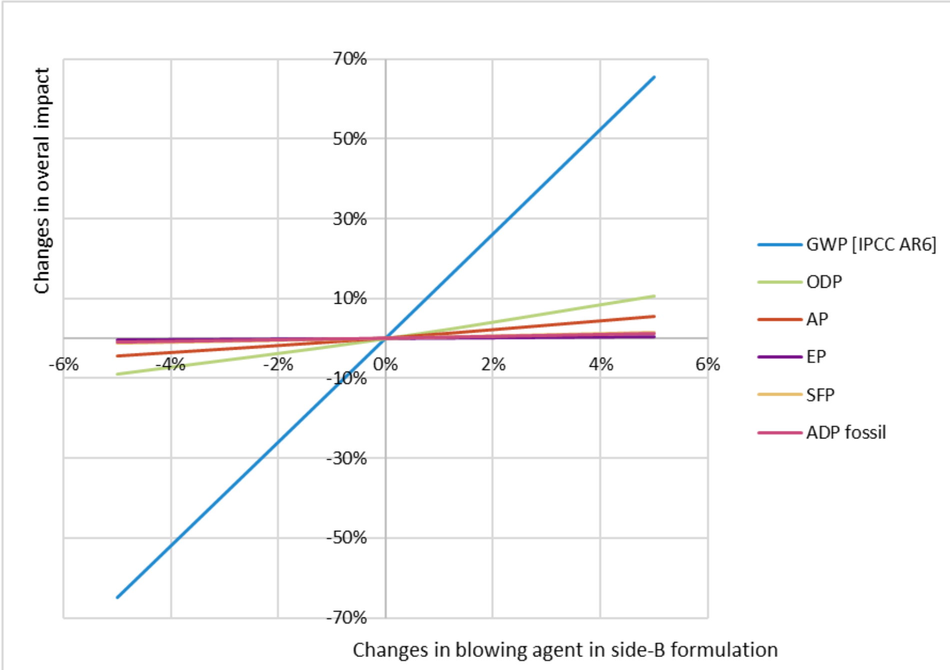


Figure 4-17: Blowing agent sensitivity analysis – Roofing, HFC

4.5. Uncertainty Analysis

An uncertainty analysis was performed to explore how the combined uncertainty of the density, R-value per inch, and blowing agent emissions affect the results. The uncertainty analysis was performed using the Monte Carlo simulation in Sphera LCA FE software, which draws random numbers from defined uncertainty intervals to calculate a multitude of possible results. The less these results vary, the lower the overall parameters' uncertainty affects the final results. A total of 500 simulations were run, and the arithmetic mean, standard deviation, and comparative baseline GWP100 [IPCC AR6] results are presented in Table 4-16.

The interval for the density and R-value parameters were defined using the minimum and maximum values from industry data. The uncertainty around the blowing agent emissions is assumed to be 5% and varied between 45% to 55% of total blowing agent emissions over the product's lifetime (baseline scenario for blowing agent emissions is 50%).

The results indicate that GWP100 results of the analysis are generally robust to changes in density, R-value per inch, and blowing agent emissions over its lifetime.

Table 4-16: Uncertainty analysis results with uncertainty around density, R-value per inch, and blowing agent emissions on GWP100 [IPCC AR6]

Product Name	Baseline	Mean	+/- Standard Deviation
Open Cell	1.21	1.19	4.7 %
Closed Cell, HFC	18.1	18.9	7.6 %
Closed Cell, HFO	2.71	3.06	11.7 %
Roofing, HFC	18.8	18.9	10.9 %
Roofing, HFO	4.02	4.52	10.2 %

5. Interpretation

5.1. Identification of Relevant Findings

The results in Section 4 represent the cradle-to-grave environmental performance of 1 m^2 of installed SPF at RSI = 1 $m^2 \cdot K/W$ over 75 years RSL. These results are consistent with the SPF blowing agent where SPF products with a HFC based blowing agent have the highest environmental impact, SPF with HFO based blowing agent have lower environmental impacts, and open cell products with a reactive blowing agent (water) have the lowest environmental impacts.

The high GWP100 for HFC based SPF products are primarily driven by the emissions released over its lifetime. The GWP100 for closed cell SPF with HFC and roofing SPF with HFC are 18.1 kg CO_2/ m^2 of installed SPF and 18.8 kg CO_2 eq./ m^2 of installed SPF, respectively, where 81 – 87% is contributed by the HFC emissions. Based on the study done by Honeywell on a predictive model of SPF emissions, it is assumed a total of 50% of blowing agent is released over the product lifetime – 10% during installation (A5), 24% during use phase (B1), and 14% during end of life (C4) (Honeywell International). The same assumption was used for HFO based SPF products and open cell products, but the released HFOs have approximately 0.1% of the GWP100 of HFCs, and the water used in the open cell products has no associated GWP100.

For GWP100 of open cell and HFO based SPF products, raw materials (A1) are the most dominant contributor. The burden from the upstream production of methylene diphenyl diisocyanate (MDI) which makes up side-A (35 - 37% of overall GWP100), and the raw materials in side-B such as polyols (21 - 26% of overall GWP100) and TCPP (7 - 17% of overall GWP100) were main contributors due to high mass contribution to the final product.

In AP, EP, and SFP, installation (A5) contributed 19% to 35% of the impact for all five products due to the onsite diesel generator used for installation as well as emissions from foam waste disposal.

For ODP, the dominant contributor was the cardboard used in module A5 (material for installation) (76 – 99%) and module A3 (packaging material for manufacturing) (0 – 23%). For HFO based products, the dominant contributor was the HFO upstream production.

Although some raw materials are transported over long distances, the inbound transportation (A2) and transportation to site (A4) have modest contributions to the overall impact. Inbound transportation (A2) ranged from 0% to 11% of the overall impact, and transportation to site (A4) ranged from 0 to 5%. Other transportation modules such as the transportation to end-of-life (C2) have negligible impacts.

5.2. Assumptions and Limitations

The following limitations to the study have been identified:

- The study does not account for energy savings from the use of spray foam in buildings.
- Datasets selected to represent the various inputs are based on regional or global averages rather than primary data collected directly from member company supply chains. When selecting these datasets, a conservative approach is applied in that datasets with higher impacts were used when there are multiple options.

- Proxy datasets were used where no exact dataset match was found. Similarly, a conservative approach was applied when selected these datasets.
- This study reports 50% of its blowing agents are released over its lifetime (Honeywell International). However, actual emissions may vary, which will affect impact categories such as global warming potential.

5.3. Update from Previous 2018 Study

There was an improvement in data collection for the five SPF formulations since the 2018 study. Changes in this study include:

- Updated primary data from member companies participating in this LCA study
- Changed the side-A background dataset for MDI from the one developed by ACC to the one developed by ISOPA
- Updated side-B formulation to use weighted averages instead of generic formulations
- Additional chemicals in side-B formulations were incorporated into the model
- Updated densities and R-values of each formulation

It is evident from the results that there is also an improvement in the LCIA results across all impact categories for all five formulations.

- All formulations showed an improvement in GWP100 with a decrease of approximately 18% to 35% except for HFC closed cell, which increased by 4%. This was due to an increase in HFC composition in side-B formulation and an increase in the characterization factor for HFC emissions.
- AP, EP, and SFP showed a decrease for all five formulations of 46 – 64% due to the diesel combustion update where it shows improvement in SO_2, VOCs and NO_x emissions.
- ODP also decreased by 81% to 100% where less mass per functional unit contributed to this factor.

5.4. Results of Sensitivity, Scenario, and Uncertainty Analysis

5.4.1. Sensitivity Analysis

Sensitivity analyses were performed to test the sensitivity of the results towards changes in the composition of blowing agent in side-B formulation.

The following summarizes the results:

- For open cell, all the impact categories showed changes of 3% or less.
- For HFO based products, closed cell, HFO and roofing, HFO SPF products, the composition of blowing agent affected the ODP category the most with variations of 57 – 65%. Other impact categories varied by 5% or less.
- For HFC based products, closed cell, HFC and roofing, HFC SPF products, the composition of blowing agents greatly affected the GWP100 category due to its emissions of HFC-245fa. A five percentage point variation in blowing agent resulted in GWP100 changes of 45% to 65%. Other impact categories showed changes of 5% or less.

5.4.2. Uncertainty Analysis

Uncertainty analysis was performed to test the robustness of the results towards the combined parameter uncertainty. The results showed that with an uncertainty around the density and R-value per inch parameters based on the minimum and maximum values, and an uncertainty of 5% in the emissions of blowing agents, the arithmetic mean is within 1% to 13% of the baseline scenario, with a 5% to 12% standard deviation. This indicates that the results of the analysis are generally robust to changes in density, R-value per inch, and blowing agent emissions over its lifetime.

5.5. Data Quality Assessment

Inventory data quality is judged by its precision (measured, calculated or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied) and representativeness (geographical, temporal, and technological).

To cover these requirements and to ensure reliable results, first-hand industry data in combination with consistent background LCA information from the Sphera MLC 2024.2 database were used. The LCI datasets from the MLC 2024.2 database are widely distributed and used with the Sphera LCA FE v10.9 Software. The datasets have been used in LCA models worldwide, in industrial and scientific applications in internal as well as in many critically reviewed and published studies. In the process of providing these datasets they are cross-checked with other databases and values from industry and science.

5.5.1. Precision and Completeness

- ✓ **Precision:** As the majority of the relevant foreground data are measured data or calculated based on primary information sources of the owner of the technology, precision is considered to be high. Seasonal variations and variations across different manufacturers were balanced out by using weighted averages over a 12-month period. All background data are sourced from Sphera MLA databases with the documented precision.
- ✓ **Completeness:** Each foreground process was checked for mass balance and completeness of the emission inventory. No data was knowingly omitted. Completeness of foreground unit process data is considered to be high. All background data are sourced from Sphera MLA databases with the documented completeness.

5.5.2. Consistency and Reproducibility

- ✓ **Consistency:** To ensure data consistency, all primary data were collected with the same level of detail, while all background data were sourced from the Sphera MLA 2024.2 databases. Consistency is considered to be high.
- ✓ **Reproducibility:** Reproducibility is supported as much as possible through the disclosure of input-output data, dataset choices, and modeling approaches in this report. Based on this information, any third party should be able to approximate the results of this study using the same data and modeling approaches. Reproducibility is considered to be high.

5.5.3. Representativeness

- ✓ **Temporal:** All primary data were collected for the year 2022. All secondary data come from the Sphera MLC 2024.2 databases and are representative of the years 2017-2022. As the study intended to compare the product systems for the reference year 2022, temporal representativeness is considered to be high.

- ✓ **Geographical:** All primary and secondary data were collected specific to the countries or regions under study. Where country-specific or region-specific data were unavailable, proxy data were used. Geographical representativeness is considered to be high.
- ✓ **Technological:** All primary and secondary data were modeled to be specific to the technologies or technology mixes under study. Where technology-specific data was unavailable, proxy data was used. Technological representativeness is considered to be high.

5.6. Model Completeness and Consistency

5.6.1. Completeness

All relevant process steps for each product system were considered and modeled to represent each specific situation. The process chain is considered sufficiently complete and detailed with regard to the goal and scope of this study.

5.6.2. Consistency

All assumptions, methods and data are consistent with each other and with the study's goal and scope. Differences in background data quality were minimized by predominantly using LCI data from the Sphera MLC 2024.2 databases. System boundaries, allocation rules, and impact assessment methods have been applied consistently throughout the study.

5.7. Conclusions, Limitations, and Recommendations

5.7.1. Conclusions

This study has been carried out for SPFA with the goal of updating the environmental performance results for the five SPF products. This enables them to communicate the results via EPDs and to gain a better understanding of and identify opportunities for improvement. It also helps to track improvements made by industry over time. The intent of the study is not to conduct a comparative assessment of SPFA member company products but to develop industry-based averages.

Th following conclusions can be made from this study:

- Raw materials used in the production of SPF products play a significant role in the final product's life cycle environmental performance. Specifically upstream production of raw materials such as MDI (side-A), polyols, and TCPP due to their larger mass contribution.
- The higher GWP100 impact in HFC based products are due to its emissions of HFC during installation, use phase, and end-of-life
- ODP impacts are predominantly driven by the upstream production of MDI (side-A) and HFO raw materials.
- The use of onsite diesel generators shows a significant impact to GWP100, AP, EP, and SFP categories, due to its VOC and nitrogen containing compounds released.

5.7.2. Limitations

This study represents a comprehensive LCA of five formulations of SPF products. However, the results from this analysis are specifically for the specified SPF formulations and participating companies, and not intended to be applied to other adjacent insulation products in the market.

5.7.3. Recommendations

As raw materials (A1) are a dominant contributor across the various environmental impact categories, SPFA can investigate alternative formulations that use fewer intensive components. The industry can continue to explore alternative options for conventional MDI (side A), as well as blowing agents, polyols, and flame retardants. SPFA member companies can also work with manufacturers in their supply chain to reduce environmental impact in their upstream production.

As insulation requirements for buildings can vary across the different regions and climates, SPFA member companies can also investigate more specific formulations to reduce certain raw materials in the side-B formulation.

Onsite installation, specifically the use of diesel generators, showed significant contribution in AP, EP, and SFP. SPFA member companies can encourage spray foam installers to use lower impact electricity sources such as batteries or mobile generators using biodiesel.

It is recommended that SPFA and its member companies continue their efforts in understanding the environmental impact of their products and update EPDs in effort to track progress and continuously identify opportunities for improvement.

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Annex A: Manufacturing Datasets

Annex A1

Table A-1: Material and Process datasets

Location	Dataset	Data Provider	Reference Year	Proxy?
DE	Carbon black (furnace black; deep black pigment)	Sphera	2022	Geo proxy
DE	Dimethyl terephthalate (DMT)	Sphera	2022	Geo proxy
DE	o-Xylene	Sphera	2022	Geo proxy
DE	Polyethylene terephthalate granulate (PET via DMT)	Sphera	2022	Tech and geo proxy
DE	R-1234yf production (approximation)	Sphera	2022	Tech and geo proxy
DE	Siloxane (cyclic) (from organosilanes)	Sphera	2022	Geo proxy
DE	Tetrafluoroethane (R134a) (approximation)	Sphera	2022	Geo proxy
GLO	Equalizing agent (on basis alcohol ethoxylate)	Sphera	2022	Tech proxy
GLO	Non-ionic surfactant (fatty acid derivate)	Sphera	2022	No
GLO	Steel cold rolled coil	Worldsteel	2022	No
GLO	Steel wire rod	Worldsteel	2022	No
GLO	Tin	Sphera	2022	No
RER	1,1,1,3,3-Pentafluoropropane (245 fa) from Vinyl chloride monomer and carbon chloride via 240fa	Sphera	2022	Geo proxy
RER	Activated carbon	Sphera	2022	Geo proxy
RER	Kraft paper (EN15804 A1-A3)	Sphera	2022	Geo proxy
RER	Polyester (PET) fabric	Sphera	2022	Geo proxy
RER	Wooden pallets (EURO, 120x80x14 cm, 22% moisture, 18% H2O content)	Sphera	2023	Geo proxy
US	Ammonia (NH3) without CO2 recovery (carbon dioxide emissions to air)	Sphera	2022	No
US	Average Corrugated Product (Cradle-to-Gate, 2014)	CPA	2017	No
US	Cotton - fabric (based on US cotton yarn, conventional)	Sphera	2022	No
US	Diethanolamine (DEA) by-prod. ethanolamines	Sphera	2022	No
US	Diethylene glycol by product ethylene glycol from ethene and oxygen via EO	Sphera	2022	No
US	Ethanol (96%) (hydrogenation with nitric acid)	Sphera	2022	No
US	Ethylene oxide (EO) by-product carbon dioxide via air	Sphera	2022	No
US	Ethylene oxide (EO) via O2/methane	Sphera	2022	No
US	Hexabromododecane (HBCD, 1,2,5,6,9,10-Hexabromododecane)	Sphera	2022	No
US	Isobutane (from n-butane)	Sphera	2022	No
US	Methane (from natural gas)	Sphera	2022	No
US	Methanol from natural gas (combined reforming)	Sphera	2022	No

Loca-tion	Dataset	Data Provider	Reference Year	Proxy?
US	Methylamine (by product di-, trimethylamine)	Sphera	2022	Tech proxy
RER	Methylenediphenyl diisocyanate ((p)MDI)	ISOPA	2018	Geo proxy
US	Monosodium phosphate	Sphera	2022	No
US	Nitrogen (gaseous)	Sphera	2022	No
US	Pentafluoroethane, HFC 125, R125 (approximation from HCF 152a)	Sphera	2022	Tech proxy
US	Pentane (estimation)	Sphera	2017	No
US	Phenol, by-product acetone, methyl styrene (from cu-mene)	Sphera	2022	No
US	Phthalic anhydride (by oxidation of xylene)	Sphera	2022	No
US	Polycarbonate granulate (PC)	Sphera	2022	No
US	Polyether Polyol (from PO+EO)	Sphera	2022	No
US	Polyethylene Film (LDPE/PE-LD)	Sphera	2022	No
US	Polyethylene glycol (PEG)	Sphera	2022	No
US	Polyethylene high density granulate (HDPE/PE-HD)	Sphera	2022	No
US	Polystyrene granulate (PS) (approximation)	Sphera	2022	No
US	Polyvinyl chloride granulate (S-PVC)	Sphera	2022	No
US	Process water from surface water	Sphera	2022	No
US	Propylene oxide (Chlorohydrin Process with Cell Liquor)	Sphera	2022	No
US	Purified terephthalic acid (PTA)	Sphera	2022	No
US	Tap water from groundwater	Sphera	2022	No
US	Tris(2-chloroisopropyl)phosphate (TCPP)	Sphera	2022	No
US	Water deionized	Sphera	2022	No
US	Water deionized (reverse-osmosis/electro-deionization)	Sphera	2022	No

Annex B: Confidential Data

Annex B1

Open cell cradle-to-grave data

Material		Unit	Value
Manufacturing			
Input	Polyester polyol	lb	0.00E+00
	Polyether polyol	lb	1.06E-01
	Mannich polyol	lb	1.20E-03
	Compatibilizer	lb	4.21E-02
	Soy polyol	lb	0.00E+00
	Brominated Flame Retardant	lb	0.00E+00
	TCPP	lb	8.45E-02
	TDCP	lb	0.00E+00
	Reactive blowing agent (water)	lb	6.53E-02
	HFC 245a	lb	0.00E+00
	HFC 134a	lb	0.00E+00
	HFC 365	lb	0.00E+00
	HFO-1233zd or HFO-1336mzzZ	lb	0.00E+00
	Amine catalyst	lb	2.83E-02
	Metal catalyst	lb	0.00E+00
	Aggregate catalyst	lb	0.00E+00
	Silicone	lb	4.31E-03
	Colorant	lb	0.00E+00
Others (outside formulation)	Boil chemicals	lb	1.82E-07
	Coolant	lb	2.25E-07
	TCPP	lb	3.56E-05
Energy	Diesel	lb	2.76E-07
	Power	BTU	4.52E+01
Side-B Packaging	Cardboard	lb	1.77E-05
	Steel drum	lb	1.48E-02
	Plastic drum	lb	0.00E+00
	Pallets	lb	3.40E-04
	Plastic film	lb	0.00E+00
	Label	lb	0.00E+00
	Plastic strap	lb	3.22E-05
	Steel strap	lb	1.78E-06
	Plastic tote	lb	2.73E-04
	Steel tote	lb	1.87E-04
	Steel drum	lb	1.37E-02

Material		Unit	Value
Side-A Packaging	Plastic strap	lb	0.00E+00
	Steel strap	lb	0.00E+00
Direct emissions	CO	lb	0.00E+00
	CO2	lb	9.26E-08
	DCE	lb	1.63E-09
	Formic acid	lb	1.14E-09
	HFC_134	lb	0.00E+00
	HFC_245fa	lb	0.00E+00
	HFO-1233zd or HFO-1336mzzZ	lb	0.00E+00
	PM	lb	6.10E-08
	VOC	lb	0.00E+00
Waste	Spray foam, produced	lb	7.08E-01
	Waste, incinerated	lb	4.61E-04
	Waste, landfilled	lb	6.92E-04
	Waste, recycled	lb	5.27E-04
	Wastewater	lb	2.75E-04
Installation			
	Chemical suits	piece	3.60E-04
	Respiratory cartridges	piece	1.37E-03
	Goggles	piece	5.82E-04
	Duct tape	piece	1.18E-04
	Plastic rolls	piece	1.83E-04
	Chemical gloves	piece	1.08E-03
	Lubricant	piece	2.97E-06
	Masking tape	piece	5.23E-05
	Cloth gloves	piece	7.19E-05
	Waste foam	lb	2.41E-02
	Waste material	lb	3.06E-03
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00
	Diesel consumption	lb	6.01E-02
	Power consumption	BTU	6.04E+01
Use phase			
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00
End of life			

Material		Unit	Value
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00

Closed cell, HFO cradle-to-grave data

Material		Unit	Value
Manufacturing			
Input	Polyester polyol	lb	2.98E-01
	Polyether polyol	lb	1.83E-01
	Mannich polyol	lb	2.74E-02
	Compatibilizer	lb	1.78E-03
	Soy polyol	lb	1.02E-03
	Brominated Flame Retardant	lb	6.73E-04
	TCPP	lb	9.59E-02
	TDCP	lb	0.00E+00
	Reactive blowing agent (water)	lb	1.87E-02
	HFC 245a	lb	0.00E+00
	HFC 134a	lb	0.00E+00
	HFC 365	lb	0.00E+00
	HFO-1233zd or HFO-1336mzzZ	lb	6.44E-02
	Amine catalyst	lb	1.28E-02
	Metal catalyst	lb	2.26E-03
	Aggregate catalyst	lb	1.35E-02
	Silicone	lb	1.00E-02
	Colorant	lb	0.00E+00
Others (outside formulation)	Boil chemicals	lb	2.35E-07
	Coolant	lb	2.94E-07
	TCPP	lb	1.75E-04
Energy	Diesel	lb	3.36E-06
	Power	BTU	1.12E+02
Side-B Packaging	Cardboard	lb	3.86E-05
	Steel drum	lb	4.13E-02
	Plastic drum	lb	0.00E+00
	Pallets	lb	7.79E-04
	Plastic film	lb	1.00E-08
	Label	lb	0.00E+00
	Plastic strap	lb	3.71E-05
	Steel strap	lb	6.47E-05

Material		Unit	Value
	Plastic tote	lb	7.87E-04
	Steel tote	lb	5.16E-04
Side-A Pack-aging	Steel drum	lb	3.62E-02
	Plastic strap	lb	0.00E+00
	Steel strap	lb	0.00E+00
Direct emis-sions	CO	lb	0.00E+00
	CO2	lb	1.25E-05
	DCE	lb	2.00E-08
	Formic acid	lb	1.40E-08
	HFC_134	lb	0.00E+00
	HFC_245fa	lb	0.00E+00
	HFO-1233zd or HFO-1336mzzZ	lb	9.16E-06
	PM	lb	8.22E-06
	VOC	lb	0.00E+00
Waste	Spray foam, produced	lb	7.08E-01
	Waste, incinerated	lb	6.78E-04
	Waste, landfilled	lb	4.10E-03
	Waste, recycled	lb	2.69E-03
	Wastewater	lb	6.38E-03
Installation			
	Chemical suits	piece	7.83E-04
	Respiratory cartridges	piece	2.98E-03
	Goggles	piece	1.27E-03
	Duct tape	piece	2.56E-04
	Plastic rolls	piece	3.99E-04
	Chemical gloves	piece	2.35E-03
	Lubricant	piece	6.46E-06
	Masking tape	piece	1.14E-04
	Cloth gloves	piece	1.57E-04
	Waste foam	lb	5.25E-02
	Waste material	lb	6.67E-03
	HFO released	lb	6.11E-03
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00
	Diesel consumption	lb	1.31E-01
	Power consumption	BTU	1.32E+02
Use phase			
	HFO released	lb	1.47E-02

Material		Unit	Value
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00
End of life			
	HFO released	lb	9.78E-03
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00

Closed cell, HFC cradle-to-grave data

Material		Unit	Value
Manufacturing			
Input	Polyester polyol	lb	3.50E-01
	Polyether polyol	lb	1.00E-01
	Mannich polyol	lb	8.92E-02
	Compatibilizer	lb	6.14E-03
	Soy polyol	lb	0.00E+00
	Brominated Flame Retardant	lb	2.49E-03
	TCPP	lb	8.10E-02
	TDCP	lb	1.88E-02
	Reactive blowing agent (water)	lb	1.95E-02
	HFC 245a	lb	7.36E-02
	HFC 134a	lb	0.00E+00
	HFC 365	lb	4.66E-04
	HFO-1233zd or HFO-1336mzzZ	lb	0.00E+00
	Amine catalyst	lb	2.76E-02
	Metal catalyst	lb	9.33E-04
	Aggregate catalyst	lb	0.00E+00
	Silicone	lb	7.38E-03
	Colorant	lb	0.00E+00
Others (outside formulation)	Boil chemicals	lb	2.31E-06
	Coolant	lb	2.89E-06
	TCPP	lb	7.63E-04
Energy	Diesel	lb	3.50E-01
	Power	BTU	5.12E-05
Side-B Packaging	Cardboard	lb	5.25E+01
	Steel drum	lb	1.44E-05
	Plastic drum	lb	6.64E-02
	Pallets	lb	0.00E+00

Material		Unit	Value
	Plastic film	lb	1.41E-03
	Label	lb	0.00E+00
	Plastic strap	lb	0.00E+00
	Steel strap	lb	3.17E-05
	Plastic tote	lb	0.00E+00
	Steel tote	lb	3.71E-04
Side-A Packaging	Steel drum	lb	2.01E-04
	Plastic strap	lb	5.85E-02
	Steel strap	lb	0.00E+00
Direct emissions	CO	lb	0.00E+00
	CO2	lb	0.00E+00
	DCE	lb	0.00E+00
	Formic acid	lb	0.00E+00
	HFC_134	lb	0.00E+00
	HFC_245fa	lb	8.19E-05
	HFO-1233zd or HFO-1336mzzZ	lb	0.00E+00
	PM	lb	0.00E+00
	VOC	lb	0.00E+00
Waste	Spray foam, produced	lb	7.08E-01
	Waste, incinerated	lb	7.12E-03
	Waste, landfilled	lb	5.68E-03
	Waste, recycled	lb	5.21E-03
	Wastewater	lb	1.39E-03
Installation			
	Chemical suits	piece	8.24E-04
	Respiratory cartridges	piece	3.13E-03
	Goggles	piece	1.33E-03
	Duct tape	piece	2.70E-04
	Plastic rolls	piece	4.19E-04
	Chemical gloves	piece	2.47E-03
	Lubricant	piece	6.80E-06
	Masking tape	piece	1.20E-04
	Cloth gloves	piece	1.65E-04
	Waste foam	lb	5.52E-02
	Waste material	lb	7.01E-03
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	6.95E-03

Material		Unit	Value
	Diesel consumption	lb	1.38E-01
	Power consumption	BTU	1.38E+02
Use phase			
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	1.67E-02
End of life			
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	1.11E-02

Roofing, HFO cradle-to-grave data

Material		Unit	Value
Manufacturing			
Input	Polyester polyol	lb	3.86E-01
	Polyether polyol	lb	1.61E-01
	Mannich polyol	lb	2.75E-01
	Compatibilizer	lb	5.03E-02
	Soy polyol	lb	0.00E+00
	Brominated Flame Retardant	lb	0.00E+00
	TCPP	lb	1.08E-01
	TDCP	lb	0.00E+00
	Reactive blowing agent (water)	lb	1.81E-02
	HFC 245a	lb	0.00E+00
	HFC 134a	lb	0.00E+00
	HFC 365	lb	0.00E+00
	HFO-1233zd or HFO-1336mzzZ	lb	8.69E-02
	Amine catalyst	lb	1.39E-02
	Metal catalyst	lb	1.07E-03
	Aggregate catalyst	lb	1.92E-02
	Silicone	lb	6.20E-03
	Colorant	lb	0.00E+00
Others (outside formulation)	Boil chemicals	lb	0.00E+00
	Coolant	lb	0.00E+00
	TCPP	lb	1.35E-05
Energy	Diesel	lb	1.40E-06

Material		Unit	Value
	Power	BTU	1.05E+02
Side-B Packaging	Cardboard	lb	4.86E-08
	Steel drum	lb	7.03E-02
	Plastic drum	lb	0.00E+00
	Pallets	lb	1.57E-03
	Plastic film	lb	0.00E+00
	Label	lb	0.00E+00
	Plastic strap	lb	9.07E-08
	Steel strap	lb	0.00E+00
	Plastic tote	lb	1.68E-03
	Steel tote	lb	1.16E-03
Side-A Packaging	Steel drum	lb	7.34E-02
	Plastic strap	lb	0.00E+00
	Steel strap	lb	0.00E+00
Direct emissions	CO	lb	0.00E+00
	CO2	lb	0.00E+00
	DCE	lb	1.07E-07
	Formic acid	lb	7.46E-08
	HFC_134	lb	0.00E+00
	HFC_245fa	lb	0.00E+00
	HFO-1233zd or HFO-1336mzzZ	lb	1.43E-07
	PM	lb	0.00E+00
	VOC	lb	0.00E+00
Waste	Spray foam, produced	lb	7.08E-01
	Waste, incinerated	lb	2.45E-03
	Waste, landfilled	lb	4.15E-03
	Waste, recycled	lb	9.88E-04
	Wastewater	lb	9.33E-06
Installation			
	Chemical suits	piece	1.22E-03
	Respiratory cartridges	piece	4.62E-03
	Goggles	piece	1.97E-03
	Duct tape	piece	3.98E-04
	Plastic rolls	piece	6.19E-04
	Chemical gloves	piece	3.65E-03
	Lubricant	piece	1.00E-05
	Masking tape	piece	1.77E-04
	Cloth gloves	piece	2.43E-04

Material		Unit	Value
	Waste foam	lb	8.14E-02
	Waste material	lb	1.03E-02
	HFO released	lb	8.30E-03
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00
	Diesel consumption	lb	2.03E-01
	Power consumption	BTU	2.04E+02
Use phase			
	HFO released	lb	1.99E-02
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00
End of life			
	HFO released	lb	1.33E-02
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	0.00E+00

Roofing, HFC cradle-to-grave data

Material		Unit	Value
Manufacturing			
Input	Polyester polyol	lb	4.85E-01
	Polyether polyol	lb	1.40E-01
	Mannich polyol	lb	2.43E-01
	Compatibilizer	lb	2.27E-02
	Soy polyol	lb	0.00E+00
	Brominated Flame Retardant	lb	5.95E-03
	TCPP	lb	1.29E-01
	TDCP	lb	0.00E+00
	Reactive blowing agent (water)	lb	3.32E-02
	HFC 245a	lb	6.56E-02
	HFC 134a	lb	0.00E+00
	HFC 365	lb	5.46E-03
	HFO-1233zd or HFO-1336mzzZ	lb	0.00E+00
	Amine catalyst	lb	3.94E-02
	Metal catalyst	lb	3.31E-03
	Aggregate catalyst	lb	0.00E+00
	Silicone	lb	7.37E-03

Material		Unit	Value
	Colorant	lb	0.00E+00
Others (outside formulation)	Boil chemicals	lb	4.53E-06
	Coolant	lb	5.66E-06
	TCPP	lb	4.08E-03
Energy	Diesel	lb	0.00E+00
	Power	BTU	1.34E+02
Side-B Packaging	Cardboard	lb	3.11E-07
	Steel drum	lb	1.09E-01
	Plastic drum	lb	0.00E+00
	Pallets	lb	2.27E-02
	Plastic film	lb	0.00E+00
	Label	lb	0.00E+00
	Plastic strap	lb	5.80E-07
	Steel strap	lb	0.00E+00
	Plastic tote	lb	2.18E-03
	Steel tote	lb	3.62E-04
Side-A Packaging	Steel drum	lb	7.90E-02
	Plastic strap	lb	0.00E+00
	Steel strap	lb	0.00E+00
Direct emissions	CO	lb	0.00E+00
	CO2	lb	0.00E+00
	DCE	lb	0.00E+00
	Formic acid	lb	0.00E+00
	HFC_134	lb	0.00E+00
	HFC_245fa	lb	1.79E-04
	HFO-1233zd or HFO-1336mzzZ	lb	0.00E+00
	PM	lb	0.00E+00
	VOC	lb	0.00E+00
Waste	Spray foam, produced	lb	7.08E-01
	Waste, incinerated	lb	4.66E-03
	Waste, landfilled	lb	1.50E-02
	Waste, recycled	lb	1.73E-02
	Wastewater	lb	0.00E+00
Installation			
	Chemical suits	piece	1.24E-03
	Respiratory cartridges	piece	4.72E-03
	Goggles	piece	2.01E-03
	Duct tape	piece	4.06E-04

Material		Unit	Value
	Plastic rolls	piece	6.32E-04
	Chemical gloves	piece	3.73E-03
	Lubricant	piece	1.02E-05
	Masking tape	piece	1.81E-04
	Cloth gloves	piece	2.48E-04
	Waste foam	lb	8.32E-02
	Waste material	lb	1.06E-02
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	6.62E-03
	Diesel consumption	lb	2.08E-01
	Power consumption	BTU	2.09E+02
Use phase			
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	1.59E-02
End of life			
	HFO released	lb	0.00E+00
	HFC 134a released	lb	0.00E+00
	HFC 245fa released	lb	1.06E-02

Self-declaration of reviewer independence and competencies (ISO/TS 14071)

Report Title and Date:

Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)

I, the signatory, hereby declare that:

☑ I am not a full-time or part-time employee of the commissioner or practitioner of the LCA study (external reviewers only)
☑ I have not been involved in defining the scope or carrying out any of the work to conduct the LCA study at hand, i.e, I have not been part of the commissioner's or practitioner's project team(s)
☑ I do not have vested financial, political or other interests in the outcome of the study

My competencies relevant to the Critical Review at hand include knowledge of and proficiency in:

☑ ISO 14040 and ISO 14044
☑ LCA methodology and practice
☑ Critical Review practice
☑ Environmental, technical and other relevant performance aspects of the product system(s) assessed
☑ Language used for the study

I declare that the above statements are truthful and complete. I will immediately notify all parties involved (commissioner of the critical review, practitioner of the LCA study, fellow reviewer(s)), as applicable, if the validity of any of these statements changes during the course of the review process.

Date: November 27, 2024

Name (print): Thomas Gloria

Signature: Digitally signed by Thomas Gloria Date: 2024.11.27 18:09:42 -05'00'

EPD Checklist – *Mechanical, Specialty, Thermal, and Acoustic Insulation Products* to ISO 21930:2017

Reference PCR:	PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, March 2022 Part B: Building Envelope Thermal Insulation EPD Requirements, UL Environment 10010-1, v.3.0, 4/1/23
EPD:	SPRAY POLYURETHANE FOAM INSULATION CLOSED CELL USING HYDROFLUOROCARBONS (CCSPF, HFC) ROOFING CELL USING HYDROFLUOROCARBONS (ROOFING SPF, HFC) CLOSED CELL USING HYDROFLUOROOLEFINS (CCSPF, HFO) ROOFING CELL USING HYDROFLUOROOLEFINS (ROOFING SPF, HFO) OPEN CELL (OCSPF)
Author:	Sphera Solutions on behalf of SPFA
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants
Date of Review	11/27/24

ISO 14020

	Item	Comment
	4.2 Principle 1 Environmental labels and declarations shall be accurate, verifiable, relevant and not misleading.	**Requirement met based on LCA Conformance review.**
	4.3 Principle 2 Procedures and requirements for environmental labels and declarations shall not be prepared, adopted, or applied with a view to, or with the effect of, creating unnecessary obstacles to international trade.	**Requirement met.**
	4.4 Principle 3 Environmental labels and declarations shall be based on scientific methodology that is sufficiently thorough and comprehensive to support the claim and that produces results that are accurate and reproducible.	**Requirement met based on LCA Conformance review.**
	4.5 Principle 4 Information concerning the procedure, methodology, and any criteria used to support environmental labels and declarations shall be available and provided upon request to all interested parties.	**Requirement met based on ASTM operating procedures.**
	4.6 Principle 5 The development of environmental labels and declarations shall take into consideration all relevant aspects of the life cycle of the product.	**Requirement met based on the requirements of the PCR and the LCA Conformance review.**
	4.7 Principle 6 Environmental labels and declarations shall not inhibit innovation which maintains or has the potential to improve environmental performance.	**Requirement met based on the requirements of the PCR, ASTM operating procedures, and the LCA Conformance review.**
	4.8 Principle 7 Any administrative requirements or information demands related to environmental labels and declarations shall be limited to those necessary to establish conformance with applicable criteria and standards of the labels and declarations.	**Requirement met based on the requirements of the PCR and ASTM operating procedures.**
	4.9 Principle 8 The process of developing environmental labels and declarations should include an open, participatory consultation with interested parties. Reasonable efforts should be made to achieve a consensus throughout the process.	**Requirement met based on the requirements of the PCR and ASTM operating procedures.**
	4.10 Principle 9 **I**nformation on the environmental aspects of products and services relevant to an environmental label or declaration shall be available to purchasers and potential purchasers from the party making the environmental label or declaration.	**Requirement met based on ASTM operating procedures.**

	9 Content of an EDP	
	9.1 General The EPD shall include the following main parts as a minimum for B2B communication: — declaration of general information (see 9.2); — declaration of the methodological framework (see 9.3); — declaration of technical information and scenarios (see 9.4); — declaration of environmental indicators derived from LCA (see 9.5); — declaration of additional environmental information (see 9.6); — references (see 9.6.1). For B2C communication, the development and content of EPDs shall follow ISO 14025 and any relevant sub-category PCR that are in accordance with this document. The detailed content of an EPD is specified further in this clause.	**Requirement met.**
	9.2 Declaration of General Information	
	Construction product EPDs according to this document should follow the format defined in the following subclauses and shall include the indicators as identified in this document. The manufacturer(s) of the product that is the subject of the EPD are responsible for the provision of all necessary information. The following shall be declared in the EPD: a) the name and address of the EPD holder(s) (manufacturer, association, service provider, etc.); b) the description of the construction product's intended application and use (as identified when determining the product RSL), where relevant; c) construction product identification by name (including any product code) and a simple visual representation, if relevant, of the construction product or work to which the data relates; d) a description of the main product components or material that make up the construction product or work, given in percentage; NOTE 1 This description is intended to enable the user of the EPD to understand the composition of the product in delivery condition and support a safe and effective installation, use and disposal of the product. With appropriate justification, this requirement does not apply to confidential or proprietary information relating to materials and substances that apply due to a competitive business environment or covered by intellectual property rights or similar legal restrictions. It also might not be appropriate for information concerning intangible products. f) name of the EPD programme used and the programme operator's name, address, logo and website; g) a reference to this document and, if used, the sub-category PCR version number, publisher and year published; h) the date the declaration was issued; i) the end of the period of validity (e.g. 5 years); j) a statement that EPDs are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works; l) any other environmental certification programme applied to the product and a statement on where an interested party can find details of the certification programme, if relevant; m) other environmental activities of the organization, such as participation in recycling or recovery programmes, provided that the details of these programmes are readily available to the purchaser or user and contact information is provided, if relevant; o) information on where explanatory material may be obtained. NOTE 2 Guidance on the safe and correct installation, use and disposal of the product is supplied by the manufacturer.	**Requirement met.**

	In addition to the above mentioned general information, the information given in Figure 3, excluding the footnotes, shall be completed and presented in the EPD. ISO 21930:<insert year of publication>- serves as the core PCR <Sub-category PCR, if relevant> <PCR review(a,b,c) was conducted by:> <Sub-category PCR review(a,d,e) was conducted by:> <name and organization of the panel chair, and their contact information(f) > Independent verification of the declaration and data, according to ISO 21930: <insert year of publication> and ISO 14025: <insert year of publication> ☐ internal ☐ external Third party verifier(g): <Name of the third party verifier> a If relevant. b Any overarching PCR shall be in accordance with this document, particularly 6.1 and 6.2. c Any overarching PCR review shall be in accordance with 6.1. d Sub-category PCR shall be in accordance with 6.1, 6.2 and 6.3. e Sub-category PCR review shall be in accordance with 6.3. f The specific details of the review, including those to be named in the EPD, are the responsibility of the Programme Operator. g Where appropriate - optional for B2B communication; mandatory for B2C communication (see ISO 14025:2006, 9.4). **Figure 3 — Demonstration of verification**	
	9.3 Declaration of the methodological framework	
	The EPD shall specify the following: — functional unit or declared unit depending on type of EPD; — the type of EPD with respect to life cycle stages covered as given in 5.2.2; — life cycle stages covered and not covered; — for declarations representing an average of similar products from the same or different manufacturer, a description of what the average represents as stated in 5.3; — the reference conditions for achieving the declared technical and functional performance and the RSL, where relevant as described in 7.1.4; — allocation procedure; — cut-off procedure; — declaration of technical information and scenarios.	**Requirement met.**
	9.4.1 Declaration of technical and information and scenarios	
	The information modules A1 to A3 are mandatory for the three types of EPDs (see 5.2.2). All other information modules are optional. If any of the information modules beyond the factory gate are included, technical information describing the declared information modules shall be provided in the EPD (see 7.1.7.3 to 7.1.7.5). If additional technical information is provided in the EPD for any information modules beyond the factory gate, the information to specify the product's scenarios or to support development of the scenarios describing the product's installation or use at the level of the construction works assessment shall be provided as described in 7.1.7.3 to 7.1.7.5. Any scenarios for module D shall be reported in the EPD as described in 7.1.7.6.	**Requirement met.**
	9.4.2 All stages - transport	
	The following information *should,* when relevant and depending on type of EPD (see 5.2.2), be provided to specify any transport after the gate: — type of transport; — type of vehicle; — distance;	**Requirement met.**

	— type and amount of energy carrier.	
	9.4.3 Construction stage – A5, installation	
	The following information should, when relevant and depending on type of EPD (see 5.2.2), be provided to specify the installation process A5: — description of the installation process or reference to where a description can be found; — ancillary materials for installation specified by type and amount; — product loss per functional unit or declared unit; — quantitative description of energy use during installation, energy carrier type, for example electricity, and amount, if applicable and relevant; — quantitative description of water type and use during installation, for example source, amount used and fate (amount evaporated, amount disposed to sewer, etc.); — direct emissions to ambient air, soil and water; — output from the installation process including any waste treatment included in the scenario within the system boundary specified by recovery process.	**Requirement met.**
	9.4.4 Use stage – B1 to B5	
	The following information should, when relevant and depending on type of EPD (see 5.2.2), be provided to specify the scenarios for information modules B1 to B5 or to support the development of scenarios for the modules at the construction works level: — direct emissions to ambient air, soil and water; — description of the maintenance, repair, replacement or refurbishment process or reference to where a description can be found; — number of maintenance, repair, replacement or refurbishment cycles per reference service life or required service life for the construction works; — ancillary materials specified by type (e.g. cleaning agent, specify materials) and amount; — quantitative description of energy type and use during maintenance, repair, replacement or refurbishment, energy carrier type, for example electricity, and amount, if applicable and relevant; — quantitative description of water type and use during maintenance, repair, replacement or refurbishment, for example source, amount used and fate (amount evaporated, amount disposed to sewer, etc.); — output from the maintenance, repair, replacement or refurbishment process including any waste treatment included in the scenario within the system boundary specified by recovery process.	**N/A**
	9.4.5 Use stage – B6 to B7	
	The following information should, when relevant and depending on type of EPD (see 5.2.2), be provided to specify the scenarios for information modules B6 to B7: — type and amount of energy carrier used (e.g. electricity, natural gas, district heating); — power output of equipment; — characteristic performance (e.g. energy efficiency, emissions, variation of performance with capacity utilisation); — further assumptions for scenario development (e.g. frequency and time period of use, number of occupants); — quantitative description of water type and use, for example source, amount used and fate (amount evaporated, amount disposed to sewer, etc.).	**N/A**
	9.4.6 End-of-Life stage – C1 to C4	
	The following information should, when relevant and depending on type of EPD (see 5.2.2), be provided to specify the scenarios for information modules C1 to C4: — assumptions for scenario development, for example description of method of deconstruction, recycling, energy recovery and final disposal; — collection, recycling and/or recovery rates and conversion efficiencies, as applicable.	**Requirement met.**
	9.4.7 Module D	
	When any optional supplementary information regarding potential loads or benefits beyond the system boundary is provided under module D, the following information should be provided to specify the scenarios: — assumptions for scenario development, for example further processing technologies and selected substitution processes; — process and conversion efficiencies, as applicable, and assumptions on correction factors, as applicable.	**N/A**
	9.5 Declaration of environmental indicators derived from LCA	

	9.5.1 LCA results from LCIA	
	Environmental impacts and resource use are expressed with the impact category parameters of LCIA using characterization factors. The following predetermined core indicators are required and shall, as a minimum, be specified for all information modules included in the EPD: — global warming potential (GWP); — depletion potential of the stratospheric ozone layer (ODP); — eutrophication potential (EP); — acidification potential of soil and water sources (AP); — formation potential of tropospheric ozone (POCP). Optional LCIA indicators may be included in the EPD. Examples are: — abiotic depletion potential for non-fossil mineral resources (ADPelements); — land-use-related impacts, for example on biodiversity and/or soil fertility; — toxicological aspects. Scientifically developed characterization methods should be used for these additional indicators and referenced in the EPD. NOTE Table E.1 provides one example of how declaration of both mandatory and optional LCIA results can be formatted and presented.	**Requirement met.**
	9.5.2 LCA results from LCI	
	The following parameters derived from LCI shall, as a minimum, be included and specified for all information modules: — use of primary resources (several indicators); — use of secondary resources (several indicators); — abiotic depletion potential for fossil resources (ADPfossil); — consumption of freshwater resources; — waste and output flows (several indicators). Use of primary and secondary resources and recovered energy shall be provided for the impact category indicators listed in 7.2.11. The inventory indicators describing primary and secondary resource use and recovered energy shall not be combined, aggregated or amalgamated with one another. NOTE 1 Table E.2 and Table E.3 provide examples of how data on use of primary and secondary resources can be formatted and presented. The following indicators shall be included for transparency and specified for all information modules, where the respective flows occur: — removals and emissions associated with biogenic carbon content of the bio-based product; — emissions from calcination and removals from carbonation; — removals and emissions associated with biogenic carbon content of the bio-based packaging; — emissions from combustion of waste from renewable sources used in production processes; — emissions from combustion of waste from non-renewable sources used in production processes. NOTE 2 Table E.4 provides an example of how data on ADPfossil, consumption of freshwater, and emissions and removals of CO2 can be formatted and presented. Waste should be declared in the format provided in Table E.5. The output flows that have crossed the system boundary between product systems shall be declared as stated in Table 4 and specified for all information modules.	**Requirement met.**
	9.6 Declaration of additional environmental information	
	In markets where the emission of dangerous substances is regulated, this information is a mandatory part of additional environmental information. Regulated substances of very high concern shall be declared, if relevant. Reporting of substances of very high concern shall include — a description of the regulated substance, — the chemical abstracts service (CAS) number, and — a reference to standard(s) or regulation(s) applicable for the relevant market. NOTE Table D.1 provides one example of how data on regulated substances of very high concern can be formatted and presented.	**Requirement met.**

	If no such substances are identified, this should be stated in the EPD. The declaration of emission of dangerous substances, if relevant, is mandatory if this is regulated in markets for which the EPD is valid. Optional environmental information not derived from LCA are to be reported here together with a short interpretation and statement of possible limitations of the results (see 8.3). — Organization’s adherence to any environmental management system, with a statement on where an interested party can find details of the system, if relevant. — Instructions and limits for correct use, if relevant.	
	9.6.1 References	
	A list of references used shall be provided.	**Requirement met.**

Conformance to the UL Environment Part A v4.0 PCR

7.1 Declaration OF GENERAL INFORMATION

	Requirement	Comment
	The following verification information shall be declared and presented in the EPD, according to ISO 21930 Section 9.2: **ISO 21930:2017 – serves as the core PCR and UL Part A:** ▸ **Sub-category Part B PCR, if relevant** ▸ **PCR review was conducted by:** ▸ **Sub-category Part B PCR review was conducted by:** ▸ **Name and organization of the panel chair, and their contact information** **Independent verification of the declaration and data, according to ISO 21930:2017, UL Part A, and ISO 14025:2006** **☐ internal ☐ external** **Third party verifier:** ▸ **Name of third party verifier**	**Requirement met.**
	The following general information shall be declared: ☐ Name and address of the EPD holder(s) (manufacturer, association, service provider, etc. ☐ Declaration number ☐ Name of EPD program and program operator name, address, logo and website ☐ Reference to General Program Instructions and version number ☐ Reference to ISO 21930:2017, Part A PCR and sub-category (Part B) PCR, along with version numbers, publisher, and year published ☐ Declaration date of issue and period of validity ☐ Market(s) of applicability ☐ EPD scope: cradle to gate, cradle to gate with options (specify options), or cradle to grave ☐ The site(s), manufacturer or group of manufacturers or those representing them for whom the results of the LCA are representative ☐ Designation as Industry Average or Manufacturer Specific EPD ☐ Description of the product’s intended application and use (as identified when deter-mining the product RSL), where relevant ☐ The functional or declared unit ☐ Description of the product RSL, if applicable ☐ Product identification by name (including production code) and a simple visual representation of the product to which the EPD is developed ☐ A description of the main product components or material that make up the construction product or work, given in percentage ☐ A diagram of the life cycle stages included in the LCA reported according to A, B, C, and D modules per ISO 21930 and EN 15804:	**Requirement met.**

	o Product and Installation (Modules A1-A5) o Use (Modules B1-B7) o End of life (Modules C1-C4) For cradle-to-gate EPDs, additional required production information Range of dataset variability (industry-wide EPDs only; mean, median, and standard deviation) Year(s) of reported manufacturer primary data LCA software used and version number LCI database(s) used and version number LCIA methodology and version number PCR, LCA, and EPD verification information Any other environmental certification program applied to the product and a statement on where an interested party can find details of the certification program, if relevant; Other environmental activities of the organization, such as participation in recycling or recovery programs, provided that the details of these programs are readily available to the purchaser or user and contact information is provided, if relevant; Information on where explanatory material may be obtained The following statements or equivalent statements: Environmental declarations from different programs (ISO 14025) may not be comparable. o "Comparison of the environmental performance of [Product category] using EPD information shall be based on the product's use and impacts at the construction works level, and therefore EPDs may not be used for comparability purposes when not considering the construction works energy use phase as instructed under this PCR". o "Full conformance with the PCR for [Product category] allows EPD comparability only when all stages of a life cycle have been considered, when they comply with all referenced standards, use the same sub-category Part B PCR, and use equivalent scenarios with respect to construction works. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for up-stream or downstream of the life cycle stages declared. Any comparability limitations.	

7.2 Declaration OF METHODOLOGICAL FRAMEWORK

	Requirement	Comment
	Per ISO 21930 Section 9.3, the EPD shall specify the following: Functional unit or declared unit depending on type of EPD; Type of EPD with respect to life cycle stages covered as given in Section 2.8.1; Life cycle stages covered and not covered; For declarations representing an average of similar products from the same or different manufacturer, a description of what the average represents as stated in Section 2.5; Reference conditions for achieving the declared technical and functional performance and the RSL, where relevant as described in Section 2.8.2; Allocation procedure; Cut-off procedure; o Include the statement "No known flows are deliberately excluded from this EPD" Declaration of technical information and scenarios If applicable, include the statement that third party verified ISO 14040/44 secondary LCI data sets contribute more than 67% of total impact (either at the unit process lev-el or in aggregate) to any of the required impact categories identified by the applicable PCR.	**Requirement met.**

7.3 Declaration OF TECHNICAL INFORMATION AND SCENARIOS

	Requirement	Comment
	All information per ISO 21930 Section 9.4 shall be provided in the EPD and is included in the sub-category Part B PCR.	**As covered above.**

7.4 DECLARATION OF ENVIRONMENTAL PARAMETERS DERIVED FROM LCA

	Requirement	Comment
	Environmental parameters shall be declared per ISO 21930 Section 9.5. LCA results from LCIA: o Required environmental impact indicators and Impact Assessment (IA) methodology from Sections 4.7, 4.8, and/or 4.9 o Optional environmental impact indicators and IA methodology from Section 4.10 LCA results from LCI: o Required resource parameters Section 4.1 o Required waste parameters from Section 4.1.2 o Required carbon emissions from Section 4.6	**Requirement met.**

7.5 DECLARATION OF ADDITIONAL ENVIRONMENTAL INFORMATION

	Requirement	Comment
	A description of the regulated substance, The chemical abstracts service (CAS) number, and A reference to standard(s) or regulation(s) applicable for the relevant market. Optional environmental information not derived from LCA is to be reported here together with a short interpretation and statement of possible limitations of the results (see Section 4.10). Organization's adherence to any environmental management system, with a statement on where an interested party can find details of the system, if relevant. Instructions and limits for correct use, if relevant.	**Requirement met.**

7.6 REFERECES

	Requirement	Comment
	A list of references used shall be provided.	**Requirement met.**

8. Further EPD Requirements

	Requirement	Comment
	8.1 EPD OWNERSHIP, LIABILITY AND RESPONSIBILITY Per ISO 21930 Section 5.4 and EN 15804 Section 5.5, a manufacturer or a group of manufacturers are the sole owners and have liability and responsibility for an EPD, including but not limited to insuring industry wide and manufacturer specific EPD updates are made based on the most recent LCA modelling software version and impact assessment version available. Only the manufacturer or group of manufacturers is authorized to declare the environmental performance of the construction product using an EPD.	**Requirement met.**
	8.2 CONTENT OF EPD Critical, comparative, or promotional texts are not permitted unless specifically required by this PCR or if necessary, in the context of the EPD.	**Requirement met.**
	8.3 VERIFICATION An EPD created using this PCR shall be verified by a qualified independent third party acting in accordance with ISO 14025. The project report shall be made available for the verification process as required in Section 2.	**Requirement met.**

	8.4 VALIDITY An industry-average or manufacturer-specific EPD created using this PCR is valid for a five (5) year period from the date of issue, unless specified otherwise in a sub-category Part B PCR. EPDs shall only be updated at the end of the validity period if changes occur to technology affecting the product system or per other issues identified in the sub-category Part B PCR. If the underlying LCA data have not changed significantly (as a general rule, +/- 10% for any given impact category), a data refresh will not necessarily be required.	**Requirement met.**
	8.5 COMPARABILITY EPDs shall not contain statements of the superiority of one product over a competitive product that performs the same functions, or of one manufacturer against another. EPDs shall not contain directly or indirectly such comparative assertions. For more information on comparability between non-competitive products, refer to Section 9. The following ISO statements indicate the EPD comparability limitations and intent to avoid any market distortions or misinterpretation of EPDs based on this PCR. ISO 14025 requires this statement be included: **"Environmental declarations from different programs based upon differing PCRs may not be comparable".** A statement shall be included that indicates, **"comparison of the environmental performance of construction works and construction products 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."** This statement shall be included: **"When comparing EPDs created using this PCR, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to different results for upstream or downstream of the life cycle stages declared."** The EPD owner shall transparently indicate any comparability limitations.	**Please provide required construction works statement required by Part A PCR v4. Added on page 8 under section 2.3** **Requirement met.**

ULE Part B: Building Envelope Thermal Insulation EPD Requirements UL 10010-1 v.3.0

<table>
<tr><th></th><th>Item</th><th>Comment</th></tr>
<tr><td></td><td>
The following general information shall be declared.
<table>
<tr><td>EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE</td><td colspan="2">Program Operator Provided</td></tr>
<tr><td>GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER</td><td colspan="2">Program Operator Provided</td></tr>
<tr><td>MANUFACTURER NAME AND ADDRESS</td><td colspan="2"></td></tr>
<tr><td>DECLARATION NUMBER</td><td colspan="2">Program Operator Provided</td></tr>
<tr><td>DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT</td><td colspan="2"></td></tr>
<tr><td>REFERENCE PCR AND VERSION NUMBER</td><td colspan="2"></td></tr>
<tr><td>DESCRIPTION OF PRODUCT'S INTENDED APPLICATION AND USE (AS IDENTIFIED WHEN DETERMINING PRODUCT RSL)</td><td colspan="2"></td></tr>
<tr><td>PRODUCT RSL DESCRIPTION (IF APPL.)</td><td colspan="2"></td></tr>
<tr><td>MARKETS OF APPLICABILITY</td><td colspan="2"></td></tr>
<tr><td>DATE OF ISSUE</td><td colspan="2">Program Operator Provided</td></tr>
<tr><td>PERIOD OF VALIDITY</td><td colspan="2">Program Operator Provided</td></tr>
<tr><td>EPD TYPE</td><td colspan="2">[Industry-average or product-specific]</td></tr>
<tr><td>RANGE OF DATASET VARIABILITY</td><td colspan="2">[Industry-average only; mean, median, standard deviation]</td></tr>
<tr><td>EPD SCOPE</td><td colspan="2">[Cradle to gate with options (specify options), or cradle to grave]</td></tr>
<tr><td>YEAR(S) OF REPORTED MANUFACTURER PRIMARY DATA</td><td colspan="2"></td></tr>
<tr><td>LCA SOFTWARE & VERSION NUMBER</td><td colspan="2"></td></tr>
<tr><td>LCI DATABASE(S) & VERSION NUMBER</td><td colspan="2"></td></tr>
<tr><td>LCIA METHODOLOGY & VERSION NUMBER</td><td colspan="2"></td></tr>
<tr><td colspan="2">The sub-category PCR review was conducted by:</td><td>Program Operator Provided
Program Operator Provided
Program Operator Provided</td></tr>
<tr><td colspan="2">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," v3.1 (February 2018), based on CEN Norm EN 15804 (2012) and ISO 21930:2017, serves as the core PCR, with additional considerations from the USGBC/UL Environment Part A Enhancement (2017)
☐INTERNAL ☐ EXTERNAL</td><td>Program Operator Provided</td></tr>
<tr><td colspan="2">This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:</td><td>Program Operator Provided</td></tr>
<tr><td colspan="2">This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:</td><td>Program Operator Provided</td></tr>
<tr><td colspan="3">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 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.</td></tr>
</table>
</td><td>Requirement met.</td></tr>
<tr><td></td><td>2.1. Description of Company / Organization
The name of the manufacturing entity(ies) as well as the place(s) of production shall be provided. General information about the manufacturing entity(ies) may be provided, such as the existence of quality systems or environmental management systems, according to ISO 14001 or any other environmental management system in place.</td><td>Requirement met.</td></tr>
<tr><td></td><td>2.2 Product description
A narrative description of the product shall be provided that enables clear identification of the product. This description will include:
2.3 Product Identification
The declared products shall be identified by brand name(s), by material type(s), by production code(s) (if applicable), and by simple visual representation, which may be by photograph or graphic illustration.
2.4 Product Specification
Related products grouped and reported as an average product in the same EPD satisfying the variation criteria of Part A, Section 5 shall constitute an individual declared product. For each declared product, list the physical characteristics required in Section 3.1 formulas – in the form that the product would be installed or sprayed and cured – along with the reference to the test standard for each. When pertinent, provide a description of the insulation facer. Mass, and therefore density, shall be based on the total amount of material needed to produce 1 m2 of the given product, i.e. prior to yield losses, including any facing and ancillary materials. Other relevant product specification values may be provided here, e.g. acoustic performance.

The appropriate ASTM or ANSI product specification shall be provided, including additional pertinent physical properties and technical information.

2.5 Flow Diagram</td><td>Requirement met.</td></tr>
</table>

	A graphical depiction of a flow diagram illustrating main production processes according to the scope of the declaration shall be included such as the examples in Figure 1 and Figure 2. **2.6. Product Average** **2.7 Industry-Average EPD (if relevant)** The method for creating an industry-average EPD shall be described per Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Section 2.5.1. **2.8 Product Specific EPD** The method for creating a company specific individual product/product group EPD shall be described, including the method for determining a weighted average across products based on production volume as described in Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Section 2.5.2.	
	2.9 Application The designated applications for the referenced product(s) shall be specified. The applications of the declared product(s) shall be described (e.g. above-deck roof insulation, attic insulation, cavity wall insulation, and interior or exterior continuous insulation).	**Requirement met.**
	2.10 Declaration of Methodological Framework The following items shall be specified: the type of EPD with respect to life cycle stages, and the life cycle stages covered and not covered (i.e. cradle-to-gate with modules A1-A5 and C1-C4 included). The reference conditions for achieving the declared technical and functional performance and the Reference Service Life (RSL) shall be included, per Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Section 2.8.2. The allocation procedures and cut-off procedure shall be described. Include the statement “no known flows are deliberately excluded from this EPD.”	**Requirement met.**
	2.11 Technical Requirements A listing of all standards required for the specification of the declared product shall be provided. A listing of all standards required for the testing, evaluation, and approval of the declared product and its application in building assemblies for building code and other regulation compliance shall also be provided and quoted as shown in Section 8. Note: There is a separate sub-category PCR for mechanical insulation that shall be used when creating EPDs for piping, HVAC and other mechanical and technical insulation products.	**Requirement met.**
	2.12 Properties of Declared Product As Delivered The dimensions/quantities of the declared product(s) as delivered to the site of installation/application shall be indicated.	**Requirement met.**
	2.13 Material Composition The material composition of insulation products shall be disclosed and will include components as percentages or ranges of percentages of total mass as required by product Safety Data Sheet (SDS) rules, if relevant. Statements of material non-inclusion, such as “… is free of …” shall not be used. Regulated Hazardous substances and dangerous substances shall be reported per Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Section 4.11.	**Requirement met.**
	2.14 Manufacturing The manufacturing process and locations shall be described and illustrated using a simple flow-chart. If the EPD applies to several locations, the production processes for all locations shall be described and reference to quality management systems may be included.	**Requirement met.**
	2.15 Packaging Information on product-specific packaging: type, composition and possible reuse of packaging materials (paper, strapping, pallets, foils, drums, etc.) shall be included in this Section. The EPD shall describe specific packaging	**Requirement met.**

	scenario assumptions, including disposition pathways for each packaging material by reuse, recycling, or landfill disposal based on packaging type. In the absence of specific primary data, the data assumptions from Part A, Section 2.8.5, Table 2 shall be used. In the case of reusable packaging designed to last for multiple reuse cycles, one reuse shall be assumed in the absence of primary manufacturer data. At the end of its reuse cycle, reusable packaging shall be assumed to go to landfill. For non-reusable packaging, all plastic (e.g. film, scrap foam) and corrugated packaging at end-of-life is assumed to be disposed of in an appropriate landfill.	
	2.16 Transportation The following information should be provided to specify any transport after the manufacturing gate: type of transport, type of vehicle, distance, type and amount of energy carrier. Additional transportation elements are reported in Table 3.	**Requirement met.**
	2.17 Product Installation A description of the type of processing, machinery, tools, dust extraction equipment, ancillary materials, etc. to be used during installation and measures for reducing noise shall be included. Information on industrial and environmental protection may be included in this section. Any waste treatment included within the system boundary of installation waste should be specified.	**Requirement met.**
	2.18 Use Any relevant information may be provided in this section regarding specific product use conditions and/or limitations relevant to product use, including a description of any maintenance, repair, replacement or refurbishment processes and/or a reference to where a description can be found. Refer to Section 7.2 for optional reporting of energy savings during use. All quantitative information related to this section shall be reported in Section 4 "Scenarios and additional technical information".	**Requirement met.**
	2.13 Reference Service Life and Estimated Building Service Life The reference service life and building estimated service life shall be indicated according to Section 2.8.2 of Part A: Life Cycle Assessment Calculation Rules and Report Requirements. The assumptions upon which the designated RSL is based and for which the RSL exclusively applies shall be provided in the Section 4, Table 5. Influences on ageing, when applied, shall be in accordance with the state of the art.	**In section 1.13 to satisfy also reporting the building Estimated Service Life, add "/ESL" to "RSL" in the last row of the table, as in "RSL/ESL". In this case the RSL is equal to the ESL of 75 years.** **Done** **Requirement met.**
	2.19 Re-Use Phase The possibilities of re-use, recycling and energy recovery shall be described.	**Requirement met**
	2.21 Disposal The possible disposal channels shall be indicated in accordance with disposal routes and waste classification referenced in Section 2.8.5 and 2.8.6 of Part A: Life Cycle Assessment Calculation Rules and Report Requirements.	**Requirement met.**

ASTM GPI Elements to Confirm

	Item	Comment/Response
	EPDs shall include the format and parameters of the PCR, and each will have the following: organizational (manufacturer) information; product description, identification, name (including product code), and functional or declared unit; identification of PCR and program operator; identification of independent third-party verifier; publication date and period of validity; applicable product standards and countries data from life cycle assessment as per ISO 14025 modified by 21930 Section 8.1g; additional environmental information; content declaration regarding potential toxicity; information on which stages are not considered; statement that environmental declarations from different programs (i.e., PCR) may not be comparable;	**Requirement met.**

	statement that the declaration represents an average performance, where an EPD declares an average performance for a number of similar products or plants; information on the deviation of the products' performance with respect to the average shall be stated; site(s), manufacturer or group of manufacturers, or those representing them, for whom the results of the LCA are representative; information on where explanatory material may be obtained. Any additional relevant information related to environmental issues may also be included. A list of all verified EPDs shall be available.	
	Procedure for Verification of EPDs While it is not mandatory in ISO 14025 for B-to-B EPDs, ASTM will retain independent external verifiers for all EPDs. The verifier should be competent in relevant standards in the fields of environmental labeling and declarations, the regulatory framework within which requirements for Type III environmental declarations have been prepared, and the Type III environmental declarations program. The verification shall determine whether the EPD is in conformance with: ISO 14020, the relevant requirements of ISO 14025 and the requirements of ISO 21930 for building products; general program instructions, and current and relevant PCR	**Requirement met per this verification.** **Note: PCR requirements cover ISO 14025 and ISO 21930 requirements.**

Editorial Comments – CLOSED CELL USING HYDROFLUOROCARBONS (CCSPF, HFC)

Page	Item	
All	Header – remove EN 15804 as it may be construed as conformance to the latest version of EN 15805:A2/AC.	Done **Requirement met.**
11	Sec. 2.1 Small item – change units from "h" for hour to "hr" to be consistent with PCR.	Done **Requirement met.**
21	Update version of UL Part A PCR reference from v3.1 to v4.0	Done **Requirement met.**
21	Add version 3.0 to UL Part B PCR reference.	Done **Requirement met.**

Editorial Comments – ROOFING CELL USING HYDROFLUOROCARBONS (ROOFING SPF, HFC)

Page	Item	
All	Header – remove EN 15804 as it may be construed as conformance to the latest version of EN 15805:A2/AC.	Done **Requirement met.**
11	Sec. 2.1 Small item – change units from "h" for hour to "hr" to be consistent with PCR.	Done **Requirement met.**
21	Update version of UL Part A PCR reference from v3.1 to v4.0	Done **Requirement met.**
21	Add version 3.0 to UL Part B PCR reference.	Done **Requirement met.**

Editorial Comments – CLOSED CELL USING HYDROFLUOROOLEFINS (CCSPF, HFO)

Page	Item	
All	Header – remove EN 15804 as it may be construed as conformance to the latest version of EN 15805:A2/AC.	Done **Requirement met.**
12	Sec. 2.1 Small item – change units from "h" for hour to "hr" to be consistent with PCR.	Done **Requirement met.**
21	Update version of UL Part A PCR reference from v3.1 to v4.0	Done **Requirement met.**

21	Add version 3.0 to UL Part B PCR reference.	Done **Requirement met.**

Editorial Comments – ROOFING CELL USING HYDROFLUOROOLEFINS (ROOFING SPF, HFO)

Page	Item	
All	Header – remove EN 15804 as it may be construed as conformance to the latest version of EN 15805:A2/AC.	Done **Requirement met.**
12	Sec. 2.1 Small item – change units from “h” for hour to “hr” to be consistent with PCR.	Done **Requirement met.**
21	Update version of UL Part A PCR reference from v3.1 to v4.0	Done **Requirement met.**
21	Add version 3.0 to UL Part B PCR reference.	Done **Requirement met.**

Editorial Comments – OPEN CELL (OCSPF)

Page	Item	
All	Header – remove EN 15804 as it may be construed as conformance to the latest version of EN 15805:A2/AC.	Done **Requirement met.**
11	Sec. 1.13 – for the Open Cell SPF product, provide background regarding water as the blowing agent and the results of no impact reported in module B1.	Done Added comment in sec 1.12 instead (Use phase). Section 1.13 is RSL/ESL section. **Requirement met.**
11	Sec. 2.1 Small item – change units from “h” for hour to “hr” to be consistent with PCR.	Done **Requirement met.**
21	Update version of UL Part A PCR reference from v3.1 to v4.0	Done **Requirement met.**
21	Add version 3.0 to UL Part B PCR reference.	Done **Requirement met.**

The verifier confirms that the following EPDs for the SPFA authored by Sphera Solutions:

- SPRAY POLYURETHANE FOAM INSULATION
- CLOSED CELL USING HYDROFLUOROCARBONS (CCSPF, HFC)
- ROOFING CELL USING HYDROFLUOROCARBONS (ROOFING SPF, HFC)
- CLOSED CELL USING HYDROFLUOROOLEFINS (CCSPF, HFO)
- ROOFING CELL USING HYDROFLUOROOLEFINS (ROOFING SPF, HFO)
- OPEN CELL (OCSPF)

Conform to:

The PCRs:

- PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, March 2022
- Part B: Building Envelope Thermal Insulation EPD Requirements, UL Environment 10010-1, v.3.0, 4/1/23, and,
- ISO 21930:2017
-

The applicable ISO standards: ISO 14020, ISO 14025, ISO 14040, ISO 14044, ISO/TS 14071

The ASTM International GPIs, v8.0, April 2020

Digitally signed by Thomas Gloria
Date: 2024.11.27 18:07:38 -05'00'

Thomas Gloria, Ph.D., Industrial Ecology Consultants

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03 Digitally signed by Thomas Gloria Date: 2024.11.27 17:59:57 -05'00'

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			Are the methods used to carry out the study consistent with the ISO 14040/14044 standards and with the applicable PCR?			
TE1			**PCR Specific Part A (§2):** ***LCA PROJECT REPORT CONTENT, STRUCTURE, AND ACCESSIBILITY*** *The project report must document any data and information of importance to the results published in the EPD and as required by this document.*	Requirement met.		Closed
TE2			**PCR Specific Part A (§1): Background** *This document is a core PCR standard for construction works-related products and services and is meant to be used with product- and service-specific, sub-category Part B PCR documents by any Program Operator. Part B PCR documents that reference this Part A may be developed by any Environmental Product Declaration (EPD) Program Operator.* *This document specifies the calculation rules and reporting requirements for the underlying Life Cycle Assessment (LCA) reports used to inform EPDs in accordance with ISO 21930 or EN 15804 if conformance with the latter standard is sought. An LCA project report must be submitted for each EPD registered.* ***Due to inherent standard compatibility issues, this PCR shall be used with either ISO 21930:2017 or EN 15804:2012+A2:2019; conformance is only possible with one standard.*** *For example, if conformance with EN 15804:2012+A2:2019 is sought, conformance with ISO 21930: 2017 is forfeited. See Annex A for additional requirements for EPD conformance with EN 15804+A2.* *This document cites the ISO 21930:2017 standard in many sections and EN 15804:2012+A2:2019 standard in Annex A. Certain clauses of these standards' text have been omitted for reasons of readability, however not with the intention to compromise the conformity of this document with ISO 21930 and EN 15804. Those clauses are marked as [...].* *Whenever 'justification' is required in this text, it is intended to be included in the LCA report unless otherwise stated.* *The core governing standards for this Part A are ISO 14040, 14044, 14025, 21930, or EN 15804. This PCR may not be used to produce an EPD without the use of a Part B, or subcategory PCR..*	Requirement met. Verification is to ISO 21930 only.		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
TE2			**PCR Specific Part A (§2): *LCA PROJECT REPORT CONTENT, STRUCTURE, AND ACCESSIBILITY*** *The LCA project report represents the systematic and comprehensive summary of project documentation that supports the verification of an EPD. The project report must document any data and information of importance to the results published in the EPD and as required by this document. An LCA project report for an EPD must follow the calculation rules and reporting requirements for the underlying LCA reports as specified in this Part A.* *The project report must support that the LCA-based information and the additional information as declared in the EPD meet the requirements of this set of rules. Particular care shall be given to provide comprehensive explanations regarding how the information declared in the EPD arises from the LCA and how – if declared – the reference service life (RSL) was established.* *The structure of the project report shall follow the structure of this standard based on ISO 21930 or EN 15804 if conformance with the latter standard is sought. See ISO 21930 Section 10 for detailed requirements of the project report.* *The project report must be accessible to the verifier under the conditions of confidentiality (see ISO 14025, 8.1.4 and 8.3 and ISO 21930, 10.1 and 10.3).* ***ISO 14025 8.1.4 Independent verification of the Type III environmental declaration*** *The independent verification procedure shall as a minimum be appropriate to determine whether the Type III environmental declaration is in conformance with* *– ISO 14020 and the relevant requirements of this International Standard,* *– general programme instructions (see 6.4), and* *– current and relevant PCR.* *The verification procedure shall be transparent. The independent verifier shall generate a report documenting the verification process, while adhering to the obligations of 8.3 covering rules for data confidentiality. This report shall be available to any person upon request.* *The verification procedure shall confirm whether the information given in the Type III environmental declaration accurately reflects the information*	Requirement met.		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			in the documents on which the declaration is based. The verification procedure shall also confirm whether this information is valid and scientifically sound. *The PCR review and the independent verification of the Type III environmental declaration are two separate processes. The independent verification of the Type III environmental declaration may be carried out by the PCR review panel, or may be carried out by an independent verifier who may or may not have been a member of the PCR review panel.* ***ISO 14025 8.3 Rules for data confidentiality*** *Product-specific data are often confidential because of* *– competitive business requirements,* *– proprietary information covered by intellectual property rights, or* *– similar legal restrictions.* *Such confidential data are not required to be made public. The declaration typically only provides data aggregated over all or relevant stages of the life cycle. Business data identified as confidential that is provided for the independent verification process shall be kept confidential, in accordance with general programme instructions (see 6.4).* *If the programme operator determines, based on the verification report, that the data supporting the Type III environmental declaration are inadequate, the declaration shall not be published.* ***Section 10.1 General of ISO 21930:*** *The manufacturer and/or programme operator shall provide the EPD project documentation and the EPD to the verifier. The project documentation contains basic data and supporting information necessary for the EPD project as specified in Clause 7.* *The project report is the systematic and comprehensive summary of the project documentation supporting the verification of an EPD. The project report shall record that the LCA-based information and the additional information as declared in the EPD meet the requirements of this document. The project report shall be made available to the verifier with the requirements on confidentiality stated in ISO 14025.* *The project report is not part of the public communication.*			

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			The project report shall contain any data and information of importance to the results published in the EPD and as required by this document. The report shall demonstrate in a transparent way that the data and information declared in the EPD result from the LCA study and how the RSL has been established. *NOTE In this context, project means the LCA study on the primary product.* ***Section 10.3 Rules for data confidentiality of ISO 21930:*** *Product-specific data are very often confidential because of* *— competitive business issues,* *— intellectual property rights, or* *— similar legal restrictions.* *It is not a requirement to make such confidential data publicly available. Confidential business data provided for the independent verification process shall be kept confidential upon request of the body supplying the data and with the approval of the programme operator, in accordance with programme operational rules; see ISO 14025:2006, 8.3* *In conformance with ISO 21930, Section 10.2, the results, data, methods, assumptions, limitations and conclusions of the project report shall be completely and accurately reported without bias. All elements of the project report shall be reported in a transparent manner with enough detail to allow independent verification and permit an understanding of the complexities and trade-offs inherent in the LCA. The report should also allow the results and interpretation to be used in support of the data and additional information made available in the respective EPD.* *The project report is not part of the public communication.* ***Section 10.2 of ISO 21930:*** *The project report shall state the following:* *a) General aspects:* *— commissioner of the LCA study, internal or external practitioner of the LCA study;* *— date of report;* *— statement that the study has been conducted according to the requirements of this document.* *b) Goal of the study:*			

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			— reasons for carrying out the study and its intended application and audience, i.e. providing information and data for an EPD for B2B and/or B2C communication. *c) Scope of the study:* *— declared/functional unit, including:* *— definition, including relevant technical specification(s);* *— calculation rule for averaging data, for example when the declared/functional unit is defined for:* *— a group of similar products produced by different suppliers, or* *— the same product produced at different production sites.* *— system boundary according to the modular approach as outlined in Figure 2 including:* *— omissions of life cycle stages, processes or data needs;* *— quantification of energy and material inputs and outputs, taking into account how plant-level data are allocated to the declared products;* *— assumptions about electricity production and other relevant background data.* *— cut-off criteria for initial inclusion of inputs and outputs, including:* *— description of the application of cut-off criteria and assumptions;* *— list of excluded processes.* *d) LCI:* *— qualitative/quantitative description of unit processes necessary to model the life cycle stages of the declared unit, taking into account the provisions of ISO 14025 regarding data confidentiality,* *— sources of generic or proxy data or literature used to conduct the LCA;* *— validation of data and discussion considering the dimensions of data quality set out in ISO 14044:2006, 4.2.3.6 including:* *— data quality assessment,* *— treatment of missing data;* *— allocation principles and procedures including:* *— documentation and justification of allocation procedures,* *— uniform application of allocation procedures.* *e) LCIA:* *— the LCIA procedures, calculations and results of the study;* *— the relationship of the LCIA results to the LCI results;* *— reference to all characterization models, characterization factors and methods used, as defined in this document;*			

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			— a statement that the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceedance of thresholds, safety margins or risks. *f) Life cycle interpretation:* *— the results;* *— assumptions and limitations associated with the interpretation of results as declared in the EPD, both methodology and data related;* *— data quality assessment;* *— full transparency in terms of value-choices, rationales and expert judgements.*			
TE3			**ISO Requirement (§4.1):** *General Requirements - LCA studies shall include the goal and scope definition, inventory analysis, impact assessment and interpretation of results.*	Requirement met.		Closed
TE4			**ISO Requirement (§4.1):** *General Requirements - LCI studies shall include definition of the goal and scope, inventory analysis and interpretation of results. The requirements and recommendations of this International Standard, with the exception of those provisions regarding impact assessment, also apply to life cycle inventory studies.*	N/A		Closed
TE5			**ISO Requirement (§4.1):** *General Requirements - An LCI study alone shall not be used for comparisons intended to be used in comparative assertions intended to be disclosed to the public.*	N/A		Closed
TE6			**ISO Reporting Requirements (§5.1) and (§5.1.1):** *General Requirements and Considerations - The type and format of the report shall be defined in the scope phase of the study.* *The results and conclusions of the LCA shall be completely and accurately reported without bias to the intended audience. The results, data, methods, assumptions and limitations shall be transparent and presented in sufficient detail to allow the reader to comprehend the complexities and trade-offs inherent in the LCA. The report shall also allow the results and interpretation to be used in a manner consistent with the goals of the study.*	Requirement met.		Closed
TE7			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance* *When results of the LCA are to be communicated to any third party (i.e. interested party other than the commissioner or the practitioner of the study), regardless of the form of communication, a third-party report shall be prepared.* *The third-party report can be based on study documentation that contains confidential information that may not be included in the third-party report.*	Requirement met.		Closed

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
TE8			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance* *The third-party report constitutes a reference document, and shall be made available to any third party to whom the communication is made.*	Requirement met.		Closed
TE9			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance* *The third-party report shall cover the following aspects:* ***a) General aspects:*** *1) LCA commissioner, practitioner of LCA (internal or external);* *2) date of report;* *3) statement that the study has been conducted according to the requirements of this International Standard (ISO 14044).*	Date is to be provided.	Done **Acknowledged.**	Closed
TE10			**PCR Specific Part A (§2.1):** *General Information* *The project report must contain the following general information:* *The client commissioning the Life Cycle Assessment, internal or external Life Cycle analysts* *The report date* *Indications that the Life Cycle Assessment was performed in agreement with the requirements of these Product Category Rules with reference to ISO 21930 or EN 15804, if conformance with the latter standard is sought.* *Any Part B PCR which is based on this Part A standard must include all unchanged elements of this Part A PCR according to ISO 21930 Section 6.1. In the case that any requirements in the specified elements conflict between Part A and Part B, Part A shall be followed.*	Date is to be provided.	Included on page 2. **Acknowledged.**	Closed
TE11			**PCR Specific Part A (§2.1):** *General Information* *The UNSPSC code and the appropriate Construction Specifications Institute (CSI) / Constructions Specifications Canadian (CSC) classification shall be identified for the product category covered by the Part B PCR.*	Requirement met.		Closed
TE12			**ISO Requirement (§4.2.1):** *Goal and Scope Definition General – The goal and scope of an LCA shall be clearly defined and shall be consistent with the intended application. Due to the iterative nature of LCA, the scope may have to be refined during the study.*	Requirement met.		Closed
TE13			**ISO Requirement (§4.2.2):** *Goal of the study – In defining the goal of an LCA, the following items shall be unambiguously stated:* *– the intended application;* *– the reasons for carrying out the study:*	Requirement met.		Closed

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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			– the intended audience, i.e. to whom the results of the study are intended to be communicated: *– whether the results are intended to be used in comparative assertions intended to be disclosed to the public.*			
TE14			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance* *The third-party report shall cover the following aspects:* ***b) Goal of the study**:* *1) reasons for carrying out the study;* *2) its intended applications;* *3) the target audiences;* *4) statement as to whether the study intends to support comparative assertions intended to be disclosed to the public.*	Requirement met.		Closed
TE15			**PCR Specific Part A (§2.2):** *Goal of the study* *The study goal must be outlined in the project report, including the following:* *Reasons for performing the study* *Intended use* *Target group, i.e. whether the information and data for an EPD is intended for business-to-business (B2B) and/or business-to-consumer (B2C) communication.* *[ISO 21930, Section 5.4]: "The environmental information on construction products is intended mainly for B2B communication and its prime purpose is to provide measurable and verifiable input for the assessment and improvements of the environmental performance of construction works. However, some EPDs may be used in the B2C marketplace and, when doing so, the user of this document shall follow the provisions of ISO 14025:2006, Clause 9."* ***ISO 14025:2006, Claus 9:*** ***9.2 Provision of information*** ***9.2.1 Content of declaration*** *Type III environmental declarations are complex and require considerable documentation. No part of the required content of the declaration required by the PCR shall be omitted or simplified for business-to-consumer communication.* *Type III environmental declarations shall be based on the life cycle of the product, unless*	Requirement met.		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

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			– information on specific stages (e.g. the use and end-of-life stages of the product) is not available and reasonable scenarios cannot be modelled, or *– these stages may reasonably be expected to be environmentally insignificant.* *Only under these circumstances can the specific stages be excluded. A statement on omissions shall be included in the Type III environmental declaration.* *Where reasonable scenarios for the specific stages can be modelled, those stages shall not be excluded.* *Assumptions made to create the scenarios should be clearly stated in the PCR.* ***9.2.2 Availability of declaration*** *Type III environmental declarations intended for business-to-consumer communication shall be available to the consumer at the point of purchase.* ***9.2.3 Explanatory material*** *When Type III environmental declarations are used for business-to-consumer communication, the organization making the declaration shall provide, upon request and at a reasonable cost, extra explanatory material to facilitate consumer understanding of the data in the declaration. The organization making the declaration shall publish information allowing a consumer to contact the organization from any area in which the product is sold. Suitable means of contacting the organization may include telephone or other electronic access. Means of obtaining the explanatory material shall be clearly stated in the declaration.* ***9.3 Involvement of interested parties*** *In addition to the requirements of 5.5, the interested parties involved in the development of a Type III environmental declaration or programme for use in business-to-consumer communication shall include representatives of both consumer interests and environmental interests. These representatives may be selected by local, national or regional groups, bodies or organizations.*			

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			The programme operator shall be responsible for facilitating this participation. ***9.4 Verification*** *Verification required in this International Standard shall, in the case of Type III environmental declarations used for business-to-consumer communication, be carried out by a third party (see competence for verifiers in 8.2).* *When the intended audience for the Type III environmental declaration is a consumer, as defined in 3.16, the declaration shall clearly state that the verification was performed by a competent third party.*			
TE16			**ISO Requirement (§4.2.3.1):** ***Scope of the study - General****.* *In defining the scope of an LCA, the following items shall be considered and clearly described:* *– the product system to be studied;* *– the functions of the product system or, in the case of comparative studies, the systems;* *– the functional unit;* *– the system boundary;* *– allocation procedures;* *– LCIA methodology and types of impacts;* *– interpretation to be used;* *– data requirements;* *– assumptions;* *– value choices and optional elements;* *– limitations;* *– data quality requirements;* *– type of critical review, if any;* *– type and format of the report required for the study.* *In some cases, the goal and scope of the study may be revised due to unforeseen limitations, constraints or as a result of additional information. Such modifications, together with their justification, should be documented.*	Requirement met.		Closed
TE17			**ISO Requirement (§4.2.3.2):** ***Scope of the study - Function and functional unit*** *The scope of an LCA shall clearly specify the functions (performance characteristics) of the system being studied. The functional unit shall be consistent with the goal and scope of the study. One of the primary*	Requirement met.		Closed

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			purposes of a functional unit is to provide a reference to which the input and output data are normalized (in a mathematical sense). Therefore, the functional unit shall be clearly defined and measurable. *Having chosen the functional unit, the reference flow shall be defined. Comparisons between systems shall be made on the basis of the same function(s), quantified by the same functional unit(s) in the form of their reference flows. If additional functions of any of the systems are not taken into account in the comparison of functional units, then these omissions shall be explained and documented. As an alternative, systems associated with the delivery of this function may be added to the boundary of the other system to make the systems more comparable. In these cases, the processes selected shall be explained and documented.*			
TE18			**ISO Requirement (§4.2.3.3.1): *Scope of the study - System boundary*** *The system boundary determines which unit processes shall be included within the LCA. The selection of the system boundary shall be consistent with the goal of the study. The criteria used in establishing the system boundary shall be identified and explained.* *Decisions shall be made regarding which unit processes to include in the study and the level of detail to which these unit processes shall be studied.* *The deletion of life cycle stages, processes, inputs or outputs is only permitted if it does not significantly change the overall conclusions of the study. Any decisions to omit life cycle stages, processes, inputs or outputs shall be clearly stated, and the reasons and implications for their omission shall be explained.* *Decisions shall also be made regarding which inputs and outputs shall be included and the level of detail of the LCA shall be clearly stated.*	Requirement met.		Closed
TE19			**ISO Requirement (§4.2.3.3.2): *Scope of the study - System boundary*** *It is helpful to describe the system using a process flow diagram showing the unit processes and their inter-relationships. Each of the unit processes should be initially described to define:* *– where the unit process begins, in terms of the receipt of raw materials or intermediate products,* *– the nature of the transformations and operations that occur as part of the unit process, and*	Requirement met.		Closed

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			– where the unit process ends, in terms of the destination of the intermediate or final products. *Ideally, the product system should be modelled in such a manner that inputs and outputs at its boundary are elementary and product flows. It is an iterative process to identify the inputs and outputs that should be traced to the environment, i.e. to identify which unit processes producing the inputs (or which unit processes receiving the outputs) should be included in the product system under study. The initial identification is made using available data. Inputs and outputs should be more fully identified after additional data are collected during the course of the study, and then subjected to a sensitivity analysis (see 4.3.3.4).* *For material inputs, the analysis begins with an initial selection of inputs to be studied. This selection should be based on an identification of the inputs associated with each of the unit processes to be modelled. This effort may be undertaken with data collected from specific sites or from published sources. The goal is to identify the significant inputs associated with each of the unit processes.* *Energy inputs and outputs shall be treated as any other input or output to an LCA. The various types of energy inputs and outputs shall include inputs and outputs relevant for the production and delivery of fuels, feedstock energy and process energy used within the system being modelled.*			
TE20			**ISO Requirement (§4.2.3.3.3): *Scope of the study – Cut-off Criteria*** *The cut-off criteria for initial inclusion of inputs and outputs and the assumptions on which the cut-off criteria are established shall be clearly described. The effect on the outcome of the study of the cut-off criteria selected shall also be assessed and described in the final report.* *Several cut-off criteria are used in LCA practice to decide which inputs are to be included in the assessment, such as mass, energy and environmental significance. Making the initial identification of inputs based on mass* *contribution alone may result in important inputs being omitted from the study. Accordingly, energy and environmental significance should also be used as cut-off criteria in this process.* *a) **Mass**: an appropriate decision, when using mass as a criterion, would require the inclusion in the study of all inputs that cumulatively contribute more than a defined percentage to the mass input of the product system being modelled.*	Requirement met.		Closed

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			b) ***Energy****: similarly, an appropriate decision, when using energy as a criterion, would require the inclusion in the study of those inputs that cumulatively contribute more than a defined percentage of the product system's energy inputs.* *c)* ***Environmental significance****: decisions on cut-off criteria should be made to include inputs that contribute more than an additional defined amount of the estimated quantity of individual data of the product system that are specially selected because of environmental relevance.* *Similar cut-off criteria may also be used to identify which outputs should be traced to the environment, e.g. by including final waste treatment processes.* *Where the study is intended to be used in comparative assertions intended to be disclosed to the public, the final sensitivity analysis of the inputs and outputs data shall include the mass, energy and environmental significance criteria so that all inputs that cumulatively contribute more than a defined amount (e.g. percentage) to the total are included in the study.* *All of the selected inputs identified through this process should be modelled as elementary flows.* *It should be decided which inputs and outputs data have to be traced to other product systems, including flows subject to allocation. The system should be described in sufficient detail and clarity to allow another practitioner to duplicate the inventory analysis.*			
TE21			**ISO Requirement (§4.2.3.4):** ***Scope of the study – LCIA methodology and types of impacts*** *It shall be determined which impact categories, category indicators and characterization models are included within the LCA study. The selection of impact categories, category indicators and characterization models* *used in the LCIA methodology shall be consistent with the goal of the study and considered as described in 4.4.2.2.*	Requirement met.		Closed
TE22			**ISO Requirement (§4.2.3.6):** ***Scope of the study – Data quality requirements*** ***4.2.3.6.1*** *Data quality requirements shall be specified to enable the goal and scope of the LCA to be met.*	Requirement met.		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			4.2.3.6.2 *The data quality requirements should address the following:* *a) time-related coverage: age of data and the minimum length of time over which data should be collected;* *b) geographical coverage: geographical area from which data for unit processes should be collected to satisfy the goal of the study;* *c) technology coverage: specific technology or technology mix;* *d) precision: measure of the variability of the data values for each data expressed (e.g. variance);* *e) completeness: percentage of flow that is measured or estimated;* *f) representativeness: qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period and technology coverage);* *g) consistency: qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis;* *h) reproducibility: qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study;* *i) sources of the data;* *j) uncertainty of the information (e.g. data, models and assumptions).* *Where a study is intended to be used in comparative assertions intended to be disclosed to the public, the data quality requirements stated in a) to j) above* ***shall*** *be addressed.* ***4.2.3.6.3*** *The treatment of missing data shall be documented. For each unit process and for each reporting location where missing data are identified, the treatment of the missing data and data gaps should result in* *– a "non-zero" data value that is explained,* *– a "zero" data value if explained, or* *– a calculated value based on the reported values from unit processes employing similar technology.*			
TE23			**ISO Requirement (§4.2.3.7):** ***Scope of the study – Comparisons between systems*** *In a comparative study, the equivalence of the systems being compared shall be evaluated before interpreting the results. Consequently, the scope of the study shall be defined in such a way that the systems can be compared. Systems shall be compared using the same functional unit and equivalent methodological considerations, such as performance, system boundary, data quality, allocation procedures,*	N/A		Closed

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			decision rules on evaluating inputs, and outputs and impact assessment. Any differences between systems regarding these parameters shall be identified and reported. If the study is intended to be used for a comparative assertion intended to be disclosed to the public, interested parties shall conduct this evaluation as a critical review. *A life cycle impact assessment shall be performed for studies intended to be used in comparative assertions intended to be disclosed to the public.*			
TE24	p. 24		**ISO Requirement (§4.2.3.8):** ***Scope of the study – Critical review considerations*** *The scope of the study shall define* *– whether a critical review is necessary and, if so, how to conduct it,* *– the type of critical review needed (see Clause 6), and* *– who would conduct the review, and their level of expertise.*	Provide the verifier name.	Done **Acknowledged.**	Closed
TE25			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance* *The third-party report shall cover the following aspects:* ***c) Scope of the study:*** *1) function, including* *i) statement of performance characteristics, and* *ii) any omission of additional functions in comparisons;* *2) functional unit, including* *i) consistency with goal and scope,* *ii) definition,* *iii) result of performance measurement;* *3) system boundary, including* *i) omissions of life cycle stages, processes or data needs,* *ii) quantification of energy and material inputs and outputs, and* *iii) assumptions about electricity production;* *4) cut-off criteria for initial inclusion of inputs and output, including* *i) description of cut-off criteria and assumptions,* *ii) effect of selection on results,* *iii) inclusion of mass, energy and environmental cut-off criteria.*	Requirement met.		Closed
TE26			**PCR Specific Part A (§2.3):** *Methodological Framework* *The LCA shall follow an attributional approach as outlined in ISO 21930 Section 7.1.1.* ***ISO 21930 Section 7.1.1:***	Requirement met.		Closed

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			7.1.1 Overarching principles for LCA modelling and calculation *Two main modelling approaches exist for LCA: attributional and consequential.* *This document follows the attributional LCA approach. The attributional life cycle model depicts the actual or anticipated specific or average supply chain, use and end-of-life scenarios. The consequential life cycle model depicts the anticipated generic supply chain as a consequence of a potentially relevant* *decision.* *The attributional and the consequential life cycle models differ with respect to the selection of data and the manner in which co-production processes are considered. In the attributional approach, coproduction processes are allocated based on physical or economic relationships; in the consequential* *approach, system expansion including avoided processes is applied.* *The setting of the system boundary for the product system shall follow two principles:* *— The "modularity principle": Where processes influence the construction product's environmental performance during its life cycle, they are assigned to the information module of the life cycle stage where they occur; all environmental aspects and potential impacts are declared in the life cycle* *stage where they can be attributed (see Figure 2).* *— The "polluter pays principle": Processes relevant to waste processing are assigned to the product system that generates the waste until the system boundary between product systems is reached.*			
TE27			**PCR Specific Part A (§2.4):** *Scope of the study – Declared/Functional Unit* *The LCA of the construction product must be calculated for a declared or functional unit as specified in the relevant sub-category Part B PCR for the product group, in conformance with ISO 21930 Section 7.1.2 and 7.1.3. The selected declared or functional unit must be documented in the project report. In addition, a mass conversion factor of the declared or functional unit shall be provided, where appropriate.* *ISO 21930 Section 7.1.2:* ***7.1.2 Functional unit***	Requirement met. Functional unit has been defined.		Closed

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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			The functional unit defines the way in which the identified functions and performance characteristics of the product are quantified. The primary purpose of the functional unit is to provide a reference by which product, material and energy flows (input and output data) of a construction product's LCA results and any other information are normalized to produce data expressed on a common basis. *NOTE 1 Comparisons of construction products with the same functional unit follow the rules in 5.5.* *The functional unit, used as the denominator, provides the basis for the addition of product, material or energy flows and the relevant environmental impacts for any of the life cycle stages and their information modules for the construction product or construction service.* *The description of the functional unit of a construction product shall include, but not be limited to* *— the quantified function and performance characteristics of the construction product when integrated into a construction works, taking into account the intended use of the product with respect to the functional equivalent of the works, and* *— the product's RSL (see 7.1.4), under defined reference in-use conditions or specific in-use conditions.* *In this way, quantification of both the qualitative and quantitative aspects of the function in relation to end use in a construction works context, for example, "what", "how much", "how well" and "for how long" has to be performed.* *NOTE 2 Guidance on establishing "how well" and "how long" aspects of performance is provided in Annex A.* *NOTE 3 Guidance on the development of a functional unit is given in ISO 14040:2006, 4.2.2.* *NOTE 4 Guidance on describing in-use conditions is given in ISO 15686-1, ISO 15686-2, ISO 15686-7 and ISO 15686-8.* *NOTE 5 The functional unit for a product might incorporate aspects of functionality that are not always required for a particular use case of that product. For example, a concrete block can have structural performance functionality, acoustic functionality and thermal functionality, but in a given use case one or more of these functions might not be required. If this is the case, then these aspects of functional unit can be disregarded, if for example, functional unit is being used as the basis for comparison of two or more products for the given use case.*			

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			EXAMPLE A functional unit can be: a roofing product sufficient to cover 100 m2 of a building, maintain a barrier to water penetration into the building and to include any repair, refurbishment or replacement of replaceable components over a required service life of 50 years. ***7.1.3 Declared unit*** *When the precise function of the product or scenarios at the construction works level is not stated, or is unknown, a declared unit may be used instead of the functional unit. The declared unit provides a reference by which product, material and energy flows (input and output data) of the information module of a construction product's LCA results and any other information are normalized to produce data expressed on a common basis.* *The declared unit, used as the denominator, provides the basis for the addition of product, material and energy flows attributed to the product and the relevant environmental impacts for EPDs that do not cover the full life cycle (see Figure 2). It shall relate to the typical applications of products and their product categories.* *The declared unit in the EPD shall be one of the following:* *— an item, an assemblage of items, for example, 1 window (dimensions of items shall be specified);* *— mass (kg or metric tonne), for example, 1 000 kg or 1 t of cement;* *— length (m), for example, 1 m of pipe, 1 m of a beam (dimensions of elements shall be specified);* *— area (m2), for example, 1 m2 of wall elements, 1 m2 of roof elements (dimensions of elements shall be specified);* *— volume (m3), for example, 1 m3 of timber, 1 m3 of ready-mixed concrete.* *A different unit may be declared for reasons that shall be explained and in such cases, information shall be provided on how to convert this unit to one or more of the required unit types.* *EXAMPLE If an EPD for an insulation material is declared in units of thermal resistance, R (m2K/W), in the construction works, then a conversion factor, for example, to 1 kg of material is required.* *For the development of, for example, transport and disposal scenarios, conversion factors to mass per declared unit shall be provided.*			

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			NOTE Reasons for declaring units other than those listed include the need to use units normally used for design, planning, procurement and sale. *The following information is the minimum that shall be provided together with the declared unit for the construction product or component:* *— intended application, where relevant;* *— statement that comparability of EPDs is limited to those applying a functional unit.*			
TE28			**PCR Specific Part B (§3.1):** *Functional Unit* *The functional unit for building envelope thermal insulation is based on the thermal property (design) as determined by the relevant standards/methods for an insulation type (see Section 9). Where there is an applicable ASTM material standard, that standard shall be referenced.* *Functional units may be expressed as: FU = RSI ·λ ·ρ · A [kg] where, RSI = thermal resistance [m²K/W] λ = thermal conductivity [W/mK] ρ = density of insulation product [kg/m³] A = Area [m²] (here, 1 m²)* *The result for any other RSI-values than 1 m²K/W can be found by simple conversion multiplication.* *The thermal resistance may also be expressed as: RSI = d/λ where d [m] is the thickness of the insulation. This PCR applies to a wide variety of thermal insulation types, each with its own applicable ASTM standard. Some insulation types are offered in different densities that will directly impact R-value. In turn, other insulation types have R-values that are linear with respect to thickness, while others are non-linear. Therefore, since this PCR is based on an R-value functional unit, adjustments for density and thicknesses are to be provided.* *The functional unit, mass, and thickness to achieve the functional unit shall be indicated in the appropriate table as declared.* ***TABLE 1. FUNCTIONAL UNIT PROPERTIES*** ***Name*** | ***Value*** | ***Unit*** *Functional unit* | *1 m² of insulation material with a thickness that gives an average thermal resistance RSI = 1 m²K/W*	Requirement met.		Closed

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			Mass | | *kg* *Thickness to achieve Functional Unit* | | *m*			
TE29			**PCR Specific Part A (§2.5):** *Product averages for EPDs.* *Averaging of products may significantly reduce EPD development efforts by allowing manufacturers to use one LCA for multiple products and should be considered during the PCR development. Two types of product averages are allowed using this PCR; industry average EPDs and product-specific averages.* *The range of products included in an EPD shall be justified in the context of EPD application; i.e. what the EPD represents. It is crucial that the reasoning be explained and the average reported value can be understood. For example, if a single product is made using a single process, but contains variance of recycled content (different for different locations), an EPD can represent the product as an average of the virgin and recycled material content given the rationale is fully explained. An average is also appropriate in the case of products demonstrating a wide range of variation based on selection of materials serving the same function, such as choice of upholstery fabric on a seat chair cushion.* *Further guidance and clarification for calculating and reporting product averages may be provided by the relevant Part B PCR and shall be followed.*	N/A – individual products are represented.		Closed
TE30			**PCR Specific Part A (§2.5.1):** *Industry Average EPD.* *The method for creating an industry-average EPD shall be described. To ensure an industry average EPD is representative, the information provided in the average EPD and in the LCA report shall include the requirements in ISO 21930 Section 5.3.* *Note: Note: Include how a sufficient statistical representation is achieved, how geographic location is assessed, and how the average is weighted to ensure sufficient representation so as to avoid bias. A quantitative assessment of primary dataset variability, including mean, median, standard deviation, and best fitting probability distribution function shall be included.*	Provide analysis to demonstrate that the products assessed did not differ in their environmental impact indicators by more than ±10 %. If they do differ by more than ±10 %, provide justification of their inclusion or report separately.	This EPD is representative of the industry and is weighted based on production volumes. As required by ISO 21930, Sec 5.3, we have declared a range of the product composition (Table 3.2), density, thermal conductivity, thicknesses (Table 2.2). Minimum and maximum values have also been added for R-value and density in Table 2.2. **Acknowledged.**	Closed

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			In cases where industry associations decide, for disclosed or undisclosed reasons, to not make publicly available a quantitative assessment of primary dataset variability, including mean, median, standard deviation, and best fitting probability distribution function, sensitivity and scenario analysis shall be conducted. Additional requirements and/or recommendations may be provided in the sub-category Part B PCR. *The method of dataset averaging shall be described (i.e., horizontal or vertical averaging) and justified. The justification shall consider if data is more appropriately represented by standalone gate-to-gate processes (horizontal averaging) versus capturing the flow of goods within a facility(ies) (vertical averaging).* *A qualitative assessment shall be provided within the EPD that estimates percent representation of industry and percent geographical region representation, the median reference flow units (e.g. weight, area, volume), and other contributing sources of variation (e.g. operational capacity, grid mix). Per ISO 21930 Section 5.3, a sensitivity analysis should be conducted on the differences between the products included the average.* ***ISO 21930 Section 5.3:*** ***5.3 Average EPDs for groups of similar products*** *Average EPDs may be derived for similar products from one or more sites of one company or multiple companies using data specific to that product. Average EPDs may also be developed for groups of similar products using averaged environmental performance data. Both these types of average EPDs might significantly reduce the effort associated with producing separate EPDs for similar products.* *NOTE 1 Products can be considered similar on the basis of materials, manufacturing or function, as relevant to the product category.* *The larger the variance among the products covered by an average EPD, the less the average represents the intended typical product. The selection of products to be covered in an average EPD should be made in such a way that the resulting average EPD is reasonably descriptive for the products covered in the average EPD when considering the use*			

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			of the average EPD information in an overall assessment of a construction works. *Average EPDs, for example EPDs from trade associations, shall describe what they represent. This means, as a minimum, providing details on the variation in the composition of the product compared with the average product. Such information shall give the user an indication, either qualitatively or quantitatively, of the range of results that are likely for the products covered by the average EPD. See Annex B for examples of average EPDs.* *When there is a selection of sites or products assessed, the type of average and what it represents shall be clearly stated in the EPD. To ensure an average EPD is representative, the information provided in the average EPD and in the LCA report shall include, but not be limited to:* *— a technical description of the average product group (see EXAMPLES 1 to 3);* *— the number of manufacturing plants included in the EPD;* *— the names of manufacturing companies or brands or associations;* *— a description of the relative production representativeness covered by the EPD;* *— the geographical coverage;* *— the range of products for which the EPD is relevant;* *— the information on restrictions to the use of the average EPD.* *In addition, the following information shall be provided in the project report in order to be transparent:* *— description of how the selection of the sites/products was done and how the average was determined;* *— information on parameters in the LCA having the most influence.* *EXAMPLE 1 For an average EPD for a declared unit of R-value of a specific type of insulation material, the representativeness of the average EPD could be described by relevant technical properties such as the range of density, thermal conductivity and thickness for which the average EPD is representative.* *EXAMPLE 2 For an average EPD for a declared unit of 1 m2 of carpet with a given pile mass, the representativeness of the average EPD could be described by relevant technical properties, such as the range of pile mass/m2 as the most influencing parameter.*			

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			EXAMPLE 3 For an average EPD for declared unit of 1 m2 of insulated steel cladding panel, the representativeness of the average EPD could be described by relevant technical properties such as kg/m2 or thickness of steel and insulation. *NOTE 2 Average EPDs are important at the early stages of planning. Apart from this, there is a need for product-specific EPDs for the selection/sourcing of particular products.* *Average EPD may be developed for a group of similar products from the same or different manufacturing plants produced using the same processes and having the same functionality.* *EXAMPLE 4 An example is a mortar, where the manufacturing is done by mixing different components.* *Different types of mortar used, for example as a plaster, can vary in their composition while using a limited number of components. In that case, data specific to a typical product can be used. The typical product is modelled and calculated by assuming an average composition taken from the range of the group of similar products. The calculation of the environmental indicators then results in representative values.* *A sensitivity analysis should be conducted on the differences between the similar products in the grouped system.* *Where an average composition, representative composition or worst case environmental indicators are used, the products included in an average EPD shall not differ in their environmental impact indicators by more than ±10 %. Similar products included in other average EPDs should not differ in their environmental impact indicators by more than ±10 %. Where larger impact differences are found for the companies/sites and/or products evaluated, these need to be justified in the project report or the system separated.* *NOTE 3 An average EPD can provide the impact of an average product, for example, by weighting impacts considering total production volume or a representative sample of the products. For some aspects of technical performance, a conservative estimate of product performance, ensuring adequate technical functionality in the context of the construction works, might be relevant.*			

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TE31			**PCR Specific Part A (§2.5.2):** *Manufacturer Specific EPD* *The method for creating a company specific individual product/product group EPD shall be described according to ISO 21930, section 5.3, including the method for determining a weighted average across products based on production volume. If a product is manufactured at different production sites, the sites shall be indicated and method for determining the weighted average shall also be described.* *Note: Products of similar specifications, and utilized for the same application(s) may be grouped and reported as an average declared product in the same EPD provided that 1) the products included in the grouping differ by no more than ±10 % for any environmental impact indicator and 2) the weighted coefficient of variation across all products shall be less than or equal to 20% for any impact category with the exception of Ozone Depletion Potential (ODP). If the weighted coefficient of variation is 20% or greater for any impact category with the exception of ODP, each product shall be shown separately. Quantitative justification should be provided in the LCA that substantiates the reported average declared product.*	N/A		Closed
TE32			**PCR Specific Part A (§2.6):** *Product Description* *The declared product must be described with regards to its technical and functional specifications.* *[ISO 21930, section 6.3]: "The product group covered by a sub-category PCR shall be described unambiguously.* *The definition may consider product functionality (e.g. conveyance of materials through pipes), typical production processes (e.g. mining or oil refinery) or applications (e.g. for use in cold climates).* *If there is potential ambiguity in the product sub-category, the description shall also state which products are not covered by the sub-category Part B PCR."*	Requirement met.		Closed
TE33			**PCR Specific Part A (§2.7):** *Product Application The designated application(s) for the referenced product(s) shall be specified/described.*	Requirement met.		Closed
TE34			**PCR Specific Part A (§2.8):** *System Boundaries* *The system boundaries of the LCA and EPD shall follow the modular structure in line with ISO 21930 Section 5.2.1. This PCR encourages,*	Requirement met.		Closed

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when possible, EPDs that are cradle to grave in scope (Modules A1-C4) but also recognizes EPDs that are cradle to gate (Modules A1-A3) and cradle to gate with optional modules as being in scope.
The environmental information of an EPD shall be subdivided into four life cycle stages per Figure 1: Production (Modules A1-A3); Construction (Modules A4-A5); Use (Modules B1-B7); and EOL (Modules C1-C4).

Only the declaration of the Production modules, A1-A3, is required for conformance with ISO 21930. The declaration of other life cycle modules is optional, unless specifically addressed in a sub-category Part B, with the exception of Module C (see Section 2.8.4.5). Module D is not a life cycle stage like the life cycle stages assessed in information modules A1 to C4. Module D is outside the system boundary of the studied product system and construction works system.

Any omissions of life cycle stages, processes or data shall be documented and justified in the LCA and EPD.

Figure 1. Common four life cycle stages and their information modules for construction products and construction works and the optional supplementary module D

	PRODUCTION			CONSTRUCTION		USE							END OF LIFE				BENEFITS & LOADS BEYOND SYSTEM BOUNDARY	
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	
EPD Type	Raw material supply	Transport	Manufacturing	Transport to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential	Reference Service Life
Cradle to gate	Required			Excluded									Required, depending on Section 2.8.4.5				Optional	Optional
Cradle to gate with options	Required			Optional		Ex.	Op.	Excluded					Optional				Optional	Optional
Cradle to grave	Required																Optional	Required

** Modules B2 – B5 include production, transport and disposal of necessary materials*
*** Module B4 is not applicable at the product level*

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			For construction products requiring activity or use of energy and/or water during the use stage, technical information for the relevant information modules (B2 to B5 or B6 and/or B7, respectively) is required per ISO 21930, Section 5.2.1. *When a product EPD only includes Module A (Production stage), the following information regarding intended use of the product shall be provided as additional information:* *Other products not included in assessment needed for product to serve intended function in the construction work* *Anticipated replacement cycle of product in the construction work context* *Intended use* *Supplementary environmental information may also be provided in module D that addresses potential loads and benefits beyond the product system boundary.*			
TE35			**PCR Specific Part A (§2.8.1):** *Types of EPDs* *Per ISO 21930, Section 5.2.2 "The LCA-based information in an EPD may cover different combinations of information modules, i.e. cover different life cycle stages or parts thereof.* *There are three types of EPDs: "cradle to gate", "cradle to gate with options" and "cradle to grave". See Figure 1 for the information modules included in each type of EPD.* *The sub-category Part B PCR shall state the type of EPDs allowed according to the definitions provided in ISO 21930, Section 5.2.2, and shall also include the required scenarios according to ISO 21930, Section 7.1.7.* *It may also contain only the relevant technical information for further calculation of the environmental performance in the scenarios.*	Requirement met. Cradle to Grave.		Closed
TE36			**PCR Specific Part B (§3.2):** *System Boundary* *The type of EPD shall be specified as either cradle to installation with end of life or cradle to grave. The modules considered in the LCA shall be described in brief as per "System boundaries" outlined in Section 2.8 of Part A. It should be apparent as to what processes are considered in*	Requirement met.		Closed

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			what modules per the module descriptions in Section 2.8 of Part A. Any relevant aspects or impacts not included in an information module shall be supported with relevant additional environmental information and the omissions shall be justified. *Capital goods and infrastructure flows shall not be excluded from unit processes used to model the LCIA to the extent they significantly affect the conclusions of the LCA or additional environmental information. The LCA report should specify lifetimes of capital goods and infrastructure included. The impact burden from capital goods and infrastructure shall be allocated to the product(s) in the LCA by either a) proportional to the specified lifetime of the asset, or b) proportional to the production output of the asset. Any deviation shall be explicitly specified and justified.*			
TE37			**PCR Specific Part A (§2.8.2):** *Reference Service Life and Building Estimated Service Life* *The indication of the RSL is required for EPDs covering the complete use stage (modules B1-B7), or if a use stage scenario is described, which refers to the lifetime of the product. If no use stage modules are declared, and no use stage scenario which refers to the lifetime of the product is described, the indication of the RSL is voluntary. Refer to ISO 21930 Section 7.1.4 for more information.* *The RSL information to be declared in an EPD covering the use stage shall be provided by the manufacturer. If primary data to support declaration are unavailable, a default RSL of 75 years may be assumed for the product category system (if applicable; described as part of the functional unit or reported under additional environmental information, if all life cycle stages are not declared) unless the sub-category Part B PCR indicates otherwise, or if otherwise stated and substantiated. When reporting the number of replacements necessary to fulfil the required performance and functionality over the construction works Estimated Service Life (ESL), fractional values shall be rounded up to the nearest tenth. An assumed ESL of 75 years shall be used for the construction works life.* *The RSL shall refer to the declared technical and functional performance of the product. A standard life expectancy based on the prescribed method or default of 75 years shall be used, with the option of any deviation allowed only if justified in writing, publicly available for review, and posted for publication. When reported, the RSL shall be*	Requirement met.		Closed

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			established in line with all of the specific rules in North American (NA) product standards and shall also consider, but not necessarily adhere to, the ISO 15686-1, -2, -7 and -8 standards. Where information is available for deriving the RSL from NA product standards, such data has priority. This PCR acknowledges product manufacturers cannot be held responsible for the actual design of the construction works, use and application of the product, environment, or workmanship. *The assumptions upon which the designated RSL is based and for which the RSL exclusively applies shall be provided in project report. Influences on ageing, when applied, shall be in accordance with the state of the art.*			
TE38			**PCR Specific Part A (§2.8.3):** *System Boundary with Nature and Between Product Systems* *System boundaries with nature and between product systems shall be defined, calculated and reported according to ISO 21930 sections 7.1.5 and 7.1.6.* *ISO 21930 Section 7.1.5:* ***7.1.5 System boundary with nature*** *The system boundary with nature is defined when material flows move from natural systems to the technosphere (i.e. when they are flows caused or influenced by human technological activity) and when emissions are released from the technosphere to the environment. The studied system should therefore include all processes in the technosphere which are necessary to provide the function or declared unit of the product.* *NOTE Biogenic carbon enters the product system during managed agricultural processes or during harvest of biogenic material from natural systems.* *ISO 21930 Section 7.1.6:* ***7.1.6 System boundary between products systems*** *Product systems can use secondary materials, secondary fuels and recovered energy from previous product systems, and can generate wastes and energy that are recovered to produce secondary materials, secondary fuels and recovered energy for use in subsequent product systems. To ensure that* *there is no double counting or undercounting of burdens, it is essential that a system boundary between product systems is defined and the*	Requirement met.		Closed

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			same system boundary is used to assign burdens to the appropriate product system for both inputs and outputs from the studied product system. *See Table 1 for application of the system boundary between product systems. For input flows to the studied product system, the product system that generates waste is the upstream product system. For output flows from the studied product system, it is the studied product system generating the waste.* *For input flows to the studied product system, the product system that uses waste, secondary materials or secondary fuels is the studied product system. For output flows used from the studied product system, it is the downstream product system.* *The setting of the system boundary between products systems shall follow the polluter pays principle set out in 7.1.1.* *A flow shall be considered as reaching the system boundary between product systems when it complies with all the following criteria:* *— the recovered material, product or fuel is commonly used for specific purposes;* *— a market or demand, identified, for example by a positive economic value, exists for such a recovered material, product or fuel;* *— the recovered material, product or fuel fulfils the technical requirements for the specific purposes for which it is used and meets the existing legislation and standards applicable to products or secondary fuels.* *NOTE The "specific purpose" in this context is not restricted to the function of a certain product but can also be applied to a material serving as input to the production process of another product or of energy.* *As the criteria for the system boundary between product systems relate to common use, demand, economic value, legislation, standards and regulations, it is clear that a particular substance can have a different status in different locations at different points in time. For manufacturers that use wastes,* *secondary materials and/or secondary fuels as a resource and also produce waste that is recovered in terms of time of data collection and geography of the supply chain for the use of these substances, the current situation shall be used to identify the system boundary between product systems.*			

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			A conservative approach shall be used, meaning that if there is uncertainty as to whether a substance has reached the system boundary between product systems, it should be included in the studied product system in the relevant life cycle stage. Additionally, if wastes are used for energy or material recovery *and do not have a clearly defined point when they cross the system boundary between product systems in all regions, the most conservative figures shall be specified in the communication of the LCA results in information modules A1 to A3 and shall include the environmental impacts caused by the emissions* *including processing, incineration and/or co-incineration of waste (gross figure).* *For transparency reasons, a net figure can be provided as additional information:* *— the environmental impacts caused excluding the processing, e.g. incineration of waste (net figure), see Table 1.* *For the end-of-life stage, any waste treatment or recovery process that occurs before the system boundary between product systems is reached shall be included in information module C3 or C4.*			
TE39			**PCR Specific Part A (§2.8.4):** *System Boundaries and Scenarios* *[ISO 21930, Section 7.1.7.1]: "The information modules A1, A2 and A3 are based on the actual and representative data of the production process of the product. However, as soon as a construction product leaves the factory gate, the assessment shall be based on scenarios and assumptions. The scenarios and assumptions considered depend upon various details including location, type of transport, method of installation and construction, type of construction works, use, maintenance and repair, end-of-life treatment and waste handling." ©ISO. This material is from ISO 21930:2017 with permission of the American National Standards Institute (ANSI) on behalf of the International Electrotechnical Commission. All rights reserved.* *Specific requirements for scenarios and assumptions shall follow ISO 21930 Section 7.1.7.1, and additional requirements may be provided in the sub-category Part B PCR.* *[ISO 21930, Section 7.1.7.1]: "Within an EPD, the indicators declared in the individual information modules of a product life cycle (i.e. A1 to A5, B1 to B7, C1 to C4) and the optional supplementary information beyond*	Requirement met.		Closed

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			the life cycle (module D) shall not be aggregated in any combination of the individual information modules into a total or subtotal of the life cycle stages. As an exception, individual indicators for information modules A1, A2 and A3 may be aggregated to a total for each indicator in the production stage." *Scenarios shall be provided only for the environmental assessment. A scenario shall be based on relevant technical information. With the help of the scenario, the predetermined parameters of the EPD are derived by applying the calculation rules given in this standard.* *A scenario shall be realistic and representative of one of the most probable alternatives. (If there are, e.g. three different applications, the most representative one, or all three scenarios shall be declared). Scenarios shall not include processes or procedures that are not in current use or which have not been demonstrated to be practical.* *EXAMPLE 1: A recycling system is not practical if it includes a reference to a return system for which the logistics have not been established.* *EXAMPLE 2: Energy recovery needs to be based on existing technology and current practice.* *For EPDs that declare optional information modules, the additional technical information related to the scenarios underlying these modules is required."* *If an optional module declares the life cycle, the relevant technical information, e.g. recycling or reuse rates, must be documented in the project report with reference to the respective literary source."*			
TE40			**PCR Specific Part A (§2.8.4.1): *A1-A3, Product Stage, Information Modules*** *[ISO 21930 Section 7.1.7.2, supplemented with EN 15804 Section 6.2.2]: "The product stage includes:* *A1 Extraction and upstream production;* *A2 Transport to the factory;* *A3 Manufacturing.* *Information modules A1 to A3 shall be included in every EPD. The system boundary with nature shall include those technical processes that provide the material and energy inputs into the system and the*	Requirement met.		Closed

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			subsequent manufacturing and transport processes up to the factory gate, as well as the processing of any waste arising from those processes. All materials, products and energy, as well as processing up to the system boundary between product systems1 or disposal of final residues during the product stage shall be provided. For a detailed description of what shall be included in modules A1-A3, refer to ISO 21930 Sections 7.1.7.2.2 – 7.1.7.2.4.			
TE41			**PCR Specific Part A (§2.8.4.1):** *[ISO 21930 Section 7.1.7.1 and EN 15804 Section 6.2.2]: "Modules A1, A2 and A3 may be declared as an aggregated Module A1-3."*	Requirement met.		Closed
TE42			**PCR Specific Part A (§2.8.4.1):** *A1-A3, Product Stage, Information Modules* *The flows crossing into the system at the A1-A3 boundary are determined as follows:* *Production waste that is recycled without any modification of the material inherent characteristics (i.e. closed-loop or open-loop considered closed loop) can be considered as recycled within Modules A1-A3. This is only possible up to the volume that was used as input in production.* *Heat and power from energy recovery of production waste in Modules A1-A3 can be considered closed-loop within Module A1-A3 if they are used at the same quality with-in Modules A1-A3 and only to the maximum amount in MJ as is required of the respective energy quality in MJ during production (assumption: overall manufacturing, A1-A3, considered as a module).*	Requirement met.		Closed
TE43			**PCR Specific Part A (§2.8.4.1):** ***A1-A3, Product Stage, Information Modules*** *If an allocation procedure different from co-product allocation is chosen for flows that reach the system at the boundary A1-A3, or datasets are chosen where allocation procedures are unknown, this procedure has to be justified or clarified as a dataset limitation. Ideally, datasets should be used that clarify allocation procedures. The resulting material and energy flows are to be described transparently in the project report with regard to the amounts of materials and energy within Module A1-A3.*	Requirement met.		Closed
TE44			**PCR Specific Part A (§2.8.4.1.1):** *Coproducts leaving the system [ISO 21930 Section 7.1.7.2.6]: "Co-products from unit processes leaving the system at the production stage (A1-A3) shall be allocated in accordance with ISO 21930 Section 7.2.5.*	N/A		Closed

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			Loads and benefits from allocated co-products shall not be declared in Module D." (See Section 2.8.4.6 of this standard.)			
TE45			**PCR Specific Part A (§2.8.4.1.1):** *Output of waste* *[ISO 21930 Section 7.1.7.2.7]: "The output of waste during [the Production] life cycle stage may become a useable output flow, such as a secondary material/fuel or recovered energy, when it has been through a recovery process and complies with the conditions described in the system boundary between product systems (see ISO 21930 Section 7.1.6). These useable output flows shall not be considered as co-products but shall be considered waste and no allocation to secondary material, secondary fuels or recovered energy shall be permitted."* *While loads and benefits from allocated co-products shall not be declared in Module D, waste recovered as a useable output flows may be considered from recovery processes and included as supplementary information in module D.*	Requirement met.		Closed
TE46			**PCR Specific Part A (§2.8.4.2):** *A4-A5, Construction stage, Information modules* *[ISO 21930 Section 7.1.7.3.1, supplemented with EN 15804 Section 6.2.3]: "The construction process stage includes the following two information modules A4 to A5:* *A4 Transport to site;* *A5 Installation;* *Information modules A4 to A5 include provision of all materials, products and energy, as well as waste processing up to the system boundary between product systems or disposal of final residues during the construction stage. They also include all aspects and impacts related to any losses during this construction process stage (i.e. production, transport and waste processing and disposal of the lost products and materials)."* *When a product is sold as a system, e.g. as a package including the installation materials, then the entire production of all components and product residues that might occur in A5 are to be declared in A1-A3. The transport of the system to the site is to be declared in A4. The installation inclusive waste treatment is to be declared in A5.* *[ISO 21930 Sections 7.1.7.3.2 – 7.1.7.3.3]: "The construction stage includes the optional information modules for:*	Requirement met.		Closed

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			A4 Transportation from the factory gate to central warehouse or intermediate storage site, if relevant *A4 Transportation to the construction site* *A4-A5 Storage of products, including heating, cooling, humidity control, etc.* *A5 Construction product waste (additional production and transport processes to compensate for the loss of product waste)* *A5 Waste processing of product packaging waste and product waste during the construction process up to the system boundary between product systems or disposal of final residues* *A5 Product installation into the construction works, including the manufacturing and transport of ancillary materials, direct energy use, and freshwater consumption required for installation* *A5 Site preparation required for product installation, including ancillary materials and waste management* *Transport distances should be as specific as possible. The distance to the construction site may be estimated based on weighted average distance to the market of the product.* *If no specific information for the efficiency of waste incineration plants (R1 value; see Section 2.8.7) of the incineration plant is available, it is assumed that packaging materials (and potential product waste from the installation process) are treated thermally in a plant with R1<0.6. Thus, the combustion process (loads) for the packaging is to be declared in Module A5, the resulting benefits in Module D.* *The information in from ISO 21930 Section 7.1.7.3.4 shall be included, as below: "The information in [the following table] shall be provided for all construction products to specify the end-of-life scenarios used for packaging or to support development of the end-of-life scenarios for packaging at the construction works level where the module is not declared. Scenarios shall only model processes, for example recycling systems that have been proven to be economically and technically viable.*			

Module	***Parameter***	***Unit** (expressed per functional unit or per declared unit)*	***Value***
A5 Installation of the product	*Mass of packaging waste Specify by type*	*kg or other unit as appropriate*	

Type of comment: **GE** = general **TE** = technical **ED** = editorial

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			A5 Installation of the product | *GWP based in biogenic carbon content of packaging, specify by type, (where relevant)* | *kg CO_2e* | |			
TE47	p. 30	Sec. 3.2.6	**PCR Specific Part A (§2.8.4.3):** *B1-B5, Use stage information modules* *[ISO 21930 Section 7.1.7.4.1] "The use stage of the construction works includes information modules covering the period from the handover to when it is deconstructed or demolished.* *The product level use stage may be vastly different when considered in the context of the construction works since the products will have varying RSLs, encounter differing exposure conditions (with corresponding ESLs) and might be replaced, repaired, and maintained several times over the span of the required service life of a construction works."* *"Any deviation from the categorization of aspects and impacts into modules B1 to B5 and B6 to B7 shall be reported in a transparent manner and justified."* *[ISO 21930 Section 7.1.7.4.2]: "The use stage of the construction works includes the following five information modules:* *B1 Use or application of the installed product* *B2 Maintenance (preventative and regular maintenance activities required for product function and technical performance, e.g. cleaning);* *B3 Repair (corrective, responsive, or reactive treatment of a product or its parts (e.g. a broken component), including preservation of aesthetic qualities);* *B4 Replacement (required when an entire product needs to be replaced, instead of a repairing a broken part or component);* *B5 Refurbishment (required to return a product to its functional condition during its service life, i.e. restoration).* *This includes provision and transportation of all materials, products and related energy and water use, as well as waste processing up to system boundary between product systems or disposal of final residues during this part of the use stage. These information modules also include all aspects and impacts related to the losses during this part of the use*	Provide basis for no impacts associated with use (B1) for Open Cell SPF. A similar comment will be made regarding the SPF Open Cell EPD section 1.12.	Added comment in section 3.2.6 and in Open Cell EPD. **Acknowledged.**	Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			stage (i.e. production, transport, waste processing and disposal of the lost products and materials)." *The B1 - B5 use stage information modules shall be covered according to ISO 21930 Section 7.1.7.4.2. Additional required assumptions for these in-formation modules may be included in a sub-category Part B PCR.*			
TE48			**PCR Specific Part A (§2.8.4.4):** *B6-B7, Use stage information modules relating to the operation of the building* *[ISO 21930 Section 7.1.7.4.3.1]: "The use stage relating to the operation of the construction products includes the following two information modules:* *B6 Operational energy use (e.g. operation of a heating system and other technical construction works-related installed services);* *B7 Operational water use;* *Information modules include provision and transport of all materials, products, as well as energy and water provisions, waste processing up to the system boundary between product systems or disposal of final residues during this part of the use stage."* *B6 - B7 use stage information modules shall be covered according to ISO 21930 Sections 7.1.7.4.3.2 - 7.1.7.4.3.3]* ***7.1.7.4.3.2 B6, operational energy use*** *The information module "operational energy use" covers the operation of integrated technical systems (e.g. operation of heating system and other construction works related installed services).* *Integrated technical systems are installed technical equipment that support operation of a construction works. This includes technical systems for heating, cooling, ventilation, lighting, domestic hot water and other systems for sanitation, security, fire safety, internal transport, building automation and control and IT communications.* *This includes generation, distribution and use of energy during the operation of the product (the integrated technical system), together with its associated environmental aspects and impacts including processing and transportation of any waste arising on site from the use of energy.*	N/A		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			NOTE 5 Use of energy for heating of domestic water is assigned to B6, while consumption of freshwater associated with use of hot water is assigned to B7. *If relevant for the product group, aspects related to the production of integrated technical systems equipment shall be assigned to information modules A1 to A3, for example radiators, boiler, ventilation system. Aspects related to transportation and installation of integrated technical systems equipment shall be assigned to information modules A4 to A5. Energy use and other impacts during maintenance, repair, replacement or refurbishment activities for the equipment shall be assigned to information modules B2 to B5. Aspects related to the waste processing and final disposal of equipment shall be assigned to information modules C1 to C4.* ***7.1.7.4.3.3 B7, operational water use*** *The information module “operational water use” covers water use by integrated technical systems during the period from the handover of the construction works to when it is deconstructed or demolished.* *This includes water use during the operation of the product (the integrated technical system), together with its associated environmental aspects and impacts considering the life cycle of water including production and transportation and waste water treatment.*			
TE49			**PCR Specific Part A (§2.8.4.5):** *C1-C4 End-of-Life stage information modules* *The declaration of Module C is required in an EPD unless either of the following conditions are met1:* *1. Life cycle data for end-of-life is included and broken out separately in the LCA project report, in addition to one of the following:* * Recycling is directly controlled or supported by manufacturer, OR* * Landfill generic data per the product category is used, and has been standardized for comparability.* *OR* *2. A qualitative statement is provided in the LCA and EPD describing the typical end-of-life treatment of the product, including:* * Typical end-of-life scenarios are outlined*	Requirement met.		Closed

(1) Comment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			Recycling is reported as average or product specific recycling rates and standard reporting procedures are outlined, such as manufacturer take-back programs *Biogenic carbon content/potential for decay is addressed* *The end-of-life information modules are as follows, and should be covered per ISO 21930 Section 7.1.7.5:* *C1 Deconstruction/Demolition (includes dismantling or demolition of the product from the site and the required energy to do this, including on-site material sorting)* *C2 Transportation to waste processing or disposal* *C3 Waste processing (includes collection of waste from deconstruction, recovery, and waste processing of material flows resulting in materials for reuse, secondary materials, secondary fuels, or export of energy recovered from waste with an efficiency of at least 60%, regardless of existing legislation)* *C4 Disposal of waste* *It is important to note that if there are, for example, three different recovery and disposal options for a product system, the most commonly used one, or all three scenarios, shall be declared separately. Also, per ISO 21930 Section 7.1.7.5, "A scenario based on a typical end-of-life, for example a mix of recovery and disposal options based on a national situation, shall only be provided if the scenarios for the separate individual options are also provided."* *A sub-category Part B PCR may provide additional requirements regarding product disposal pathway assumptions beyond what is provided in Section 2.8.5.* *The end-of-life system boundary of the construction product system to Module D is set where outputs, i.e. secondary materials or fuels, have reached system boundary between product systems or disposal of final residues.* *1 This is a USGBC PCR guidance document requirement, in addition to the requirements listed in ISO 21930 Section 5.2.1.*			
TE50			**PCR Specific Part A (§2.8.4.6):** *Benefits and loads beyond the product system boundary, information Module D*	N/A		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			[ISO 21930 Section 7.1.7.6] "Module D is not a life cycle stage like the life cycle stages assessed in information modules A1 to C4. Module D is outside the system boundary of the studied product system and construction works system. Module D is not an allocation approach and does not report impacts that are allocated to other product systems as a result of co-production or recovery processes. Module D provides optional supplementary information about the potential net benefits from reuse, recycling and energy recovery beyond the system boundary of the studied product system." *Unless specified otherwise in a sub-category Part B PCR, Module D may be included in an LCA and EPD, and the results shall conform with ISO 21930 Section 7.1.7.6 as well as the requirements below.* *Specifically, per ISO 21930 Section 7.1.7.6, "the net output flow for all products for reuse, secondary materials, secondary fuels and/or recovered energy leaving a product system is calculated by adding all output flows of the secondary material or fuel or recovered energy and subtracting any input flows of this secondary material or fuel or recovered energy from each information module (e.g. A1 to A5, B1 to B5, C1 to C4) thus arriving at the net output flow of secondary material or fuel or recovered energy from the product system."* *When reporting Module D results, the potential environmental loads and benefits shall be reported separately. When reporting Module D, the following non-emission specific quantitative and qualitative data shall also be included, but is not limited to:* *Recycled content* *Percent recyclability* *Reuse and recovery opportunities* *Mass of recyclable materials*			
TE51			**PCR Specific Part A (§2.8.5):** *Disposal Pathways by Region* *The following disposal pathways for the product shall be used by region or country unless justified otherwise or specified differently in the sub-category Part B PCR. Results for each of the individual options shall also be separately reported, as required by ISO 21930 Section 7.1.7.5 (i.e., if results are presented of a scenario that includes landfill, recycling, and incineration, then results must also be presented separately for 100% landfill, 100% recycling, and 100% incineration).*	Requirement met.		Closed

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

(1)	(2)	(3)	(4)	(5)	(6)	(7)
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Table 2. Product Disposal Assumptions by Region

Country/Region	***Material***	***Recycling Rate***	***Landfill Rate***	***Incineration Rate***
Brazil[2]	*All*	*0%*	*100%*	*0%*
Canada	*Aluminum3*	*95%*	*5%*	*0%*
	All other metals4	*85%*	*15%*	*0%*
	Other materials	*7%5*	*93%*	*0%*
China6	*All*	*5%*	*95%*	*0%*
EU	*All*	*50%7*	*37%8*	*13%9*
India10	*All*	*0%*	*100%*	*0%*
Japan11	*All*	*53%*	*4%*	*43%*
Korea12	*All*	*83.9%*	*9.4%*	*6.1%*
United States13,14	*Aluminum*	*95%*	*5%*	*0%*
	Structural steel	*97%*	*3%*	*0%*
	Steel rebar	*59%*	*41%*	*0%*
	All other metals	*74%*	*26%*	*0%*
	Other materials	*0%*	*100%*	*0%*
South East Asia - Malaysia15	*Concrete and aggregate*	*68%*	*32%*	*0%*
	Wood	*4%*	*96%*	*0%*
	Others	*0%*	*100%*	*0%*
South East Asia – Singa- pore9	*All*	*94%*	*6%*	*0%*
South East Asia – Other16	*All*	*5%*	*95%*	*0%*

TE52			**PCR Specific Part A (§2.8.5):** *Disposal Pathways by Region*	Requirement met.		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			The following disposal pathways shall be used for the product packaging unless justified otherwise or specified differently in the sub-category PCR. ***Table 3. Packaging Disposal Assumptions by Region***	Pathways followed for US.		

Country/Region	Material Type	Recycling Rate	Landfill Rate	Incineration Rate
Brazil[17]	Plastic	13.5%	86.5%	0%
	Metals	70%[18]	30%	0%
	Glass	2.4%	97.6%	0%
	Pulp (cardboard, paper)	13.1%	86.9%	0%
	Wood	51.4%	48.6%	0%
Canada	Plastics	78%[19]	22%	0%
	Other materials	20%[20]	80%	0%
China	Plastics	25%[21]	56%	19%[22]
	Metals	20%[23]	80%	0%
EU[24]	Plastic	41%	39%	31.0%
	Metals	78%	22%	0.5%
	Glass	73.6%	26.4%	0.1%
	Pulp (cardboard, paper)	82.3%	17.7%	7.8%
	Wood	31.1%	68.9%	25.7%
India	All	10%	90%[25]	0%
	Metals	98%[26]	2%	0%

(1) Comment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			(table continued below)			
TE53			**PCR Specific Part A (§2.8.6):** *Waste Classification by Region* *The following relevant legislation references shall be used by region or country:* ***Table 3. Waste classification by region*** (table below)	Requirement met.		Closed

Japan	Other materials	21%[27]	1%	78%
Korea[28]	All	83.9%	9.4%	6.1%
United States[29,30]	Plastics	9%	68%	17%
	Metals	57%	34%	9%
	Pulp (cardboard, paper)	68%	20%	5%

Table 3. Waste classification by region

Country/Region	*Legislation*
Brazil	*Annex 1-A to 1-C of the CONAMA Resolution no 23, from Decembe 1996, unless they do not present any characteristics listed in Annex the same legislation.* *Annex 10-A and 10-B of the CONAMA Resolution no 235, from Janu 7, 1998*
China	*List of Toxic Chemicals Severely Restricted on the Import and Expo China (Circular No. 65 [2005])* *Measures for the Administration of Restricted Use of Hazardous Substances in Electrical and Electronic Products (Circular No. 32 [2*
Europe	*REACH Substances of Very High Concern*
India	*REACH Substances of Very High Concern*

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			Japan: *Hazardous wastes defined by the Basel Law are as follows:* *A. The following materials which are exported or imported for the disposal operations listed in Annex IV of the Basel Convention.* *1. Materials listed in Annex I of the Convention and having one or more hazardous characteristics listed in Annex III of the Convention;* *2. Materials listed in Annex II of the Convention;* *3. Materials to be notified to the Secretariat of the Convention by the Government of Japan through the designation by the Cabinet Order in accordance with Section 1 or 2 of Article 3 of the Convention; and* *4. Materials informed by the Secretariat of the Convention in accordance with Section 3 of Article 3 of the Convention.* *B. Materials, exportation, importation, transportation (including storage) and disposal of which must be regulated based on bilateral, multilateral or regional agreements or arrangements defined in Article 11 of the Convention.* *Korea*: *Waste Control Act with some regulation under the Act on the Promotion of Saving and Recycling of Resources.* *North America*: *Resource Conservation and Recovery Act (RCRA), Subtitle 3* *Southeast Asia*: *REACH Substances of Very High Concern*			
TE54			**PCR Specific Part A (§2.8.7):** *Incineration Efficiency* *If data are available, the efficiency of waste incineration plants (R1) shall be calculated in accordance with Annex II of the EU waste directive as follows:* $R1WIP = ((Epe \times 2{,}6 + Eph,use \times 1{,}1) - (Ef + Ei)) / (0{,}97 \times (Ew + Ef))$ Epe *means annual energy produced as electricity* (GJ/a) Eph,use *means annual energy produced as heat for commercial use* (GJ/a) Ef *means annual energy input into the system from fuels contributing to the production of steam* (GJ/a) Ei *means annual energy imported excluding* Ew *and* Ef (GJ/a) Ew *means annual energy contained in the treated waste calculated using the net calorific value of the waste* (GJ/a)	N/A		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			0,97 is a factor accounting for energy losses due to bottom ash and radiation *WIP waste incineration plant* *In summary, three different cases of modelling thermal recycling of waste should be modelled and declared can be distinguished:* *Thermal treatment of waste, i.e. the waste flow has not reached the end of the waste status before combustion, and the incineration plant has a R1-value <0.6: the environmental loads of waste processing and incineration processes are declared as a waste disposal process in Module C4. Produced net energy due to treatment of waste is declared as exported energy in C4 and the benefits of the generated net energy is declared in Module D.* *Energy Recovery, i.e. the waste flow has not reached the end of waste status before combustion, and the incineration plant has a R1 value> 0.6: the environmental impact of waste processing and incineration processes are declared as energy recovery in C.3, the produced net energy is declared as exported energy in C3 and the associated benefits of the generated net energy is declared in Module D.* *Energetic use of a secondary fuel, i.e. the waste flow has reached the end of waste status prior to the combustion or thermal energy recovery process. This qualifies the material flow at the system boundary as a secondary fuel and the criteria of the R1 value is not applicable: the environmental impacts of any waste treatment of the future secondary fuel are accounted in C3, the material flow is declared as a material for energy recovery in C3, and the benefits associated with the generated net energy are declared in Module D.* *NOTE: The default assumption shall be thermal treatment of waste unless the proper justification can be provided for other methods with supporting documentation.*			
TE55			**PCR Specific Part A (§2.8.8):** *Power Mix* *All electricity assumptions shall be documented in the project report. The following applies as regards selecting the power mix:* *At production facilities in the US, regionally specific grid mix data on electricity shall be based on EPA's eGRID database.32 Preference should be given to subnational consumption mixes that account for power trade between these regions. Alternatively, US production mixes of the three continental interconnections (East, West, Texas) as well as those of Hawaii and Alaska may be used.*	Requirement met. Electricity grids are appropriate for US.		Closed

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			At production facilities in Canada, province specific grid mix data on electricity shall be based on StatCan statistics. Alternatively, production mixes of the two continental interconnections (East, West) may be used. *At production facilities in the EU, the European Continental (UCTE), Nordic, United Kingdom, Ireland and Baltic electricity grids shall be considered to be interconnected.* *At production facilities in China, region specific grid mix data on electricity shall be based on grid mixes of the State Grid Corporation of China (SGCC) or the China Southern Power Grid (CSG), depending on the provider of the facility.* *At production facilities in Brazil, India, Indonesia, Japan, Korea, Malaysia, or Thailand, country-specific grid mixes shall be based on IEA/OECD statistics.* *At production facilities outside of the countries listed above, comparable country-specific or region-specific processes shall be used provided they comply with the current state of the art.* *At production facilities in several countries, the applicable power mixes shall be assessed specifically for each country or combined weighted by production volumes in the respective countries.* *If "green" power is used, it must not be reported in inventory or impact assessment results in the LCA and EPD; results must specify the original grid source used for production.* *However, if there is a transparent path, such as in the EU (Guarantee of Origin), where chain of custody of green power can be traced by kwh and origin (not just CO2e attributes), these results may be reported separately with an explanatory note stating how the green power is used in the calculations. Certificates must be available for the entire period of EPD validity. If certificates cannot be provided for the full 5 years when issuing the EPD, the program operator must request the certificates for the preceding five (5) years in order to extend the Declaration.*			
TE56			**PCR Specific Part A (§2.8.9):** *CO2 Certificates* *CO2 certificates shall not be included in the Life Cycle Assessment but may be reported separately, apart from LCA results. The following CO2 certificates may be recognized:* *Clean Development Mechanism (CDM) Gold Standard* *Gold Standard Verified Emission Reduction (VER)* *Voluntary Carbon Standard* *Verified Emission Reduction (VER)*	N/A		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

<table>
<tr><th>(1)
Com-ment Type & No.</th><th>(2)
Page No.</th><th>(3)
Para/ Fig/ Tbl/ Note</th><th>(4)
ISO/PCR Requirement</th><th>(5)
Comment (justification for change)/Proposed change</th><th>(6)
Decisions on each comment submitted</th><th>(7)
Open/ Closed</th></tr>
<tr><td></td><td></td><td></td><td>Other certificates can be considered if they comply with the criteria on which this selection is based.

Given EPDs are valid for a period of five (5) years, the manufacturer must provide evidence of discontinuation of CO2 pollution rights in order to obtain recognition.

CO2 credits shall be specified separately and not reported in inventory or impact assessment results. There shall be clear delineation between the product life cycle impacts and then any carbon offsets or credits used to mitigate this impact.

Purchased CO2 offsets shall not be used to reduce the declared impact of a product in an EPD. Additionally, a manufacturer must not have sold or transferred any impact reductions separately from the product.

Example 1: A product contains 10kg of biogenic carbon from a sustainable source, and sells (or intends to sell) an offset. The EPD may not apply -36.7 kg CO2e in the A1 stage.

Example 2: XYZ Company substitutes a material that avoids 10 kg CO2e of emissions per declared unit, and reflects this reduction in the EPD. XYZ Company cannot sell or transfer that reduction separately from the product, or the EPD is no longer valid.</td><td></td><td></td><td></td></tr>
<tr><td>TE57</td><td></td><td></td><td>PCR Specific Part A (§4.12) Specific Part B (§3.4): Units
SI units are required for all LCA results. Other units commonly used in a regional market may be optionally included in addition to the required SI units.

TABLE 2. MANDATORY CONVERSION FACTORS TO BE USED IF REPORTING IN IMPERIAL UNITS

<table>
<tr><th>Convert from</th><th>To</th><th>Multiply by</th></tr>
<tr><td>square meter (m^2)</td><td>Square foot (ft^2)</td><td>10.76391</td></tr>
<tr><td>kilogram (kg)</td><td>Pound (lb)</td><td>2.204622</td></tr>
<tr><td>Mega joule (MJ)</td><td>British Thermal Unit (BTU)</td><td>947.8170</td></tr>
<tr><td>degree Celsius (°C)</td><td>degree Fahrenheit (°F)</td><td>t/°C = (t/°F - 32)/1.8</td></tr>
<tr><td>cubic meter (m3)</td><td>cubic foot (ft3)</td><td>35.31466</td></tr>
</table></td><td>There are three occurrences of the units: h·ft^2·°F, whereby the “h” is for hour and should be abbreviated as “hr” for consistency.
Sec. 2.2, first paragraph fourth line
RSI definition of equation (2)
Table 2-2 Units for R-value per inch.</td><td>Done
Acknowledged.</td><td>Closed</td></tr>
</table>

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			Part B (§3.4): *SI units are required for all LCA results. Other units commonly used in a regional market may be optionally included in addition to the required SI units.* ***TABLE 2. Mandatory conversion factors to be used if reporting in Imperial units*** *Convert from / To / Multiply by:* *square meter (m2) / Square foot (ft2) / 10.76391* *kilogram (kg) / Pound (lb) / 2.204622* *Mega joule (MJ) / British Thermal Unit (BTU) / 947.8170* *degree Celsius (°C) / degree Fahrenheit (°F) / t/°C = (t/°F - 32)/1.8* *cubic meter (m3) / cubic foot (ft3) / 35.31466* *Btu-ft./hr·ft2 ·°F / Btu-in./hr·ft2·°F / 0.083* *W/m°K / Btu-in./hr·ft 2·°F / 6.94* ***Optional Imperial Reporting Units*** *Functional Unit FU = DU = R · λ · ρ · A [lb] where; R = thermal resistance [ft²·°F·hr/Btu] λ = thermal conductivity [Btu-in./hr· ft2 ·°F] ρ = density of insulation product [lb/ft³]* *A = Area [ft²], here 1 ft²* *Note: Common units for thermal conductivity in the U.S. are Btu-in./hr·ft2·°F.*			
TE58			**PCR Specific Part A (§2.9) and Part B (§3.5):** *Cut-off Rules [ISO 21930 Section 7.1.8 supplemented]: "Criteria for the exclusion of inputs and outputs (cutoff rules) in the Life Cycle Assessment and information modules and any additional information are intended to support an efficient calculation procedure. They shall not be applied in order to hide data. Any application of the criteria for the exclusion of inputs and outputs shall be documented."* *The procedure detailed in ISO 21930, Section 7.1.8 shall be followed for the exclusion of inputs and outputs.* *Application of the cut-off criteria shall be documented in the project report:*	Requirement met.		Closed

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			Description of the application of cut-off criteria and assumptions *List of processes not taken into consideration* ***7.1.8 Criteria for the inclusion and exclusion of inputs and outputs*** *The criteria for the exclusion of inputs and outputs (cut-off rules) in the LCA and information modules and any additional information are intended to support an efficient calculation procedure. Cut-off rules shall not be applied in order to hide data. Any application of the criteria for the exclusion of inputs and outputs shall be documented.* *When impacts are assessed and reported, the cut-off rules shall be based on the environmental impacts related to the respective material flows. The cut-off rules shall be justified and documented in the EPD and project report.* *The following procedure shall be followed for the inclusion and exclusion of inputs and outputs.* *— All inputs and outputs to a (unit) process shall be included in the calculation of the pre-set parameters results, for which data are available. Data gaps shall be filled by conservative assumptions with average, generic or proxy data. Any assumptions for such choices shall be documented.* *— Particular care should be taken to include material and energy flows that are known or suspected to release substances into the air, water or soil in quantities that contribute significantly to any of the pre-set indicators of this document. In cases of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1 % of renewable primary resource (energy), 1 % nonrenewable primary resource (energy) usage, 1 % of the total mass input of that unit process and 1 % of environmental impacts. The total of neglected input flows per module shall be a maximum of 5 % of energy usage, mass and environmental impacts. When assumptions are used in combination with plausibility considerations and expert judgement to demonstrate compliance with these criteria, the assumptions shall be conservative.* *— All substances with hazardous and toxic properties that can be of concern for human health and/or the environment shall be identified and declared according to normative requirements in standards or regulation applicable in the market for which the EPD is valid, even though the given process unit* *is under the cut-off criterion of 1 % of the total mass.*			

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			Application of the cut-off criteria shall be documented in the project report: *Description of the application of cut-off criteria and assumptions* *List of processes not taken into consideration .* **Part B (§3.5):** *Cut-off rules as specified per Part A Section 2.9 shall be used and documented. All known mass and energy flows shall be reported. No known flows should be deliberately excluded.*			
TE59			**PCR Specific Part A (§3.1):** *Life Cycle Inventory Analysis –* ***DATA SELECTION, COLLECTION, AND DATA QUALITY*** *The requirements detailed in ISO 21930 Sections 7.1.9, 7.2.1, and 7.2.2 shall apply to the selection and collection of data used to calculate an LCA and report an EPD.* *Manufacturer specific data shall be no more than five years old.* *The data selection and collection procedures shall be documented in the project report.* *Primary data shall be collected for every process in the product system under the control of the organization developing the LCA. Primary data shall be collected using either direct measurement or facility personnel's best engineering estimates based on actual production if measurements are not available. The method of collection shall be specified for each process in the LCA report.* *The specified secondary sources should have temporal, geographic, and technological coverage appropriate to the scope of the product category. The system boundaries of the secondary sources should be equivalent and reference flows should be adaptable to the product system specified in the PCR. Allocation procedures used in the specified secondary sources should be appropriate for the product category.* *For industry-average EPDs, data shall be collected from participants in a consistent manner.* *All data sources shall be specified, including database and year of publication (reference).*	Requirement met.		Closed

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			Secondary data sources from regions other than the primary market may be used only if primary market data are unavailable in any commercial database. The substitute source shall be documented. *LCA models used to generate results for an EPD are encouraged to use unit process data sets (as opposed to system process data sets) so that the modeller may edit the underlying data in pursuit of optimizing the representativeness of the data set to the product system.*			
TE60	Annex A1		**PCR Specific Part A (§3.1):** *Life Cycle Inventory Analysis –**DATA SELECTION, COLLECTION, AND DATA QUALITY*** *The requirements detailed in ISO 21930 Sections 7.1.9, 7.2.1, and 7.2.2 shall apply to the selection and collection of data used to calculate an LCA and report an EPD.* *Manufacturer specific data shall be no more than five years old.* *The data selection and collection procedures shall be documented in the project report.* *Primary data shall be collected for every process in the product system under the control of the organization developing the LCA. Primary data shall be collected using either direct measurement or facility personnel's best engineering estimates based on actual production if measurements are not available. The method of collection shall be specified for each process in the LCA report.* *The specified secondary sources should have temporal, geographic, and technological coverage appropriate to the scope of the product category. The system boundaries of the secondary sources should be equivalent and reference flows should be adaptable to the product system specified in the PCR. Allocation procedures used in the specified secondary sources should be appropriate for the product category.* *For industry-average EPDs, data shall be collected from participants in a consistent manner.* *All data sources shall be specified, including database and year of publication (reference).*	Update or provide justification for LCI datasets older than 10 years (before 2014) – particularly for MDI as there is a recent (July 2022) ACC study that is publicly available: https://www.americanchemistry.com/better-policy-regulation/plastics/resources/cradle-to-gate-life-cycle-analysis-of-methylene-diphenyl-diisocyanate-mdi-resin-precursor	MDI dataset has been replaced with an ISOPA dataset (reference year in 2018) and pallet dataset has been updated to a more recent one (reference year in 2017). **Acknowledged.**	Closed

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			Secondary data sources from regions other than the primary market may be used only if primary market data are unavailable in any commercial database. The substitute source shall be documented. *LCA models used to generate results for an EPD are encouraged to use unit process data sets (as opposed to system process data sets) so that the modeller may edit the underlying data in pursuit of optimizing the representativeness of the data set to the product system.* *As a general rule, specific data derived from specific production processes shall be the first choice as a basis for calculating an EPD. In addition, the following rules shall apply to EPDs in accordance with this PCR:* *[ISO 21930 Section 7.1.9]:* *"The quality of the data used to calculate an EPD shall be addressed in the project report (see ISO 21930 Section 7.1.9 and ISO 14044 Section 4.2.3.6). In addition the following specific requirements apply for construction products:* *An EPD describing a specific product shall be calculated using specific data for at least the processes over which the manufacturer of the specific product has influence. Generic and proxy data may be used for the processes over which the manufacturer has no influence, for example processes dealing with the production of input commodities, such as raw material extraction or electricity generation, often referred to as upstream data (see following table)."*			

Modules	**A1 to A3**		**A4 to A5**	**B1 to B7**	**C1 to C4**
	Production of com-modities, raw mate-rials	Product manufacture	Installation pro-cesses	Use processes	End-of-life processes
Process type	Upstream processes	Manufacturer's processes	Downstream processes		

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			Data type | Generic data or EPD of upstream processes See also [ISO 21930] Annex B | Manufacturer's aver- age or specific data See also [ISO 21930] Annex B | Scenario based generic data based on technical information given in [ISO 21930] 7.1.7.3 to 7.1.7.5 *Data shall be as current as possible. Data sets used for calculations shall have been updated within the last ten (10) years for background data and within the last five (5) years for producer-specific (foreground) data34. Deviations shall be justified.* *Manufacturer-specific data sets shall be based on 12 consecutive months of averaged data; deviations shall be justified in the project report. If future production conditions are to be incorporated at the time of generating the EPD, the following shall apply:* *o Processes which do not have an influence on the manufacturing process (e.g. procurement of green electricity) may be integrated in the Declaration. For green electricity, this means that the Declaration may not be issued until such a time as procurement takes place and is verified by contract.* *o For processes which have an influence on manufacturing processes (e.g. new furnace), data must be available over a certain period of time which provides a representative set of data for the new process. This need not be a full year; 3- 4 months often suffices in this case.* *[ISO 21930 Section 7.1.9]:* *The time period over which inputs to and outputs from the system shall be accounted for is 100 years from the year for which the data set is deemed representative. A longer time period shall be used if relevant and shall be justified in the project report;* *Emissions from a landfill should be accumulated over 100 years after the material was deposited on or in the landfill.* *o NOTE Long-term emissions are considered emissions occurring beyond 100 years after the material was deposited on or in the landfill.* *The technological coverage shall reflect the physical reality for the declared product or product group;*			

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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TE61			**ISO Requirement (§4.3.2.1):** *Life Cycle Inventory Analysis – Collecting Data* *The qualitative and quantitative data for inclusion in the inventory shall be collected for each unit process that is included within the system boundary. The collected data, whether measured, calculated or estimated, are utilized to quantify the inputs and outputs of a unit process.* *When data have been collected from public sources, the source shall be referenced. For those data that may be significant for the conclusions of the study, details about the relevant data collection process, the time when data have been collected, and further information about data quality indicators shall be referenced. If such data do not meet the data quality requirements, this shall be stated.* *To decrease the risk of misunderstandings (e.g. resulting in double counting when validating or reusing the data collected), a description of each unit process shall be recorded.* *Since data collection may span several reporting locations and published references, measures should be taken to reach uniform and consistent understanding of the product systems to be modelled.*	Requirement met.		Closed
TE62			**ISO Requirement (§4.3.3.1):** ***Life Cycle Inventory Analysis – Calculating Data - General*** *All calculation procedures shall be explicitly documented and the assumptions made shall be clearly stated and explained. The same calculation procedures should be consistently applied throughout the study.* *When determining the elementary flows associated with production, the actual production mix should be used whenever possible, in order to reflect the various types of resources that are consumed. As an example, for the production and delivery of electricity, account shall be taken of the electricity mix, the efficiencies of fuel combustion, conversion, transmission and distribution losses.* *Inputs and outputs related to a combustible material (e.g. oil, gas or coal) can be transformed into an energy input or output by multiplying them by the relevant heat of combustion. In this case, it shall be reported whether the higher heating value or the lower heating value is used.*	Requirement met.		Closed

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			Several operational steps are needed for data calculation. These are described in 4.3.3.2 to 4.3.3.4 and 4.3.4.			
TE63			**ISO Requirement (§4.3.3.2):** ***Life Cycle Inventory Analysis – Calculating Data – Validation of data*** *A check on data validity shall be conducted during the process of data collection to confirm and provide evidence that the data quality requirements for the intended application have been fulfilled.* *Validation may involve establishing, for example, mass balances, energy balances and/or comparative analyses of release factors. As each unit process obeys the laws of conservation of mass and energy, mass and energy balances provide a useful check on the validity of a unit process description. Obvious anomalies in the data resulting from such validation procedures require alternative data that comply with the data selection as established according to 4.2.3.5.*	Requirement met.		Closed
TE64			**ISO Requirement (§4.3.3.3):** ***Life Cycle Inventory Analysis – Calculating Data – Relating Data to Unit Processes and Functional Unit*** *An appropriate flow shall be determined for each unit process. The quantitative input and output data of the unit process shall be calculated in relation to this flow.*	Requirement met.		Closed
TE65			**ISO Requirement (§4.3.3.4):** ***Life Cycle Inventory Analysis – Calculating Data – Refining the system boundary*** *Reflecting the iterative nature of LCA, decisions regarding the data to be included shall be based on a sensitivity analysis to determine their significance, thereby verifying the initial analysis outlined in 4.2.3.3. The initial system boundary shall be revised, as appropriate, in accordance with the cut-off criteria established in the definition of the scope. The results of this refining process and the sensitivity analysis shall be documented.* *The sensitivity analysis may result in* *– exclusion of life cycle stages or unit processes when lack of significance can be shown by the sensitivity analysis,* *– exclusion of inputs and outputs that lack significance to the results of the study, or* *– inclusion of new unit processes, inputs and outputs that are shown to be significant in the sensitivity analysis.* *This analysis serves to limit the subsequent data handling to those input and output data that are determinedto be significant to the goal of the LCA.*	Requirement met. System boundary set by the PCR.		Closed

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TE66			**ISO Requirement (§4.3.4.1): *Life Cycle Inventory Analysis – Calculating Data – Allocation - General*** *The inputs and outputs shall be allocated to the different products according to clearly stated procedures that shall be documented and explained together with the allocation procedure.* *The sum of the allocated inputs and outputs of a unit process shall be equal to the inputs and outputs of the unit process before allocation.* *Whenever several alternative allocation procedures seem applicable, a sensitivity analysis shall be conducted to illustrate the consequences of the departure from the selected approach.*	Requirement met.		Closed
TE67			**ISO Requirement (§4.3.4.2): *Life Cycle Inventory Analysis – Calculating Data – Allocation Procedures*** *The study shall identify the processes shared with other product systems and deal with them according to the stepwise procedure presented below.* *a) **Step 1**: Wherever possible, allocation should be avoided by* *1) dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes, or* *2) expanding the product system to include the additional functions related to the co-products, taking into account the requirements of 4.2.3.3.* *b) **Step 2**: Where allocation cannot be avoided, the inputs and outputs of the system should be partitioned between its different products or functions in a way that reflects the underlying physical relationships between them; i.e. they should reflect the way in which the inputs and outputs are changed by* *quantitative changes in the products or functions delivered by the system.* *c) **Step 3**: Where physical relationship alone cannot be established or used as the basis for allocation, the inputs should be allocated between the products and functions in a way that reflects other relationships between them. For example, input and output data might be allocated between co-products in proportion to the economic value of the products.* *Some outputs may be partly co-products and partly waste. In such cases, it is necessary to identify the ratio between co-products and waste since the inputs and outputs shall be allocated to the co-products part only.*	Requirement met.		Closed

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			Allocation procedures shall be uniformly applied to similar inputs and outputs of the system under consideration. For example, if allocation is made to usable products (e.g. intermediate or discarded products) leaving the system, then the allocation procedure shall be similar to the allocation procedure used for such products entering the system. *The inventory is based on material balances between input and output. Allocation procedures should therefore approximate as much as possible such fundamental input/output relationships and characteristics.*			
TE68			**ISO Requirement (§4.3.4.3):** *Life Cycle Inventory Analysis – Calculating Data – Allocation Procedures – resuse and recycling* *4.3.4.3.1 The allocation principles and procedures in 4.3.4.1 and 4.3.4.2 also apply to reuse and recycling situations.* *Changes in the inherent properties of materials shall be taken into account. In addition, particularly for the recovery processes between the original and subsequent product system, the system boundary shall be identified and explained, ensuring that the allocation principles are observed as described in 4.3.4.2.* *4.3.4.3.2 However, in these situations, additional elaboration is needed for the following reasons:* *– reuse and recycling (as well as composting, energy recovery and other processes that can be assimilated to reuse/recycling) may imply that the inputs and outputs associated with unit processes for extraction and processing of raw materials and final disposal of products are to be shared by more than one product system;* *– reuse and recycling may change the inherent properties of materials in subsequent use;* *– specific care should be taken when defining system boundary with regard to recovery processes.* *4.3.4.3.3 Several allocation procedures are applicable for reuse and recycling. The application of some procedures is outlined conceptually in Figure 2 and is distinguished in the following to illustrate how the above constraints can be addressed.* *a) A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials. However, the first use of virgin materials in applicable open-loop product systems may follow an open-loop allocation procedure outlined in b).*	Requirement met.		Closed

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			b) An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties. *4.3.4.3.4 The allocation procedures for the shared unit processes mentioned in 4.3.4.3 should use, as the basis for allocation, if feasible, the following order:* *– physical properties (e.g. mass);* *– economic value (e.g. market value of the scrap material or recycled material in relation to market value of primary material); or* *– the number of subsequent uses of the recycled material (see ISO/TR 14049).*			
TE69			**ISO Reporting Requirement (§5.2):** *Additional Requirements and Guidance* *The third-party report shall cover the following aspects:* *d) **Life cycle inventory analysis**:* *1) data collection procedures;* *2) qualitative and quantitative description of unit processes;* *3) sources of published literature;* *4) calculation procedures;* *5) validation of data, including* *i) data quality assessment, and* *ii) treatment of missing data;* *6) sensitivity analysis for refining the system boundary;* *7) allocation principles and procedures, including* *i) documentation and justification of allocation procedures, and* *ii) uniform application of allocation procedures.*	Requirement met.		Closed
TE70			**PCR Specific Part A (§3.1.1) Part B (§3.6) Part B (§3.7):** *Life Cycle Inventory Analysis – Data Quality Evaluation.* *An evaluation of data quality, including temporal, geographical, technological representativeness, and completeness, shall be included in the project report.* *If the data quality assessment gives sufficient reason to believe that any of the employed generic material or process LCI data is not representative of the product(s) under study and may introduce error to the reported impact category results, then a reasonable effort shall be made by the declaring organization to improve the data quality either by 1) collecting primary data on the material or process in question from suppliers or process operators, 2) developing LCI data based on other*	Requirement met.		Closed

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			data sources like scientific literature, equipment specs, or trade publications, *or 3) assessing whether more representative LCI data is available from any of the sources listed in Section 3.1.2. If none of these options is viable within given constraints, the source and nature of the expected error shall be documented in the project report and a disclaimer should be added to the EPD that the reported values are likely an over- or underestimate of potential environmental burdens.* **Part B (§3.6):** *Data sources shall be documented per Part A Section 3.1.* **Part B (§3.7):** *An evaluation shall be provided regarding data quality, including temporal, geographical, technological representativeness, and completeness and shall follow the requirements outlined in PCR, Part A Section 3.1.1.*			
TE71			**PCR Specific Part A (§3.1.2) Part B (§3.8):** *Life Cycle Inventory Analysis – Background Data.* *The following rules shall apply for selecting the background data base:* *As a general rule, consistent background data should be used in order to ensure comparability of results.* *Allocation by system expansion is not allowed for background datasets* *The following databases35 may be used:* *o NREL US LCI / LCA Digital Commons (https://www.lcacommons.gov)* *o European/International Life Cycle Database (https://eplca.jrc.ec.europa.eu/LCDN/index.xhtml)* *o GaBi (http://www.gabi-software.com/databases)* *o ecoinvent (www.ecoinvent.org)* *o WorldSteel database (https://www.worldsteel.org/steel-by-topic/life-cycle-thinking.html)* *o WorldAluminum database (https://international-aluminium.org/resource/lifecycle-inventory-data-and-environmental-metrics/)* *o eBalance (http://support.ike-global.com/downebalancefree)* *o AusLCI (http://www.auslci.com.au/)* *o Agri-footprint (http://www.agri-footprint.com/)* *The documentation format for LCI data sets should use the current ILCD format and nomenclature as defined in the "International Reference Life Cycle Data System (ILCD) Handbook – Nomenclature and other conventions"*	Requirement met.		Closed

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			A third party verified ISO 14040/44 conforming report shall be available for all secondary data sets with the exception of the databases listed above (either at the unit process level or in aggregate) that contribute to more than 80% of total impact, considered over the full life cycle, to any of the required impact categories identified by the applicable PCR. *The project report shall:* *Indicate the data sets used and sources (e.g., name of database, literary source), including the year for which the data set is representative* *Document the representativeness of data sets used* *Document the treatment of missing data* *Evaluate data quality of generic and primary data* **Part B (§3.8):** *The period under review and ensuing averages shall be documented.*			
TE72			**PCR Specific Part A (§3.2):** *Life Cycle Inventory Analysis – Calculation Procedures* *Calculation procedures described in ISO 14044 and referenced in ISO 21930 Section 7.2.2 shall apply. All calculation procedures shall be applied consistently throughout the LCA.* *When transforming the inputs and outputs of combustible materials into energy, the lower caloric value of fuels (LHV) shall be applied according to scientifically based and accepted values specific to the combustible material.* ***ISO 21930*** ***7.2.2 Calculation procedures*** *The calculation procedures described in ISO 14044 shall apply. The same calculation procedures shall be applied consistently throughout the study.* *When transforming the inputs and outputs of combustible material into inputs and outputs of energy, the net calorific value of fuels shall be applied according to scientifically based and accepted values specific to the combustible material.*	Requirement met.		Closed
TE73			**PCR Specific Part A (§3.3):** *Life Cycle Inventory Analysis – Allocation Procedures – coproducts and between product systems*	Requirement met.		Closed

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			Allocation procedures for co-products and between product systems shall be addressed according to ISO 21930, Sections 7.2.4, 7.2.5, and 7.2.6. Generally speaking, allocation shall be avoided by dividing unit processes into sub-processes that can be allocated to co-products and by then collecting the input and output data related to these sub-processes. *Unless specified otherwise in a sub-category Part B PCR, allocation shall be based on physical properties (e.g. mass, volume) when the difference in revenue from the co-products is low;* *Regardless of the allocation approach chosen for a co-production process or for secondary flows crossing the system boundary between product systems, specific inherent properties of such coproducts or flows (e.g. calorific content, composition (biogenic carbon content, CaO/Ca(OH)2 content)), shall not be allocated but always reflect the physical flows;* *In all other cases, allocation shall be based on economic values;* *Impacts from allocated co-products shall not be included in module D.* *System expansion (the approach of expanding the product system to include the additional functions related to the coproducts) is not considered as an option for avoiding allocation within EPD studies. It shall not be used to avoid the allocation of impacts to any co-products which are produced or used in the manufacture of construction products* *NOTE 1: Contributions to the overall revenue of the order of 1% or less is regarded as very low. A difference in revenue of more than 25% is regarded as high.* *NOTE 2: A common position on the definition of the most appropriate allocation rule needs to be defined together with other relevant sectors.* *NOTE 3: Products and functions are the outputs and/or services provided by the process, having a positive economic value.* *NOTE 4: In industrial processes, there may be a wide variety of different types of materials produced in conjunction with the intended product. In business vocabulary, these may be identified as by-products, co-products, intermediate products, non-core products or sub-products. In this Part A PCR these terms are treated as being equivalent. However, for the allocation of environmental aspects and impacts a distinction between co-products and products is made in this Part A PCR."*			
TE74			**PCR Specific Part A (§3.3.1):** *Life Cycle Inventory Analysis – Allocation Procedures – Reuse, Recycling and Recovery*	Requirement met.		Closed

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			[ISO 21930 Section 7.2.6] "The allocation procedure for flows crossing the system boundary between product systems (allocation to recycling) is simple. No burdens are allocated across the system boundary with secondary material, secondary fuel, or recovered energy flows arising from waste." *It is important to note that "Module D does not show allocated impact and is not a form of allocation as there is no allocation of burdens across the system boundary."* *Where relevant […], informative Module D declares potential benefits or avoided loads of secondary material, secondary fuel or recovered energy leaving the product system. Module D recognizes the "design for reuse, recycling and recovery" concept for construction works by indicating the potential benefits of avoided future use of primary materials and fuels while taking into account the loads associated with the recycling and recovery processes beyond the system boundary."* *NOTE 1: Module D also contains benefits from recovered energy exported from waste disposal processes declared in Module C4 and A5.* *Where a secondary material or fuel crosses the system boundary and if it substitutes another material or fuel in the following product system, the potential benefits or avoided loads can be calculated based on a specified scenario which is consistent with any other scenario for waste processing and is based on current average technology or practice.* *If today's average is not available for the quantification of potential benefits or avoided loads, a conservative approach shall be used that substitutes primary material based on the current technology mix for the material.* *In Module D, the impacts of net output flows are calculated as follows:* *By adding all output flows of a secondary material or fuel and subtracting all input flows of this secondary material or fuel from each sub-module first (e.g. B1-B5, C1-C4 etc.), then from the modules (e.g. B, C), and finally from the total product system thus arriving at net output flows of secondary material or fuel from the product system;* *By adding the impacts connected to the recycling or recovery processes from be-yond the system boundary up to the point of functional equivalence where the secondary material or fuel substitutes primary production and subtracting the impacts resulting from the*			

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			substituted production of the product or substituted generation of energy from primary sources; *By applying a justified value-correction factor to reflect the difference in functional equivalence where the output flow does not reach the functional equivalence of the substitution process.* *In Module D substitution effects are only calculated for the resulting net output flow.* *The amount of secondary material output, which is for all practical purposes able to replace one to one the input of secondary material as a closed loop is allocated to the product system under study and not to Module D.* *NOTE 2: Avoided impacts from allocated co-products are not part of Module D information […].”* *When selecting the substituted processes, the following shall apply for packaging energy utilization (Also see Section 2.8.4.2):* *For production locations in the US, regionally specific inventory data on electricity based on the current version of EPA’s eGRID database shall be used. Preference should be given to subnational consumption mixes that account for power trade be-tween these regions. Alternatively, US production mixes of the three continental interconnections (East, West, Texas) as well as those of Hawaii and Alaska may be used. Substituted thermal energy shall be accounted for as thermal energy from natural gas, indicating the year of reference.* *In the case of production facilities in Germany, the current average “Strom Deutsch-land” index shall be used for power and the “Thermal energy from natural gas” index for heat, indicating the year of reference.* *In the case of production facilities in Brazil, China, India, Japan, Korea, or Southeast Asia, refer to Section 2.8.8 for electricity requirements. Substituted thermal energy shall be accounted for as global average thermal energy from natural gas, indicating the year of reference.* *For production locations outside of the countries and region listed above, the respective location where energy is provided must be taken into consideration.*			

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			When selecting the substituted processes, the following shall apply for 1) packaging energy use (Also see Section 2.8.4.2) and 2) product energy use at end of life: *For production locations in the US, regionally specific inventory data on electricity based on the current version of EPA's eGRID database shall be used. Preference should be given to subnational consumption mixes that account for power trade between these regions. Alternatively, US production mixes of the three continental interconnections (East, West, Texas) as well as those of Hawaii and Alaska may be used.* *Substituted thermal energy shall be accounted for as thermal energy from natural gas, indicating the year of reference.* *In the case of production facilities in Europe, refer to Section 2.8.8 for electricity requirements. Substituted thermal energy shall be accounted for as EU average thermal energy from natural gas indicating the year of reference.* *In the case of production facilities in Brazil, China, India, Japan, Korea, or Southeast Asia, refer to Section 2.8.8 for electricity requirements. Substituted thermal energy shall be accounted for as global average thermal energy from natural gas, indicating the year of reference.* *For production locations outside of the countries and region listed above, the respective location where energy is provided must be taken into consideration.*			
TE75			**PCR Specific Part A (§3.3.2):** *Life Cycle Inventory Analysis – Allocation Procedures – Processes in the Project Report* *Allocations performed must be described in the project report, at least (if relevant):* *Allocations when using secondary materials as raw materials* *Allocations in the plant (differentiation from other products manufactured in the plant)* *Allocation of multi-input processes if performed during modelling* *Allocations of reuse, recycling and energy recovery* *The allocation processes selected must be justified and the allocation factors used must be confirmed by independent sources.* *Uniform application of the allocation rules must be documented.*	Requirement met.		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

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TE76			**PCR Specific Part A (§3.4):** *Life Cycle Inventory Analysis – Description of the Unit Processes in the Project Report.* *The project report must transparently document the unit process modelling in the LCA. With regards to data confidentiality, relevant confidential information shall be shared for verification purposes and kept confidential by the Program Operator. The report may not include confidential information for communication with third-parties.* *Documentation may be done in a tabular form or as flow charts (e.g. screenshots from LCA software), whereby the following must be clarified:* *Attribution of company data to LCI background data sets* *Allocation of process data to the life cycle modules in the LCA* *If several products are declared in a single EPD or if a product is manufactured at several locations, modelling must be described for each product and/or location and the weighing of data sets documented.*	Requirement met.		Closed
TE 77			**PCR Specific Part B (§3.10): Allocation** *Part A, Section 3.3 shall be used as the basis for allocation decisions, and mass should be used as the primary basis for co-product allocation in this Part B. Allocation methods deemed more appropriate than on the basis of mass may be used but only when justified. The allocations of relevance for calculation (appropriation of impacts across various products) shall be indicated, at least:* • *Allocation in the use of recycled and/or secondary raw materials* • *Allocation of energy, ancillary and operating materials used for individual products in a factory* *whereby reference shall be made to the modules in which the allocations are performed.*	Requirement met.		Closed
TE78			**PCR Specific Part A (§4.0): Life Cycle Inventory Analysis and estimated impacts** *The results of the Life Cycle Assessment must be described in the project report in tabular form for all Modules A1 to D. The Life Cycle Inventory Analysis indicators to be declared and the estimated impacts shall also be indicated.* *If individual modules or entire life cycle stages are not declared, the corresponding fields in the table must be marked as "MND" (module not declared).*	Requirement met.		Closed

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
TE79			**PCR Specific Part A (§4.1): Life Cycle Inventory Analysis as per ISO 21930** *[ISO 21930 Section 7.2.10]: "Parameters to describe the use of resources:* *The following environmental parameters use data from the inventory analysis. They describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water. The parameters are required and shall be specified in the EPD according to Table 6, adapted from ISO 21930, Section 7.2.10.* *Refer to the ACLCA ISO 21930 Guidance document for further calculation instructions.* RPR_E: Renewable primary energy used as energy carrier (fuel) — (First use) bio-based materials used as an energy source. Hydropower, solar and wind power used in the technosphere are also included in this indicator — [MJ, LHV] RPR_M: Renewable primary re-sources with energy content used as material — (First use) biobased materials used as materials (e.g. wood, hemp, etc.). — [MJ, LHV] $NRPR_E$: Non-renewable primary resources used as an energy carrier (fuel) — (First use) materials such as peat, oil, gas, coal, uranium used as an energy source. — [MJ, LHV] $NRPR_M$: Non-renewable primary resources with energy content used as material — (First use) primary resources such as oil, gas and coal, used for products (e.g. plastic-based products). — [MJ, LHV]	Requirement met.		Closed

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			(see nested table and note below)			

SM: Secondary materials	Materials recycled from previous use or waste (e.g. scrap metal, broken concrete, broken glass, plastic and wood) that are used as a material input from another product system. These include both renewable and non-renewable resources, with or without energy content, depending on the status of the material when it was originally extracted from the environment	[kg]
RSF: Renewable secondary fuels	Renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g. biomass residue pellets, chipped waste wood).	[MJ, LHV]
NRSF: Non-renewable secondary fuels	Non-renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g. processed solvents, shredded tyres).	[MJ, LHV]
RE: Recovered energy	Energy recovered from disposal of waste in previous systems, such as energy recovery from combustion of landfill gas or energy recovered from other systems using energy sources.	[MJ, LHV]
FW: Use of net fresh water re-sources	See section 4.1.1 below	[m³]

NOTE 1: In order to identify the input part of renewable/non-renewable primary energy used as an energy carrier and not as a raw materials, the parameter "use of renewable/non-renewable primary energy excluding the renewable/non-renewable primary energy resources used as raw materials" parameter is considered and can be calculated as the

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			difference between the total input of energy resources and the input of primary energy resources used as a raw materials. *The use of the primary energy, which is used as raw material, is calculated as the energy content from the mass of the components (content composition) multiplied with the respective lower calorific value (LHV) of the components.* ***7.2.10 Inventory indicators describing resource use*** *The declaration of use of renewable and non-renewable primary resources (energy and materials), along with the use of secondary resources (secondary materials, secondary fuels and recovered energy), shall be derived from LCI and specified for all information modules.* *To provide transparency, when declaring the use of primary and secondary resources, the individual inventory indicators shall not be combined, aggregated or amalgamated.* *The following indicators shall be included.* *a) Renewable primary resources used as an energy carrier (fuel), RPRE, are (first use) bio-based materials used as an energy source. Hydropower, solar and wind power used in the technosphere are also included in this indicator.* *b) Renewable primary resources with energy content used as material, RPRM, are (first use) biobased materials used as materials (e.g. wood, hemp, etc.).* *c) Non-renewable primary resources used as an energy carrier (fuel), NRPRE, are (first use) materials such as peat, oil, gas, coal, uranium used as an energy source.* *d) Non-renewable primary resources with energy content used as material, NRPRM, are (first use) primary resources such as oil, gas and coal, used for products (e.g. plastic-based products).* *e) Secondary materials, SM, are materials recycled from previous use or waste (e.g. scrap metal, broken concrete, broken glass, plastic and*			

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			wood) that are used as a material input from another product system. These include both renewable and non-renewable resources, with or without energy content, depending on the status of the material when it was originally extracted from the environment. *f) Renewable secondary fuels, RSF, are renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g. biomass residue pellets, chipped waste wood).* *g) Non-renewable secondary fuels, NRSF, are non-renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g. processed solvents, shredded tyres).* *h) Recovered energy, RE, is energy recovered from disposal of waste in previous systems, such as energy recovery from combustion of landfill gas or energy recovered from other systems using energy sources.* *The quantification on the indicators RPRM and NRPRM is calculated by multiplication of the mass (kg) of the material input (or its components) with the net calorific value (lower heating value) (MJ/kg) of this input (or its components) for each functional or declared unit. The result for each indicator is a value of MJ/functional or declared unit.* *When the total primary energy is given in LCA tools, the indicators RPRE and NRPRE may be calculated as the difference between the total primary energy used and the primary resources used as raw material for the product.* *Where a product consists of a mix of renewable and non-renewable primary resources, then the NCV and the mass of each individual input material should be considered so that a separate value for renewable and non-renewable resources used as material is provided.* *NOTE These indicators are about use or inputs of resources into the product system. Outputs of secondary resources and recovered energy are considered as a separate set of indicators.*			

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			Since no burdens are allocated across the system boundary between product systems with respect to secondary resources and recovered energy, they might not be itemized in the inventory for background datasets. Considering the cut-off criteria (see 7.1.8), such missing data should be estimated to calculate these indicators for background data or the lack of inventory shall be described in the project report and EPD. These indicators shall always be provided for the foreground system according to the cut-off criteria. *The abiotic depletion potential for fossil resources (ADPfossil) shall be reported. It includes all fossil resource indicators (e.g. coal, oil, fossil gas) used as energy and material.*			
TE80			**PCR Specific Part A (§4.1.1) Freshwater Consumption** *Net freshwater consumption shall be reported as an LCI indicator and calculated according to ISO 14046. Net freshwater is equal to consumptive freshwater use (freshwater consumption) and should not consider water which is not consumed.* *The parameter contains: evaporation (e.g. cooling towers), evapotranspiration (evaporation of irrigated water), embedded freshwater (e.g. concrete), drainage of freshwater into the ocean.* *Further guidance is provided in ISO 21930, Section 7.2.13, and additional calculation guidance may be provided in a sub-category Part B PCR.* ***7.2.13 Inventory indicator describing consumption of freshwater*** *This document uses the consumption (or net use) of freshwater as LCI indicator for declaring water consumption related to a construction product during its life cycle. This indicator shall be calculated in compliance with ISO 14046.* *The use of water, which is not consumed (e.g. water used for river transport, used to power hydroelectric turbines or used as coolant and returned to the original source), should not be considered within the indicator.* *That water which would have been lost from the original, natural system, for example from evaporation of rainwater or from a water body, should not be considered within the losses from the technical system*	Requirement met.		Closed

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			studied. *Evaporated freshwater is considered consumption unless it is demonstrated otherwise. For each process, the water flows should be identified, in terms of volume extracted, volumes discharged and the source or the destination, for example surface water, ground water, sea water.* *Where tap water (water from the public grid) is used, the water treatment and distribution systems should be included as an upstream process, which will have its own resource use and discharges. Similarly, where water is discharged to the sewer, then the sewer and water treatment system should be included as a downstream process with its own resource use and discharges.* *Other water flows, for example, water that evaporates or water that is incorporated into the product, should ideally be itemized in the process inventory so that a full water balance can be made.* *For each process, the water consumed is the sum of the water that is lost from a drainage basin. This may be more easily calculated as the sum of water, which evaporates, transpires from biomass as a result of human activity (e.g. irrigation), is incorporated into products or is discharged to a different drainage basin. As previously mentioned, water consumption does not need to account for water that would have been lost from the drainage basin in the natural system before the technical system was implemented.* *EXAMPLE 1 Rainwater would normally be expected to drain to surface or ground water. If a factory or building is placed on the site, then water could instead be directed to the sewer and could be discharged, after treatment, to the sea, surface or ground water. Water, which is diverted through the water treatment system from its original drainage basin is consumed. If rainwater is used in the building before discharging it into the sewer, then this will be considered no differently than if the water was discharged directly to the sewer. However, if rainwater is used for cleaning and evaporates, then this water is consumed.* *EXAMPLE 2 For an agricultural process, water that evaporates or transpires from the plants as a result of human activity (irrigation) is considered as consumption. Water such as rainwater, which evaporates or goes to the drainage basin in the same way as if it would, were there*			

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			was no agricultural process, is not consumption. The assumption is that natural vegetation would have the same effect. *EXAMPLE 3 For a quarry, where dewatering takes place, if this water is returned to the same drainage basin it would naturally have drained to, then it is not consumption. If, however, it is used in a process and evaporates, then it is consumption.*			
TE82			**PCR Specific Part A (§4.1.2)** *The indicators describing waste categories and other material flows are output flows derived from LCI and shall be reported according to ISO 21930 Section 7.2.14 and EN15804 Section 7.2.4.* [Noted by reviewer, reference to EN 15804 is in error] *They shall be included in the EPD as follows:* ***Table 7. Life Cycle Inventory Results: Output Flows and Waste Categories***	Requirement met.		Closed

Parameter	Parameter Name	
HWD	Hazardous waste disposed	[kg]
NHWD	Non-hazardous waste disposed	[kg]
HLRW	High-level radioactive waste, conditioned, to final repository	[kg] or [m^3]
ILLRW	Intermediate- and low-level radioactive waste, conditioned, to final repository	[kg] or [m^3]
CRU	Components for re-use	[kg]
MR	Materials for recycling	[kg]
MER	Materials for energy recovery	[kg]

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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			<table><tr><td>EE</td><td>Exported energy</td><td>MJ, heating value ([Hi] lower heating value) per energy carrier</td></tr></table> *"Hazardous waste disposed" is the amount of hazardous waste that is disposed according to the section 2.8.4.5, Table 4. Radioactive waste is not included.* *"Non-hazardous waste disposed" is the amount of non-hazardous waste that is disposed.* *"Radioactive waste disposed" is the amount of radioactive waste that is disposed. High-level radioactive waste, e.g., when generated by electricity production, consists mostly of spent fuel from reactors. Low- and intermediate-level radioactive wastes, e.g., when generated by electricity production, arise mainly from routine facility maintenance and operations.* *See ISO 21930, section 7.2.14, Table 4 for how to assign output flows to information modules* *C1-C4.* *The output material flows are declared in the module from which they cross the system boundary, as a rule when they reach the end of waste status.* *NOTE: For the calculation and communication of indicators on environmental aspects:* *As long as the LCA software used does not allow distinguishing the **primary energy used as raw material or as energy carrier,** it is permissible to calculate the primary energy as a fuel source across modules A1-A3 as the difference between primary energy and primary energy used as a raw material, where primary energy used as a raw material is calculated based on the product material composition and corresponding LHVs. When communicating the values in the EPD, this shall be indicated by the design of the frame in the table.* *As long as the used LCA software does not allow calculating the **use of secondary materials or secondary fuels** directly, it is permissible to*			

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			declare these indicators based on available information from the main system (i.e. manufacturer´s data) as a minimum value. *The indicators may be declared for the production stage across the modules A1-A3. When communicating the values in the EPD, this is to be indicated by the design of the frame in the table.* ***7.2.14 Environmental information describing waste categories and output flows*** *The indicators describing waste categories and other material flows are output flows derived from the LCI.* *The following waste categories shall be declared and specified for all information modules included in the EPD:* *— hazardous waste disposed, in kg;* *— non-hazardous waste disposed, in kg;* *— radioactive waste disposed;* *— high-level radioactive waste, conditioned, to final repository, in kg or m3;* *— intermediate- and low-level radioactive waste, conditioned, to final repository, in kg or m3.* *NOTE 1 Hazardous waste disposed does not include radioactive waste.* *NOTE 2 High-level radioactive waste, e.g., when generated by electricity production, consists mostly of spent fuel from reactors.* *NOTE 3 Low- and intermediate-level radioactive wastes, e.g., when generated by electricity production, arise mainly from routine facility maintenance and operations.* *The following output flow categories shall be declared and specified for all information modules included in the EPD:* *— components for reuse;* *— materials for recycling, i.e. secondary material for use in the next product system;* *— materials for energy recovery, i.e. secondary fuels for use in the next product system;* *— recovered energy exported from the product system.* *Table 4 shows how to assign output flows at the construction product's end-of-life to information modules C1-C4 (see also Table 1). Output flows from other information modules shall be assigned to the information modules where they occur.*			

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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Table 4 — Assignments of output flows at the construction product's end-of-life

Type of flow	Fate	Material specifications	Unit	Exits the system boundary from			Comments
				C1	C3	C4	
Material flows reached the boundary between product systems (see 7.1.6)	Components for reuse[a]	Type 1	kg				Reused components to be declared in C1. If the component needs processing before reuse, then it will be declared in C3.
		Type n	kg				
	Materials for recycling used in the next product system[a]	Type 1	kg				Output of secondary material to be declared in C3. If the material reaches the system boundary between product systems when collected at the construction site, it is declared in C1.
		Type n	kg				
	Material for energy recovery used as secondary fuels in the next product system[a]	Secondary fuel 1, with NCV	kg				Output of renewable secondary fuels or non-renewable secondary fuels to be declared in C3 (assuming processing in C3 to create secondary fuel). NCV of any net output of secondary fuels to be provided.
		Type n, with NCV	kg				

[a] Potential loads and benefits from net outflows may be considered in module D.

[b] Shall not be considered in module D.

Table 4 *(continued)*

Type of flow	Fate	Material specifications	Unit	Exits the system boundary from			Comments
				C1	C3	C4	
Material flows have not reached the system boundary between product systems (see 7.1.6) or material converted to energy within the system boundary	Exported energy from waste with energy recovery ≥ 60 % efficiency[a]	Energy Type 1	MJ				Electricity and/or heat from energy recovery processes to be declared in C3. (Waste from energy recovery processes within the system boundary are considered below.)
		Energy Type n	MJ				
	Incineration of waste with energy recovery <60 % efficiency	Waste disposed 1[b]	kg				Waste disposed is the input of waste into the incinerator. Any output of recovered electricity and/or heat from waste incineration to be declared in C4. (Waste generated by incineration processes within the system boundary, see below.)
		Waste disposed n[b]	kg				
		Energy Type 1[a]	MJ				
		Energy Type n[a]	MJ				
	Wastes disposed in landfill and where relevant energy recovered from landfill gas	Waste disposed 1[b]	kg				Waste entering landfill to be declared in C4[b].
		Waste disposed n[b]	kg				
		Energy Type 1[a]	MJ				Energy recovered from landfill gas to be declared in C4[a] as exported energy.
		Energy Type n[a]	MJ				

[a] Potential loads and benefits from net outflows may be considered in module D.

[b] Shall not be considered in module D.

NOTE 4 The indicators in Table 4 are calculated on the net amounts leaving the system boundary if they have crossed the system boundary between product systems, as described in 7.1.7.5.

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			NOTE 5 The declaration of "components for reuse" and "materials for recycling" fulfils the conditions of 7.1.7.5. *NOTE 6 The indicator "material for energy recovery" does not include materials for waste incineration. Waste incineration is a method of waste processing and is assigned within the system boundary. Waste incineration plants have a lower energy efficiency rate than power stations using secondary fuels. Materials for energy recovery are based on thermal energy efficiency rate of the power station not less than 60 %.* *NOTE 7 Recovered energy relates to energy exported from waste incineration and landfill.*			
TE83			**PCR Specific Part A (§4.2): Accounting for Biogenic Carbon Uptake and Emissions** *See ISO 21930, section 7.2.7, for requirements on accounting for the biogenic carbon removal(s) and emissions of the product system in the form of mass flows to and from nature. The amount of biogenic carbon contained within the packaging material shall be included in the scenario information for module A5. The amount of biogenic carbon removed via the declared unit of product shall be documented in the scenario information at end-of-life. In both instances, biogenic carbon shall be expressed as kg CO2.* ***7.2.7 Accounting of biogenic carbon uptake and emissions during the life cycle*** *Bio-based materials originating from renewable resources (such as wood, linseed oil, cork or bio-based polymers) contain biogenic carbon. The mass flows to and from nature and biogenic carbon removal(s) and emissions throughout the product system shall be reported as a flow of biogenic carbon expressed in CO2 in the LCI. When entering the product system (i.e. a flow to the technosphere from nature), this biogenic carbon flow shall be characterized in the LCIA with −1 kg CO2e/kg CO2 of biogenic carbon in the calculation of the GWP, since it represents a removal of carbon that is part of the carbon cycle of bio-based materials. When this bio-based material, partly or as a whole, is converted to emissions, for example, by combustion or biodegradation, it shall be accounted for as emitted biogenic CO2 and other emissions such as biogenic CH4 in the information module where*	N/A		Closed

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			they occur, depending on the end-of-life scenario. Emissions of biogenic CO2 shall be characterized with +1 kg CO2e/kg CO2 of biogenic carbon in the calculation of the GWP. If a bio-based material containing biogenic carbon leaves the studied product system at the system boundary between product systems in information modules C1 to C4 (or any other information module), this export of bio-based material and associated flow of biogenic carbon is reported as an export of biogenic carbon expressed in CO2 in the LCI and characterized with +1 kg CO2e/kg CO2 of biogenic carbon in the calculation of the GWP in the respective information module C1 to C4 (or any other information module). Similarly, any import of bio-based material into the product system as secondary fuel or secondary material is reported as an input of biogenic carbon removal(s) expressed in CO2 in the LCI and shall be characterized with −1 kg CO2e/kg CO2 of biogenic carbon in the calculation of the GWP. For wood, biogenic carbon may be characterized with a −1 kg CO2e/kg CO2 biogenic carbon flow when entering the product system only when the wood originates from sustainably managed forests (see also NOTE 2 in 7.2.11). *NOTE 1 The flows of biogenic carbon expressed in CO2 in bio-based materials that are reused, recycled or combusted as the end-of-life scenario will result in zero net contribution to the GWP when the GWP is considered over the whole life cycle (information modules A1 to C4), except for the part of biogenic carbon that is converted to CH4 or other emissions over the life cycle.* *NOTE 2 This accounting approach is valid for all information modules from A1 to C4.* *The amount of biogenic carbon contained within bio-based material leaving the product system shall be declared as technical scenario information in the module where the material is leaving the product system, irrespective of whether the environmental impacts and aspects of this module are declared. For bio-based packaging material, the quantity of biogenic carbon (expressed in kg CO2) contained within the packaging for the declared unit shall be documented in information module A5 as technical scenario information. For construction products, the quantity of removals of biogenic carbon (expressed in kg CO2) within the declared unit of the product (excluding packaging) shall be documented at the end-of-life stage in information modules C3/C4 technical scenario information.*			

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			NOTE 3 The quantity of biogenic carbon contained within packaging and/or product provided as technical scenario information in information module A5 and/or modules C3/C4 will allow the correct calculation of end-of-life scenarios for the packaging and product where the module is not declared or the scenario is not appropriate for a particular construction works level assessment.			
TE84			**PCR Specific Part A (§4.3): Accounting for Calcination and Carbonation** *According to ISO 21930 Section 7.2.8, "Carbonation is the reaction of atmospheric carbon dioxide with calcium oxide or calcium hydroxide containing products to form calcium carbonate.[…] Environmental impacts considered during the production, use and end-of-life stages shall include carbonation as detailed in ISO 21930, Section 7.2.8. More detailed guidance and requirements may be provided in a sub-category Part B PCR.* ***7.2.8 Carbonation*** *Carbonation is the reaction of atmospheric carbon dioxide with calcium oxide or calcium hydroxide containing products to form calcium carbonate.* *NOTE 1 Calcium oxide dissolved in water forms Ca(OH)2 and then reacts with the dissolved CO2.* *NOTE 2 Products containing calcium oxide or calcium hydroxide include hydrated lime, quick lime, mortars, screeds and all types of concrete. Environmental impacts considered during the production, use and end-of-life stages shall include carbonation.* *NOTE 3 For lime-based products, carbonation is the essential mechanism to gain strength. Carbonation takes place quickly and is complete in the early stage of the service life. The amount of carbon dioxide absorbed will equal the amount of carbon dioxide emitted from the calcium carbonate during lime production.* *NOTE 4 In the case of concrete, the amount of carbon dioxide absorbed depends upon the concrete surface exposed to air/ground, the concrete strength, the concrete texture and the environment to which it is exposed.*	N/A		Closed

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			Low strength, open textured and thin section concrete will carbonate fully within a few years of manufacture. *This process will start immediately after manufacture and be complete in the use stage. High performance, reinforced and fully compacted concrete will carbonate more slowly. Such concretes will not carbonate fully until they are crushed at or after the end-of-life stage.* *The ability to carbonate is an inherent quality of a material related to the content of calcium oxide or calcium hydroxide. Environmental benefits attributed to carbonation in a product shall not be allocated to co-products or secondary materials.* *The quantification of carbonation as a part of the GWP shall be based on recognized methods for the calculation of carbonation and the underlying methodology shall be referenced in the project report and results interpreted with respect to uncertainty of calculations.* *NOTE 5 Examples of recognized methods for calculation of carbonation can be found in the bibliography of this document.*			
TE85			**PCR Specific Part A (§4.4): Accounting for Delayed Emissions** *Per ISO 21930 Section 7.2.9, there is no consensus of approaches to address delayed emissions in the calculation of GWP. "If a manufacturer wishes to declare quantitative or qualitative information on delayed emissions within the EPD, the information shall be reported under "Additional environmental information not derived from LCA" (see ISO 21930, Section 9.6) and the underlying methodology shall be referenced." More detailed guidance and requirements may be provided in a sub-category Part B PCR.* ***7.2.9 Accounting of delayed emissions*** *Several methodological approaches have been proposed to address delayed emissions in the quantification of the GWP, for example approaches based on discounting or approaches based on time-dependent characterization factors within a predefined reference study period. Since there is no common acceptance of these approaches, such calculations are not part of the quantification of the GWP. If a manufacturer wishes to declare quantitative or qualitative information on delayed emissions within the EPD, the information shall be reported*	N/A		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			under "Additional environmental information not derived from LCA" (see 9.6) and the underlying methodology shall be referenced.			
TE86			**PCR Specific Part A (§4.5): Greenhouse Gas Emissions from Land-Use Change** *Per ISO 21930 Section 7.2.11, "When significant, the greenhouse gases (GHG) emissions occurring as a result of land-use change shall be included in the quantification of the GWP. They should be assessed in accordance with internationally recognized methods such as the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.* *This contribution to GWP shall be declared separately in the EPD as GWP (land-use change) as additional environmental information, including a short interpretation of the data.* *The project report shall include an interpretation of the results reflecting the influence of data availability and the underlying methodology shall be referenced."* *Refer to ISO 21930, Section 7.2.11, for further considerations.* *More detailed guidance and requirements may be provided in a sub-category Part B PCR.* ***7.2.11 Greenhouse gas emissions from land-use change*** *When significant, the greenhouse gases (GHG) emissions occurring as a result of land-use change shall be included in the quantification of the GWP. They should be assessed in accordance with internationally recognized methods such as the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.* *This contribution to GWP shall be declared separately in the EPD as GWP (land-use change) as additional environmental information, including a short interpretation of the data.* *The project report shall include an interpretation of the results reflecting the influence of data availability and the underlying methodology shall be referenced.* *NOTE 1 The consideration of GHG emissions arising from land-use change is not restricted to biogenic materials, for example in the context of deforestation or conversion of grassland to energy crops, but can also*	Provide statement regarding the exclusion of GWP impacts associated with land use change.	Statement added in Section 2.6. and in EPDs. **Acknowledged.**	Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			include other materials and processes, for example related to the conversion of land to quarries, infrastructure, production plants, etc. Wood from sustainably managed forests may be accounted for as having zero emissions concerning land-use change. This includes wood products responsibly sourced and certified to the Canadian Standards Association (CSA), Forest Stewardship Council (FSC) and Sustainable Forestry initiative (SFI) Standards, as well as all other standards globally endorsed by the Programme for the Endorsement of Forest Certification International (PEFC International) and the FSC. *NOTE 2 The concept of sustainably managed forests is linked but not limited to respective certification schemes. Other evidences such as national reporting under the United Nations Framework Convention on Climate Change (UNFCCC) can be used to identify forests with stable or increasing forest carbon stocks.*			
TE87			**PCR Specific Part A (§4.6): Carbon Emissions and Uptake** *[ISO 21930, section 7.2.12]: "For transparency, the following indicators on the uptake and emissions of CO2 shall be separately reported, where relevant and available, if included in the quantification of the GWP:* *Table 8 shall be included in an EPD if included in the GWP calculation.* ***Table 8. Carbon Emissions and Removals*** (see table below)	Justified as excluded.		Closed

Table 8. Carbon Emissions and Removals

Parameter	*Parameter*	*Unit*
BCRP	*Biogenic Carbon Removal from Product*	*[kg CO_2]*
BCEP	*Biogenic Carbon Emission from Product*	*[kg CO_2]*
BCRK	*Biogenic Carbon Removal from Packaging*	*[kg CO_2]*
BCEK	*Biogenic Carbon Emission from Packaging*	*[kg CO_2]*
BCEW	*Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes*	*[kg CO_2]*
CCE	*Calcination Carbon Emissions*	*[kg CO_2]*
CCR	*Carbonation Carbon Removals*	*[kg CO_2]*

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

(1) Comment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			CWNR | *Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes* | *[kg CO_2]* ***7.2.12 Additional inventory indicators describing emissions and removals of carbon*** *For transparency, the following indicators on the uptake and emissions of CO2 shall be separately reported, where relevant and available, if included in the quantification of the GWP:* *— biogenic CO2, reporting the removals and emissions associated with biogenic carbon content contained within bio-based products, occurring in each module;* *— biogenic CO2, reporting the removals and emissions associated with biogenic carbon content contained within bio-based packaging, occurring in each module;* *— CO2 from calcination and carbonation, reporting the emissions and uptake of CO2 from calcination and carbonation occurring in the relevant module;* *— biogenic CO2, reporting the emissions from combustion of waste from renewable sources used in production processes;* *— CO2 emissions from combustion of waste from non-renewable sources used in production processes.* *These indicators enhance the transparency on the different contributions to the GWP in each module.*			
TE88			**PCR Specific Part B (§4): Scenarios and additional technical information** *The following information shall be reported for declared modules. Irrelevant or non-applicable module rows may be excluded in the EPD; additional information may also be listed if necessary* *The following technical information is a basis for the declared modules or may be used for developing specific scenarios in the context of a building assessment if modules are not declared (MND).*	Requirement met.		Closed
TE89			**PCR Specific Part B (§4): Scenarios and additional technical information** ***Transport to the building site (A4)*** ***TABLE 3. TRANSPORT TO THE BUILDING SITE (A4)***	Requirement met.		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			(table continued below)			
TE90			**PCR Specific Part B (§4): Scenarios and additional technical information** ***Installation into the building site (A5)*** ***TABLE 4. INSTALLATION INTO THE BUILDING (A5)*** *(table below)*	Requirement met.		Closed

Name	*Value*	*Unit*
Fuel type		
Liters of fuel		*l/100km*
Vehicle type		
Transport distance		*km*
Capacity utilization (including empty runs, mass based		*%*
Gross density of products transported		*kg/m³*
Weight of products transported (if gross density not reported)		*kg*
Volume of products transported (if gross density not reported)		*m3*
Capacity utilization volume factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaging products)		*-*

Name	*Value*	*Unit*
Ancillary materials		*kg*
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)		*m3*
Other resources		*kg*
Electricity consumption		*kWh*
Other energy carriers		*MJ*
Product loss per functional unit		*kg*
Waste materials at the construction site before waste processing, generated by product installation		*kg*

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			Output materials resulting from on-site waste processing (specified by route; e.g. for recycling, energy recovery and/or disposal) — *kg* *Mass of packaging waste specified by type* — kg *Biogenic carbon contained in packaging* — *kg CO_2* *Direct emissions to ambient air, soil and water* — *kg* *VOC emissions* — *µg/m³* ** Method used to calculate and report airborne dust shall be identified and/or described* *The VOC emissions shall be determined in accordance to "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers- version 1.2" CA Specification 01350.*			
TE91			**PCR Specific Part B (§4): Reference Service Life** ***TABLE 5. REFERENCE SERVICE LIFE*** *Name* / *Value* / *Unit*: *Maintenance process information (cite source in report)* — *-* *Maintenance cycle* — *Number/ RSL* *Maintenance cycle* — *Number/ ESL* *Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)* — *m3* *Ancillary materials specified by type (e.g. cleaning agent)* — *kg* *Other resources* — *kg*	Requirement met. Set to 75 years.		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			Energy input, specified by activity, type and amount | | *kWh* *Other energy carriers specified by type* | | *kWh* *Power output of equipment* | | *kW* *Waste materials from maintenance (specify materials)* | | *kg* *Direct emissions to ambient air, soil and water* | | *kg* *Further assumptions for scenario development (e.g. frequency and time period of use, number of occupants);* | |			
TE92			**PCR Specific Part B (§4): Scenarios and additional technical information *Maintenance (B2)*** *NO REQUIREMENTS FOR MAINTENANCE*	N/A		Closed
TE93			**PCR Specific Part B (§4): Scenarios and additional technical information** ***Repair (B3)*** ***TABLE 7. REPAIR (B3)***	N/A		Closed

Name	*Value*	*Unit*
Repair process information (cite source in report)		-
Inspection process information (cite source in report)		-
Repair cycle		*Cycles / RSL*
Repair cycle		*Cycles / ESL*
Net freshwater consumption specified by water source and fate (e.g., X m3 river water evaporated, X m3 city water disposed to sewer))		*m3*
Ancillary materials specified by type (e.g. cleaning agent)		*Kg*

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
			Energy input, specified by activity, type and amount | | *kWh* *Waste materials from repair (specify materials)* | | *kg* *Direct emissions to ambient air, soil and water* | | *kg* *Further assumptions for scenario development (e.g. frequency and time period of use, number of occupants);* | |			
TE94			**PCR Specific Part B (§4): Scenarios and additional technical information** ***Replacement (B4) / Refurbishment (B5)*** *The number of replacements of product expected during the building ESL of 75 years shall be declared. Required or expected maintenance are to be modeled according to manufacturer's guidelines. Assumptions and key parameters shall be clearly stated, and the manufacturer is to submit supporting documentation to justify the assumptions made.* *If the RSL is less than the building's ESL of 75 years, the number of replacements that will be necessary to fulfill the required performance and functionality over the building ESL shall be identified. Replacements should be rounded-up to the nearest tenths of the ESL of the building; e.g., 1.47 rounded to 1.5.* ***TABLE 8. Replacement (B4)*** ***Name*** | ***Value*** | ***Unit*** *Replacement cycle* | | *Number/ RSL* *Replacement cycle* | | *Number/ ESL* *Energy input, specified by activity, type and amount* | | *kWh* *Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)* | | *m3* *Ancillary materials specified by type (e.g. cleaning agent)* | | *kg*	N/A		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			(table continued below)			

Replacement of worn parts, specify parts/materials		*kg*
Direct emissions to ambient air, soil and water		*kg*
Further assumptions for scenario development, e.g. frequency and time period of use		*As appropriate*

TABLE 9. Refurbishment (B5)

Name	***Value***	***Unit***
Refurbishment process description (cite source in report)		
Replacement cycle		*Number/ RSL*
Replacement cycle		*Number/ ESL*
Energy input, specified by activity, type and amount		*kWh*
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)		*m3*
Material input for refurbishment, including ancillary materials specified by type (e.g. cleaning agent)		*kg*
Waste material(s), specified by material		*kg*
Direct emissions to ambient air, soil and water		*kg*
Further assumptions for scenario development (e.g. frequency and time period of use, number of occupants);		

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**	**Open/ Closed**
TE95			**PCR Specific Part B (§4): Scenarios and additional technical information** ***Operational energy use (B6) and Operational water use (B7)*** ***TABLE 10. Operational energy use (B6) and Operational water use (B7)***	N/A		Closed

Name	*Value*	*Unit*
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)		*m3*
Ancillary materials		*kg*
Energy input, specified by activity, type and amount		*kWh*
Equipment power output		*kW*
Characteristic performance (e.g. energy efficiency, variation of performance with capacity utilization)		*Units as appropriate*
Direct emissions to ambient air, soil and water		*kg*
Further assumptions for scenario development (e.g. frequency and time period of use, number of occupants);		*As appropriate*

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Comment (justification for change)/Proposed change</th><th>(6)
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Open/ Closed</th></tr>
<tr><td>TE96</td><td></td><td></td><td>PCR Specific Part B (§4): Scenarios and additional technical information
End of life (C1-C4)
TABLE 11. End of life (C1-C4)
<table>
<tr><th>Name</th><th>Value</th><th>Unit</th></tr>
<tr><td>Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)</td><td></td><td></td></tr>
<tr><td rowspan="2">Collection process (specified by type)</td><td>Collected separately</td><td>kg</td></tr>
<tr><td>Collected with mixed construction waste</td><td>kg</td></tr>
<tr><td rowspan="6">Recovery (specified by type)</td><td>Reuse</td><td>kg</td></tr>
<tr><td>Recycling</td><td>kg</td></tr>
<tr><td>Landfill</td><td>kg</td></tr>
<tr><td>Incineration</td><td>kg</td></tr>
<tr><td>Incineration with energy recovery</td><td>kg</td></tr>
<tr><td>Energy conversion efficiency rate</td><td></td></tr>
<tr><td>Disposal (specified by type)</td><td>Product or material for final deposition</td><td>kg</td></tr>
<tr><td>Removals of biogenic carbon (excluding packaging)</td><td></td><td>kg CO2</td></tr>
</table></td><td>Requirement met.</td><td></td><td>Closed</td></tr>
<tr><td>TE97</td><td></td><td></td><td>PCR Specific Part B (§4): Scenarios and additional technical information
Reuse, recovery and/or recycling potentials (D), relevant scenario information.
TABLE 12. Reuse, recovery and/or recycling potentials (D), relevant scenario information
<table>
<tr><th>Name</th><th>Value</th><th>Unit</th></tr>
<tr><td>Net energy benefit from energy recovery from waste treatment</td><td></td><td>MJ</td></tr>
</table></td><td>N/A</td><td></td><td>Closed</td></tr>
</table>

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			declared as exported energy in C3 (R>0.6) | | *Net energy benefit from thermal energy due to treatment of waste declared as exported energy in C4 (R<0.6)* | | *MJ* *Net energy benefit from material flow declared in C3 for energy recovery* | | *MJ* *Process and conversion efficiencies* | | *Further assumptions for scenario development (e.g. further processing technologies, assumptions on correction factors);* | |			
TE98			**PCR Specific Part B (§5): Scenarios and additional technical information** *In Table 13, "Description of the system boundary," all declared modules shall be indicated with an "X". Modules A1, A2, and A3 may be declared as one aggregated module A1-A3.* *Per Part A, life cycle impact assessment (LCIA) results shall be reported for each declared module as follows. Results shall be declared with three digits using scientific notation (e.g. 1.23E-5 = 0.0000123) for each module. A uniform format shall be used for all indicator values.* • *North America (Part A, Section 4.7, Table 7, TRACI indicators)* • *EU (Part A, Section 4.8, Table 8, CML indicators)* • *Rest of World (Part A, Section 4.9, Table 8, indicators as provided)* • *Results derived from the product life cycle inventory (LCI) shall be reported as follows:* • *Resource use indicators (Part A, Section 4.1, Table 4)* • *Output flows and waste category indicators (Part A, Section 4.1.2, Table 5)* • *Carbon emissions and removals (Part A, Section 4.6, Table 6)* **TABLE 13. DESCRIPTION OF THE SYSTEM BOUNDARY MODULES**	Requirement met.		Closed

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<tr><td></td><td></td><td></td><td>
<table>
<tr><td colspan="3">PRODUCT STAGE</td><td colspan="2">CONSTRUCT-ION PROCESS STAGE</td><td colspan="5">USE STAGE</td><td colspan="4">END OF LIFE STAGE</td><td>BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY</td><td></td></tr>
<tr><td>A1</td><td>A2</td><td>A3</td><td>A4</td><td>A5</td><td>B1</td><td>B2</td><td>B3</td><td>B4</td><td>B5</td><td>C1</td><td>C2</td><td>C3</td><td>C4</td><td>D</td><td rowspan="4">Reference Service Life</td></tr>
<tr><td rowspan="3">Raw material supply</td><td rowspan="3">Transport</td><td rowspan="3">Manufacturing</td><td rowspan="3">Transport from gate to site</td><td rowspan="3">Assembly/Install</td><td>Use</td><td>Maintenance</td><td>Repair</td><td>Replacement</td><td>Refurbishment</td><td rowspan="3">Deconstruction</td><td rowspan="3">Transport</td><td rowspan="3">Waste processing</td><td rowspan="3">Disposal</td><td rowspan="3">Reuse, Recovery, Recycling Potential</td></tr>
<tr><td colspan="5">B6 Operational Energy Use of Building Integrated System During Product Use</td></tr>
<tr><td colspan="5">B7 Operational Water Use of Building Integrated System During Product Use</td></tr>
<tr><td colspan="5">Required</td><td colspan="5">Based on scenarios</td><td colspan="4">Required</td><td>Optional</td><td>Required</td></tr>
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</td><td></td><td></td><td></td></tr>
<tr><td>TE99</td><td></td><td></td><td>ISO Requirement (§4.4.1): Life Cycle Impact Assessment – General
The LCIA phase shall be carefully planned to achieve the goal and scope of an LCA study. The LCIA phase shall be coordinated with other phases of the LCA to take into account the following possible omissions and sources of uncertainty:
a) whether the quality of the LCI data and results is sufficient to conduct the LCIA in accordance with the study goal and scope definition;
b) whether the system boundary and data cut-off decisions have been sufficiently reviewed to ensure the availability of LCI results necessary to calculate indicator results for the LCIA;
c) whether the environmental relevance of the LCIA results is decreased due to the LCI functional unit calculation, system wide averaging, aggregation and allocation.</td><td>Requirement met.</td><td></td><td>Closed</td></tr>
<tr><td>TE100</td><td></td><td></td><td>ISO Requirement (§4.4.2.1): Life Cycle Impact Assessment – General
The LCIA phase shall include the following mandatory elements:
− selection of impact categories, category indicators and characterization models;
− assignment of LCI results to the selected impact categories (classification);</td><td>Requirement met.</td><td></td><td>Closed</td></tr>
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(1)	(2)	(3)	(4)	(5)	(6)	(7)
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			– calculation of category indicator results (characterization).			
TE101			**ISO Requirement (§4.4.2.2.1):** *Life Cycle Impact Assessment – Selection* *Whenever impact categories, category indicators and characterization models are selected in an LCA, the related information and sources shall be referenced. This also applies when new impact categories, category indicators or characterization models are defined.* *NOTE Examples of impact categories are described in ISO/TR 14047.* *Accurate and descriptive names shall be provided for the impact categories and category indicators.* *The selection of impact categories, category indicators and characterization models shall be both justified and consistent with the goal and scope of the LCA.* *The selection of impact categories shall reflect a comprehensive set of environmental issues related to the product system being studied, taking the goal and scope into consideration.* *The environmental mechanism and characterization model that relate the LCI results to the category indicator and provide a basis for characterization factors shall be described.* *The appropriateness of the characterization model used for deriving the category indicator in the context of the goal and scope of the study shall be described.* *LCI results other than mass and energy flow data included in an LCA (e.g. land use) shall be identified and their relationship to corresponding category indicators shall be determined.* *For most LCA studies, existing impact categories, category indicators or characterization models will be selected. However, in some cases existing impact categories, category indicators or characterization models* *are not sufficient to fulfil the defined goal and scope of the LCA, and new ones have to be defined. When new impact categories, category indicators or characterization models are defined, the recommendations in this sub-clause also apply..*	Requirement met.		Closed

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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			Figure 3 illustrates the concept of category indicators based on an environmental mechanism. The impact category "acidification" is used in Figure 3 as an example. Every impact category has its own environmental mechanism. *Characterization models reflect the environmental mechanism by describing the relationship between the LCI results, category indicators and, in some cases, category endpoint(s). The characterization model is used to derive the characterization factors. The environmental mechanism is the total of environmental processes related to the characterization of the impacts.*			
TE102			**ISO Requirement (§4.4.2.2.2):** *Life Cycle Impact Assessment – Selection* *For each impact category, the necessary components of the LCIA include* *– identification of the category endpoint(s),* *– definition of the category indicator for given category endpoint(s),* *– identification of appropriate LCI results that can be assigned to the impact category, taking into account the chosen category indicator and identified category endpoint(s), and* *– identification of the characterization model and the characterization factors.* *This procedure facilitates the collection, assignment and characterization modelling of appropriate LCI results.* *This also helps to highlight the scientific and technical validity, assumptions, value-choices and degree of accuracy in the characterization model.*	Requirement met.		Closed
TE103			**ISO Requirement (§4.4.2.2.2):** *Life Cycle Impact Assessment - The method of calculating indicator results shall be identified and documented, including the value-choices and assumptions used.*	Requirement met.		Closed
TE104			**ISO Requirement (§4.4.3.1):** *Life Cycle Impact Assessment - The [optional] application and use of normalization, grouping and weighting methods shall be consistent with the goal and scope of the LCA and it shall be fully transparent. All methods and calculations used shall be documented to provide transparency.*	Requirement met.		Closed
TE 84			**ISO Requirement (§4.4.5):** *Life Cycle Impact Assessment –* **LCIA intended to be used in comparative assertions intended to be disclosed to the public**	N/A – not a comparative assertion.		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

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			An LCIA that is intended to be used in comparative assertions intended to be disclosed to the public shall employ a sufficiently comprehensive set of category indicators. The comparison shall be conducted category indicator by category indicator. *An LCIA shall not provide the sole basis of comparative assertion intended to be disclosed to the public of overall environmental superiority or equivalence, as additional information will be necessary to overcome some of the inherent limitations in the LCIA. Value-choices, exclusion of spatial and temporal, threshold and dose-response information, relative approach, and the variation in precision among impact categories are examples of such limitations. LCIA results do not predict impacts on category endpoints, exceeding thresholds, safety margins or risks.* *Category indicators intended to be used in comparative assertions intended to be disclosed to the public shall, as a minimum, be* *− scientifically and technically valid, i.e. using a distinct identifiable environmental mechanism and/or reproducible empirical observation, and* *− environmentally relevant, i.e. have sufficiently clear links to the category endpoint(s) including, but not limited to, spatial and temporal characteristics.* *Category indicators intended to be used in comparative assertions intended to be disclosed to the public should be internationally accepted.* *Weighting, as described in 4.4.3.4, shall not be used in LCA studies intended to be used in comparative assertions intended to be disclosed to the public.* *An analysis of results for sensitivity and uncertainty shall be conducted for studies intended to be used in comparative assertions intended to be disclosed to the public*.			
TE105			**ISO Reporting Requirements (§5.2) *Additional Requirements and Guidance -*** *The third-party report shall cover the following aspects:* *e)* ***Life cycle impact assessment****, where applicable:* *1) the LCIA procedures, calculations and results of the study;* *2) limitations of the LCIA results relative to the defined goal and scope of the LCA;*	Requirement met.		Closed

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			3) the relationship of LCIA results to the defined goal and scope, see 4.2; *4) the relationship of the LCIA results to the LCI results, see 4.4;* *5) impact categories and category indicators considered, including a rationale for their selection and a reference to their source;* *6) descriptions of or reference to all characterization models, characterization factors and methods used, including all assumptions and limitations;* *7) descriptions of or reference to all value-choices used in relation to impact categories, characterization models, characterization factors, normalization, grouping, weighting and, elsewhere in the LCIA, a justification for their use and their influence on the results, conclusions and recommendations;* *8) a statement that the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.* *and, when included as a part of the LCA, also* *i) a description and justification of the definition and description of any new impact categories, category indicators or characterization models used for the LCIA,* *ii) a statement and justification of any grouping of the impact categories,* *iii) any further procedures that transform the indicator results and a justification of the selected references, weighting factors, etc.,* *iv) any analysis of the indicator results, for example sensitivity and uncertainty analysis or the use of environmental data, including any implication for the results, and* *v) data and indicator results reached prior to any normalization, grouping or weighting shall be made available together with the normalized, grouped or weighted results*.			
TE106			**PCR Specific Part A (§4.7): LCIA Indicators for North America** *The following information on environmental impacts is expressed by the impact category indicator results using characterization factors based on the current version of U.S. EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts37 (TRACI). The GWP 100 impacts from TRACI v2.1 (July 2012) are based on 100-year time horizon GWP factors provided by the IPCC 2007 Fourth Assessment Report (AR4).100-year time horizon GWP factors as provided by the Fifth Assessment Report (AR5) shall be used for conformance with ISO 21930, Section 7.3.* *The ADPfossil impacts are based on CML-baseline, v4.7 August 2016.*	Requirement met.		Closed

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			Please see the discussion in footnote 38. *These predetermined parameters are required and shall be included in the EPD, at a minimum, as follows:* *Table 9. NORTH AMERICAN LIFE CYCLE IMPACT ASSESSMENT RESULTS*			

Impact Category	**Units**
Global Warming Potential (GWP 100)	[kg CO2 eq]
Ozone Depletion Potential (ODP)	[kg CFC 11 eq]
Acidification Potential (AP)	[kg SO2 eq]
Eutrophication Potential (EP)	[kg N eq]
Smog Formation Potential (SFP)	[kg O_3 eq]
Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources (ADP_{fossil})	[MJ, LHV]

The table shall be preceded by a statement that "LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks."

It is further encouraged that additional impact measures be included in the product LCA in order to obtain a more complete understanding of environmental hot-spots for the industry being studied. Additional impact measures are encouraged to be reported with the below statement:

The EPD shall contain [It is noted by the reviewer that there is an EPD requirement in the LCA requirement section of the PCR] *the following language, "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."*

Toxicity impacts shall be reported *under "Additional Environmental Information".* [It is noted by the reviewer that reporting of toxicity LCIAs

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			are not mandatory] *If toxicity is included, USEtox39 indicators shall be used and reported only as a percentage contribution analysis.* *A sub-category Part B PCR may provide further requirements on the inclusion of other impact categories and methods to be included as additional environmental information.* *Impact results may also be included for more than one characterization method as long as they are reported separately from the default TRACI values.* *The project report shall document all LCIA procedures, calculations and results of the study including all additional environmental impact indicator results.* 37 https://www.epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci. (Accessed on 2 March 2022.) 38 Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources (ADPfossil, in MJ, LHV) is based on CML-baseline, v4.7 August 2016. Fossil Fuel Depletion (FFD), in MJ Surplus is based on TRACI v2.1, 2012. ADPfossil and FFD are two completely different indicators. • According to TRACI v2.1 and LEEDv4.1, FFD is an LCIA indicator. • According to CML, ADPfossil is an LCIA indicator. • According to ISO 21930, ADP fossil is an LCI indicator and listed in Section 7.2.10. 39 USEtox is available in TRACI and at http://www.usetox.org/ (Accessed on 2 March 2022.) **7.3 Impact assessment indicators describing main environmental impacts derived from LCA** *An EPD developed using this document shall, as a minimum, report the set of impact categories stated in Table 5.* *In order to evaluate and use EPDs at a construction works level in a particular market or geographical location, the life cycle impacts (LCIA) indicators that are reported in the EPD shall be based on*			

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			characterization factors recommended by a programme operator and suitable for the market(s) and geographical location(s) where the EPD is intended to be used. For European-market EPDs developed with this document as the core PCR, the characterization method included in the latest edition of EN 15804 shall be used. *The EPD results shall be developed using one of the relevant, commonly used characterization methods.* *In the absence of specificity or preference regarding a characterization method, the default references provided in Table 5 shall be used. Values reported for GWP are based on accumulated radiative forcing over 100 years.* *Impact category results may be provided using more than one characterization method including the default references. Results shall be reported separately for each method that is used.* *Impact category results may be reported that are in addition to those minimum results mandated in Table 5 (see also 8.2). Scientifically developed characterization methods should be used for these additional indicators. In order to evaluate and use EPDs at a construction works level, the impact categories relevant for that particular market shall be used.* *A sub-category PCR may specify additional impact categories to be reported for a given product group based on market, regulatory and other relevant and applicable factors.* *ADPelement is optional (see 8.2) as there is great uncertainty related to characterization factors. ADPelement includes all non-renewable material resources (e.g. minerals, uranium, sulphur) used as energy and material resource.* *NOTE 1 The comparability of EPDs with different impact categories reported is limited (see 5.5).* *NOTE 2 Characterization factors of the Default International Characterization Method are publicly available on http:// cml .leiden .edu/ software/ data -cmlia .htm*			

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			NOTE 3 It is considered good practice to identify any LCI data that has no calculated environmental impact within the project report. This can help to identify the need to generate complementary and consistent characterization factors for relevant LCI flows. **Table 5 — Mandatory impact categories and default characterization methods**			

Impact category and abbreviation	Default international characterization method	Default North American market characterization method	Default European market characterization method as provided in
Global warming potential (GWP 100)	IPCC[30]	TRACI	EN 15804
Ozone depletion potential (ODP)	WMO[34]	TRACI	EN 15804
Eutrophication potential (EP)	Heijungs et al.[31]	TRACI	EN 15804
Acidification potential (AP)	Hauschild and Wenzel[32]	TRACI	EN 15804
Photochemical oxidant creation potential (POCP)	Goedkoop et al.[41]	TRACI	EN 15804

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TE107			**PCR Specific Part A (§4.8): LCIA Indicators for Europe** *[ISO 21930, Section 7.3]: "For European or European-market EPDs developed with this document as the core PCR, the characterization method included in the latest edition of EN 15804 shall be used".* *See Annex A for additional guidance.*	N/A		Closed
TE108			**PCR Specific Part A (§4.9): International LCIA Indicators** *[ISO 21930, Section 7.3]: "In the absence of specificity or preference regarding a characterization method, the default references provided in Table 5 shall be used.".*	N/A		Closed

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			The following default international characterization methods shall be included for EPDs intended primarily for markets outside of North America and Europe, and may be optionally included for all other EPDs: ***Table 9. REST OF WORLD LIFE CYCLE IMPACT ASSESSMENT RESULTS*** ***Impact category and abbreviation*** — ***Method*** *Global warming potential (GWP 100)* — *IPCC* *Ozone depletion potential (ODP)* — *WMO* *Eutrophication potential (EP)* — *Heijungs et al.* *Acidification potential (AP)* — *Hauschild and Wenz* *Photochemical oxidant creation potential (POCP)* — *Jenkin and Hayman* *Characterization factors of the Default International Characterization Method are publicly available on http://cml.leiden.edu/software/data-cmlia.htm.* *The table shall be preceded by a statement that "LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks."* *A sub-category Part B PCR may provide further requirements on the inclusion of other impact categories and methods to be included as additional environmental information. Impact results may also be included for more than one characterization method as long as they are reported separately from the default method.* *The project report shall document all LCIA procedures, calculations and results of the study including all additional environmental impact indicator results.*			
TE109			**PCR Specific Part A (§4.10): OPTIONAL LCIA INDICATORS AND OTHER ADDITIONAL ENVIRONMENTAL INFORMATION** *Unless otherwise defined explicitly in the sub-category Part B PCR, an EPD may also include impact categories as defined in ISO 21930 Section 8.2 as "still under development or have high levels of uncertainty that preclude international acceptance pending further development.*	N/A		Closed

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			Such potential LCIA categories shall follow the requirements for characterization models given in ISO 14044. The following are examples of such potential impact categories: *"[…]* *Abiotic depletion potential for non-fossil mineral resources (ADPelements)* *Land-use-related impacts, for example on biodiversity and/or soil fertility* *Toxicological aspects.* *If such LCIA-type results are included in an EPD, the LCA report and the EPD shall include a written discussion of the results, including the limitations related to the LCIA-type methods used. This requirement also applies to the development of sub-category Part B PCR."* *Additional environmental information may also be included of a qualitative nature, such as those in ISO 21930 Section 8.3:* *"Geographical aspects relating to the declared environmental aspects at any stages of the life cycle* *Environmentally responsible sourcing* *Best environmental practice* *Energy use for operating pollution control systems* *Toxicity risks or hazards related to human health and/or the environment."*			
TE110	p. 26	Sec. 3.2.2	**PCR Specific Part A (§4.11.1): Mandatory Environmental Information** *EPDs shall list, at a minimum, all substances contained in the construction product that are identified as hazardous according to standards or regulations of the applicable market(s) in Section 2.8.6, Table 4. For products where no such substances are present, the EPD shall include the statement "no substances required to be reported as hazardous are associated with the production of this product."*	Please list the specific hazardous chemicals. For products that don't contain hazardous materials, provide statement: *"no substances required to be reported as hazardous are associated with the production of this product."* This statement is also to be presented in the EPD.	Added statement in section 3.2.1. and in EPDs. Statement also in Section 3.2.2 " While some of the ingredients may be classified as hazardous, per EPA's Resource Conservation and Recovery Act (RCRA), Subtitle C, Title 40 Code of Federal Regulations, Part 261 (Code of Federal Regulations , 2023), the product as installed and ultimately disposed of is not classified as a hazardous substance, as hazardous	Closed

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					ingredients are rendered chemically inert after installation." - Also included in EPDs **Acknowledged.**	
TE111			**PCR Specific Part A (§4.11.2): Dangerous Substances** *EPDs shall contain mandatory information about the release of dangerous, regulated sub-stances that affect health and environment according to the relevant market of applicability. A sub-category Part B PCR shall provide further requirements on testing and reporting the releases of dangerous substances to be included in this Section. According to ISO 21930 Section 8.4.2, this includes but is not limited to:* *Indoor air emissions* *Gamma or ionizing radiation emissions* *Chemicals released to air or leached to water and soil*	Requirement met.		Closed
TE112			**ISO Requirement (§4.5.1.1):** ***Life Cycle Interpretation*** *– General* *The life cycle interpretation phase of an LCA or an LCI study comprises several elements as depicted in Figure 4, as follows:* *– identification of the significant issues based on the results of the LCI and LCIA phases of LCA;* *– an evaluation that considers completeness, sensitivity and consistency checks;* *– conclusions, limitations, and recommendations.* *The relationship of the interpretation phase to other phases of LCA is shown in Figure 4.* *The goal and scope definition and interpretation phases of life cycle assessment frame the study, whereas the other phases of LCA (LCI and LCIA) produce information on the product system.* *The results of the LCI or LCIA phases shall be interpreted according to the goal and scope of the study, and the interpretation shall include an assessment and a sensitivity check of the significant inputs, outputs and methodological choices in order to understand the uncertainty of the results.*	Requirement met.		Closed
TE113			**ISO Requirement (§4.5.1.2):** ***Life Cycle Interpretation*** *– General* *The interpretation shall also consider the following in relation to the goal of the study:* *– the appropriateness of the definitions of the system functions, the functional unit and system boundary;*	Requirement met.		Closed

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Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
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			– limitations identified by the data quality assessment and the sensitivity analysis. *The documentation of the data quality assessment, sensitivity analyses, conclusions and any recommendations from the LCI and LCIA results shall be checked.* *The LCI results should be interpreted with caution because they refer to input and output data and not to environmental impacts. In addition, uncertainty is introduced into the results of an LCI due to the compounded effects of input uncertainties and data variability. One approach is to characterize uncertainty in results by ranges and/or probability distributions. Whenever feasible, such analysis should be performed to better explain and support the LCI conclusions.*			
TE114			**ISO Requirement (§4.5.2.3):** ***Life Cycle Interpretation*** *– Identification of Significant Issues.* *There are four types of information required from the preceding phases of the LCA:* *a) the findings from the preceding phases (LCI, LCIA) that shall be assembled and structured together with information on data quality;* *b) methodological choices, such as allocation rules and system boundary from the LCI and category indicators and models used in LCIA;* *c) the value-choices used in the study as found in the goal and scope definition;* *d) the role and responsibilities of the different interested parties as found in the goal and scope definition in relation to the application, and also the results from a concurrent critical review process, if conducted.* *When the results from the preceding phases (LCI, LCIA) have been found to meet the demands of the goal and scope of the study, the significance of these results shall then be determined. All relevant results available at the time shall be gathered and consolidated for further analysis, including information on data quality.*	Requirement met.		Closed
TE115			**ISO Requirement (§4.5.3.1):** ***Life Cycle Interpretation*** *– Evaluation - General* *The objectives of the evaluation element are to establish and enhance confidence in, and the reliability of, the results of the LCA or the LCI study, including the significant issues identified in the first element of the interpretation. The results of the evaluation should be presented in a manner that gives the*	Requirement met.		Closed

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			commissioner or any other interested party a clear and understandable view of the outcome of the study. *The evaluation shall be undertaken in accordance with the goal and scope of the study.* *During the evaluation, the use of the following three techniques shall be considered:* *– completeness check (see 4.5.3.2);* *– sensitivity check (see 4.5.3.3);* *– consistency check (see 4.5.3.4).* *The results of uncertainty analysis and data quality analysis should supplement these checks.*			
TE116			**ISO Requirement (§4.5.3.2):** ***Life Cycle Interpretation*** *– Evaluation - Completeness* *The objective of the completeness check is to ensure that all relevant information and data needed for the interpretation are available and complete.* *If any relevant information is missing or incomplete, the necessity of such information for satisfying the goal and scope of the LCA shall be considered. This finding and its justification shall be recorded.* *If any relevant information, considered necessary for determining the significant issues, is missing or incomplete, the preceding phases (LCI, LCIA) should be revisited or, alternatively, the goal and scope definition should be adjusted. If the missing information is considered unnecessary, the reason for this should be recorded.*	Requirement met.		Closed
TE117			**ISO Requirement (§4.5.3.3):** ***Life Cycle Interpretation*** *– Evaluation - Sensitivity* *The objective of the sensitivity check is to assess the reliability of the final results and conclusions by determining how they are affected by uncertainties in the data, allocation methods or calculation of category indicator results, etc.* *The sensitivity check shall include the results of the sensitivity analysis and uncertainty analysis, if performed in the preceding phases (LCI, LCIA).* *In a sensitivity check, consideration shall be given to* *– the issues predetermined by the goal and scope of the study,* *– the results from all other phases of the study, and* *– expert judgements and previous experiences.*	Requirement met.		Closed

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			When an LCA is intended to be used in comparative assertions intended to be disclosed to the public, the evaluation element shall include interpretative statements based on detailed sensitivity analyses. *The level of detail required in the sensitivity check depends mainly upon the findings of the inventory analysis and, if conducted, the impact assessment.* *The output of the sensitivity check determines the need for more extensive and/or precise sensitivity analysis as well as shows apparent effects on the study results.* *The inability of a sensitivity check to find significant differences between different studied alternatives does not automatically lead to the conclusion that such differences do not exist. The lack of any significant differences* *may be the end result of the study.*			
TE118			**ISO Requirement (§4.5.3.3): *Life Cycle Interpretation*** – *Evaluation - Consistency* *The objective of the consistency check is to determine whether the assumptions, methods and data are consistent with the goal and scope. If relevant to the LCA or LCI study the following questions shall be addressed.* *a) Are differences in data quality along a product system life cycle and between different product systems consistent with the goal and scope of the study?* *b) Have regional and/or temporal differences, if any, been consistently applied?* *c) Have allocation rules and the system boundary been consistently applied to all product systems?* *d) Have the elements of impact assessment been consistently applied?*	Requirement met.		Closed
TE119			**ISO Requirement (§4.5.4): *Life Cycle Interpretation* – *Conclusions, limitations and recommendations*** *The objective of this part of the life cycle interpretation is to draw conclusions, identify limitations and make recommendations for the intended audience of the LCA.* *Conclusions shall be drawn from the study. This should be done iteratively with the other elements in the life cycle interpretation phase. A logical sequence for the process is as follows:* *a) identify the significant issues;* *b) evaluate the methodology and results for completeness, sensitivity and consistency;* *c) draw preliminary conclusions and check that these are consistent with the requirements of the goal and scope of the study, including, in*	Requirement met.		Closed

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			particular, data quality requirements, predefined assumptions and values, methodological and study limitations, and application-oriented requirements; *d) if the conclusions are consistent, report them as full conclusions; otherwise return to previous steps a), b) or c) as appropriate.* *Recommendations shall be based on the final conclusions of the study and shall reflect a logical and reasonable consequence of the conclusions.* *Whenever appropriate to the goal and scope of the study, specific recommendations to decision-makers should be explained.* *Recommendations should relate to the intended application.*			
TE120			**ISO Reporting Requirements (§5.2)** ***Additional Requirements and Guidance -*** *The third-party report shall cover the following aspects:* *f)* ***Life cycle interpretation****:* *1) the results;* *2) assumptions and limitations associated with the interpretation of results, both methodology and data related;* *3) data quality assessment;* *4) full transparency in terms of value-choices, rationales and expert judgements.*	Requirement met.		Closed
TE121			**PCR Specific Part A (§5):** *Life Cycle Interpretation* *The aggregation factors of the Life Cycle Inventory Analysis and the estimated impact indicators shall be interpreted in the project report with reference to the declared or functional unit and specifications essentially influencing the result, i.e. at least:* *[ISO 21930 Section 10.2 f: […]* *“[Interpretation of] the results [based on a dominance analysis of selected indicators (for the relevant modules)];* *[The relationship between the Life Cycle Inventory Analysis results and the results of the impact estimate];* *Assumptions and limitations associated with the interpretation of results as declared in the EPD, both methodology and data related;* *The variance from the means of LCIA results should be described, if generic data are declared from several sources or for a range of similar products;* *Data quality assessment;* *Full transparency in terms of value-choices, rationales and expert judgements.”*	Requirement met.		Closed
TE122			**PCR Specific Part B (§6):** ***Interpretation***	Requirement met.		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

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			Interpretation requirements for the Project Report are provided in Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Section 5. *An interpretation shall be provided in the EPD which discusses the assumptions and limitations associated with the interpretation of results as declared in the EPD, both methodology and data related.* *This interpretation shall also include a description of the time frame and/or variance of the LCIA results if the EPD is valid for several products. An illustration of the results with figures is recommended in the EPD, e.g. for the dominance analysis, the distribution of impacts across the modules, the CO2-balance, etc. as appropriate for a reader's understanding of the environmental profile of the declared product.*			
TE123			**PCR Specific Part A (§6.1):** *Documentation of additional information: Laboratory Results and Scenario-Related Information* *[ISO 21930 Section 10.4]: "The project report shall include any documentation on additional environmental information declared in the EPD as required in this standard. Such documentation on additional environmental information may include, e.g. as copies or references:* *Laboratory results/measurements for the content declaration;* *Laboratory results/measurements of functional/technical performance;* *Documentation on declared technical information on life cycle stages that have not been considered in the LCA of the construction product and that will be used for the assessment of construction works (e.g. transport distances, energy consumption during use, cleaning cycles etc.)* *Laboratory results/measurements for the declaration of emissions to indoor air, soil and water during the product's use stage."*	N/A		Closed
TE124			**PCR Specific Part A (§6.2):** *Documentation for Calculating the Reference Service Life (RSL) If the use stage is declared (Modules B1 to B7), a reference service life (RSL) must be indicated. In all other cases, indication of a RSL is optional.* *[ISO 21930, Section 7.1.4]: "The RSL information to be declared in an EPD covering the use stage shall be provided by the manufacturer. The RSL shall refer to the declared technical and functional performance of the product within a construction works. It shall be established in accordance with any specific rules given in product standards and shall*	Requirement met.		Closed

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			take into account ISO 15686-1, ISO 15686−2, ISO 15686−7 and ISO 15686−8. Where product standards pro-vide guidance on deriving the RSL, such guidance shall have priority. *The RSL is dependent on the properties of the product and reference in-use conditions. In-formation on the product's RSL, therefore, requires specification of compatible scenarios for the production stage, construction stage and use stage. These conditions shall be declared together with the RSL and it shall be stated that the RSL applies for the reference in-use conditions only.* *Default values shall be provided and be based on published references. If longer RSLs are used, they shall be guaranteed by the signature of the most senior officer of the product manufacturer.* *NOTE Default values can be provided in a sub-category Part B PCR.* *Requirements and guidance on both the RSL and ESL for the estimation of service life are given in normative ISO 21930, Annex A. A sub-category Part B PCR should specify requirements to define the RSL for the given product group, where relevant.* ***Annex A*** *(normative)* ***Requirements and guidance on the RSL and ESL*** *A RSL can only be determined for a cradle to grave EPD or a cradle to gate EPD with options where modules A1 to A5 and B1 to B5 have been provided. If the service life is declared, then the following principles shall apply.* *— The RSL of a product can be based upon empirical, probabilistic, statistical, deemed to satisfy or research (scientific) data and shall always take into account the intended use (description of use); see ISO 15686-1, ISO 15686−2, ISO 15686−7 and ISO 15686−8. This basis shall be reported in the EPD.* *— A manufacturer providing the RSL for a product shall take into account and describe in the EPD the intended use, declared functional performance and the scenario(s). Considering the specific in-use conditions linked to the scenario(s) defined, the estimated service life shall be transparent to allow for verification.*			

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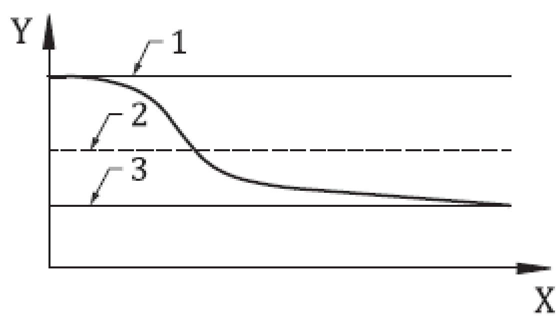
			A declared RSL shall be related to the declared functional technical performance and to any maintenance or repair necessary to provide the declared performance during the declared RSL or provided ESL. The declared technical performance may be based on specifications for determination or calculation of this performance given in the relevant product standards. These performances may be defined as initial, average or minimum levels. See Figures A.1 and A.2. *NOTE 1 The declared technical performance could be the input for calculations beyond this document.* *However, the outcome, in terms of RSL, will be input for the requirements in this document.* *NOTE 2 The manufacturer or producer of the construction product cannot be held responsible for the actual design of the construction works, the use and application of the product, the environment, workmanship or use.* *EXAMPLE The thermal performance of a window, insulation, a heating boiler, etc., will impact on the energy use of the building in the use stage. This energy use, its emissions and waste contribute to the environmental aspects and impacts of the building in the use stage. The RSL of the window, insulation, the heating boiler, etc., are linked to the product's performance in order to provide consistency in the calculation model.*  ***Key*** *X RSL*			

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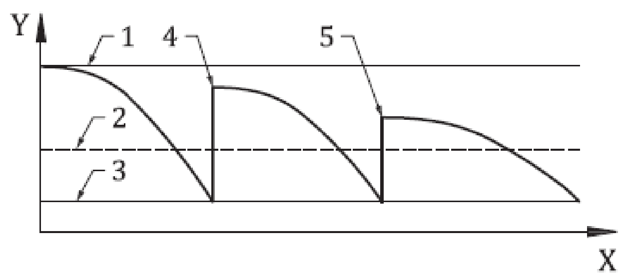
			Y functional performance *1 initial* *2 average* *3 minimum* ***Figure A.1 — Type of declared technical and functional performance and RSL***  ***Key*** *X RSL* *Y technical and functional performance* *1 initial* *2 average* *3 minimum* *4 maintenance or repair* *5 maintenance or repair* ***Figure A.2 — Type of declared technical and functional performance, repair or maintenance during RSL*** *The RSL is dependent on the properties of the product and reference in-use conditions. These conditions shall be declared together with a RSL and it shall be stated that the RSL only applies to these reference in-use conditions.*			

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			The description of the technical and functional performance of a product is required for the technical specification of a construction product. The reference in-use conditions for achieving the declared technical and functional performance and the declared RSL shall include the following, where relevant: *— RSL expressed in years;* *— declared product properties (at the gate) and those of any finishes, etc.;* *— design application parameters (if instructed by the manufacturer), including references to any appropriate requirements and application codes;* *— an assumed quality of work;* *— external environment (for outdoor applications), e.g. weathering, pollutants, UV and wind exposure, construction works orientation, shading, temperature;* *— internal environment (for indoor applications), e.g. temperature, moisture, chemical exposure;* *— usage conditions, e.g. frequency of use, mechanical exposure;* *— maintenance, e.g. required frequency, type and quality and replacement of replaceable components.* *The RSL of a construction product (e.g. a window) declared in an EPD is dependent on the service life of its individual components (handle, hinge, etc.) and may be determined by the component with the lowest service life. It also depends on whether the single components of the construction element are replaceable or repairable.* *RSL data is normally based on direct testing or both direct and indirect data acquisition (see ISO 15686-2, ISO 15686-8 and ISO/TS 15686-9). Direct data acquisition may be based on:* *— field exposure;* *— inspection of construction works and their components;* *— experimental construction works;* *— in-use exposure.* *In some cases, for products for which direct data are not available, indirect methods may be used for establishing RSLs:* *— correlated to data for existing products of a similar type with similar functions having similar use and exposure conditions;* *— comparative data obtained by testing the products of a similar type and similar function for similar uses and exposure conditions, in accordance with product test standards.* *NOTE 3 ISO/TS 15686-9 refers to procedures that can be divided into two groups, direct and indirect tests.*			

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			Direct testing: the achievement of a certain level of performance in a test of a particular property is recognized as being direct evidence of the maximum period of useful life expected as defined by the manufacturer (e.g. abrasion, fatigue, closing and impact tests) . *Indirect (proxy) testing: the measurement of “proxy” characteristics that can be correlated to actual performance and hence service life (e.g. porosity for freeze-thaw resistance and hardness for abrasion resistance).* *Tests may be either:* *— natural weathering/ageing tests, which either give a direct indication of service life (e.g. corrosion tests) or enable normal performance tests to be carried out after treatment, thus allowing the likely degradation under in-use conditions to be determined, or* *— accelerated weathering/ageing tests, in which the normal ageing process is speeded up to reduce the duration of the test. Care is needed to ensure that degradation mechanisms are just accelerated and not significantly altered in such tests.* *Tests may be long-term or short-term or a combination of both.* *Long-term tests may include:* *a) field exposure;* *b) exposure in experimental construction works.* *Short-term tests may include:* *a) accelerated short-term tests;* *b) short-term in-use exposures.*			
TE125			**ISO Requirement (§6.1):** *Critical Review - General* *The scope and type of critical review desired shall be defined in the scope phase of an LCA, and the decision on the type of critical review shall be recorded.* *In order to decrease the likelihood of misunderstandings or negative effects on external interested parties, a panel of interested parties shall conduct critical reviews on LCA studies where the results are intended to be used to support a comparative assertion intended to be disclosed to the public.*	Requirement met.		Closed
TE126			**ISO Requirement (§6.2):** *Critical Review -* ***Critical review by internal or external expert***	Requirement met.		Closed

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			A critical review may be carried out by an internal or external expert. In such a case, an expert independent of the LCA shall perform the review. The review statement, comments of the practitioner and any response to recommendations made by the reviewer shall be included in the LCA report.			
TE127			**ISO Requirement (§6.1):** *Critical Review -* ***Critical review by panel of interested parties*** *A critical review may be carried out as a review by interested parties. In such a case, an external independent expert should be selected by the original study commissioner to act as chairperson of a review panel of at least three members. Based on the goal and scope of the study, the chairperson should select other independent qualified reviewers. This panel may include other interested parties affected by the conclusions drawn from the LCA, such as government agencies, non-governmental groups, competitors and affected industries.* *For LCIA, the expertise of reviewers in the scientific disciplines relevant to the important impact categories of the study, in addition to other expertise and interest, shall be considered.* *The review statement and review panel report, as well as comments of the expert and any responses to recommendations made by the reviewer or by the panel, shall be included in the LCA report*	N/A		Closed
TE128			**ISO Reporting Requirements (§5.2)** ***Additional Requirements and Guidance -*** *The third-party report shall cover the following aspects:* *g) Critical review, where applicable:* *1) name and affiliation of reviewers;* *2) critical review reports;* *3) responses to recommendations.*	Requirement met.		Closed
TE129			**PCR Specific Part A (§6.3):** *Data Available for Verification* *The information listed in ISO 21930 Section 10.5 shall be made available to the verifier, taking into account data confidentiality specified in ISO 21930 Section 10.3..*	Requirement met.		Closed
TE130			**PCR Specific Part B (§7):** *Additional Environmental Information* ***7.1 Environmental and Health During Manufacturing*** *Measures relating to environmental and health protection during the product manufacturing process extending beyond national guidelines (of the production country) may be described, e.g. reference to a product safety data sheet (SDS), description of Environmental Management Systems or similar, programs addressing air emissions, waste water, noise, etc.*	N/A		Closed

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TE131			**PCR Specific Part B (§7):** *Additional Environmental Information* ***7.2 Energy savings during use*** *During its service life, insulation significantly reduces the energy use in a building, thereby reducing the impact on the environment. Use-stage environmental benefits of insulation during building operations can be significant as low thermal conductivity and air sealing attributes of insulation limit utility consumption and associated environmental impacts. The exclusion of the building heating and cooling during the insulation material's use phase severely underestimates the benefits that insulation has on the environment. This section may describe the energy savings and environmental benefits during use of the product in a building and only references operational consideration.* *Scenarios involving comparisons of operating energy savings to embodied energy as measured by Primary Energy Demand (PED) may be provided. Primary Energy refers to the renewable and non-renewable forms of energy extracted from nature, for example, crude oil or solar energy, and embodied in raw materials or as an energy carrier.* *Executing an analysis that demonstrates the use-phase environmental benefits of the declared insulation product involves establishing a building operation scenario compared to a baseline scenario. Such an analysis includes a reasonably accurate estimate of both scenarios in order to establish a quantified energy savings delta to compare with the environmental impact deltas.* *There are a few energy estimating methods employed by the various energy simulation programs. Due to its ease of use the Degree-Day Method is frequently utilized. However, this method is based on steady-state calculations. As stated in the ASHRAE 2017 Handbook of Fundamentals Chapter 19 (page 19.6) it "is limited in that it does not consider the effects of solar heat gain or building thermal mass, nor can it account for variations in infiltration and ventilation rates or thermostat settings (such as night setback)." These are quite normal conditions in commercial buildings and therefore, the use of the Degree-Day Method does not provide reliability for this analysis. Whole building simulation tools based on rigorous calculations, such as the Heat Balance Method would be suitable for this analysis.*	N/A		Closed

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TE131a			**PCR Specific Part B (§7):** *Additional Environmental Information* ***7.3 Environment and Health During Installation*** *Information should be provided in this section on the relationship between the product, the environment and health, including possible harmful substances or emissions e.g. reference to a product safety data sheet (SDS). Any recommendations concerning cleaning, maintenance, etc. of the declared product should be listed in Section 4 "Technical information on scenarios".*	Requirement met. E&H information included in EPD		Closed
TE132			**PCR Specific Part B (§7):** *Additional Environmental Information* ***7.4 Extraordinary Effects*** *FIRE* *Information should be included on the product's fire performance and possible impacts on the environment e.g. reaction-to-fire, other relevant fire tests as applicable, and emissions to air.* *WATER* *Information should be included on the product's performance and possible impacts on the environment following unforeseeable influence of water, e.g. flooding.* *MECHANICAL DESTRUCTION* *Information should be included on the product's performance and possible impacts on the environment following unforeseeable mechanical destruction.*	Requirement met. Performance information included in EPD		Closed
TE133			**PCR Specific Part B (§7):** *Additional Environmental Information* ***7.5 Delayed Emissions*** *If a manufacturer wishes to declare quantitative or qualitative information on delayed emissions used to calculate Global Warming Potential within the EPD, information may be provided here. See Part A Section 4.4 for more information..*	N/A		Closed
TE134			**PCR Specific Part B (§7):** *Additional Environmental Information* ***7.6 Environmental Activities and Certifications*** *Other environmental activities, such as participation in recycling or recovery programs along with the details of these programs and contact information, shall be provided.* *For certifications applied to the product and listed in the EPD, a statement shall be included on where an interested party can find details of the certification program.*	Requirement met. Information included in EPD		Closed
TE135			**PCR Specific Part B (§7):** *Additional Environmental Information* ***7.7 Further Information***	Requirement met. Information included in EPD		Closed

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			A reference source for additional information may be provided here, e.g. homepage, reference source for safety data sheet.			
TE136			**PCR Specific Part A (§9) Pre-verified Tools** *Refer to UL's General Program Instructions, Section 7.8, for applicable requirements for preverified tools used for EPD development and generation.* ***7.8 Pre-Verified EPD Tools*** *Industries and companies who seek to produce EPDs at mass scale and then provide SKU and/or batch-specific EPDs on demand can work with the UL EPD Program to pre-verify EPD generation tools. The intent behind pre-verification of such tools is to enable a streamlined verification process where an LCA model is initially verified and then used to generate specific EPD results.* *These LCA models contain parameters that represent e.g. bills of materials, manufacturing energy inputs, transportation distances, and other pre-defined model inputs that can be populated based on the specific inputs from a specific product that can be used to generate results for a specific EPD. While a user can control specific quantities of inputs to the model, the underlying model cannot be changed and the output results from the tool can be used to automatically populate the results reported in an EPD. If updates to the tool are needed, re-verification may be required according to Section 7.8.4.* ***7.8.1 EPD Tool Verification*** *The purpose of the initial tool verification is to ensure the underlying LCA model(s) 1) meet the requirements specified in the referenced Product Category Rules (more than one may apply), 2) check calculations, 3) data parameterization, 4) data quality, and 5) consistency. The model may be directly requested by UL and shall tested for all inputs and outputs and is approved after verifying the first two EPDs generated by the tool. As a general rule, if more than one PCR is utilized in a model, two EPDs per PCR shall be verified. Upon final verification, the tool is archived by the tool owner.* *An LCA project report shall be submitted along with the tool for the verification process. In addition to addressing all requirements in Section 7.5, the report will describe the model structure, all model parameters, possible input data, and possible data quality of the input data used in model parameters.*	N/A		Closed

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			7.8.2 Validity *After verification, a tool is valid for a maximum of five years and shall not extend beyond the validity of the referenced PCRs.* ***7.8.3 EPD Verification*** *The first two EPDs generated from the tool shall undergo a full individual verification according to Section 7.5. In addition, the EPD shall include a reference to the tool version and the tool project report. Further EPDs generated using the tool shall be subject to a UL-initiated spot-check for result plausibility.* ***7.8.4 Tool Updates*** *Pre-verified EPD tools may need to be periodically updated. It is the responsibility of the EPD Owner to notify UL of all significant and minor changes prior to updating the tool.* *Examples of significant changes include, but are not limited to:* *• Additional materials* *• Additional LCI libraries (including updates to existing LCI databases)* *• Plant additions* *• Plant expansion* *• Significant updates to PCR (e.g. product use assumptions)* *• Substantive changes to model parameterization** *• Additional product categories** ** These changes may occur additional fees* *Examples of minor changes include, but are not limited to:* *• Supplier changes*** *• Shifts in production volumes*** *• Distribution changes*** *• Updates to impact assessment methods/characterization factors (contingent on PCR update; PCR update doesn't necessarily require re-review of model)* *** These changes may be deemed significant if impact assessment results change beyond 20%* *All changes anticipated to be significant based on the criteria outlined above shall be discussed with UL prior to model updates. If UL deems the change significant, the model will need to be re-verified and UL will engage the original independent verifier (or suitable replacement if UL*			

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			so chooses) to perform the review of the changes at cost. Pricing will be quoted according to the level of reverification effort detailed in the pricing section. *All changes shall be tested for significance and tracked in a change log shared with UL that includes but is not limited to: type of change(s), detailed description of change, date of the implemented physical and/or model change, impacted product families and SKUs, relative magnitude of percent change (if applicable), and model version number. The model owner must update the change log immediately after making model updates and must notify UL within a week of making updates to the change log.*			
TE137			**PCR Specific Part A (§10.1) Part B (§3.10) Benchmarking in EPDs** *Benchmarking results may be included in an EPD according to the requirements listed in the Sections below.* **Part B (§3.10) Comparability and Benchmarking** *Comparison of EPD results between non-competitive products may be included this section per the requirements in Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Section 9. [Sic. Section 10]*	N/A		Closed
TE138			**PCR Specific Part A (§10.2) Industry-Average Benchmarking** *When a manufacturer-specific EPD is benchmarked against an industry-average EPD, the following requirements shall be met, in addition to the comparability requirements listed in ISO 21930 Section 5.5.* * *If the industry association has a developed dedicated LCA and EPD generator tool, this tool shall be used for all EPD comparisons.* * *A manufacturer shall have participated, either originally or retroactively, in the industry average EPD per the requirements outlined in this Part A PCR and potential additional requirements provided in a sub-category Part B PCR* *NOTE: Industry associations may want to provide a pathway for manufacturers to claim representation under a previously published industry average EPD, or claim "retroactive participation", regardless of why the manufacturer did not/was not able to originally participate. As such, sub-category Part B PCRs may specify any quantitative LCI/process data and qualitative data that must be submitted for a manufacturer to claim representation. These criteria may differ*	N/A		Closed

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			depending on the industry and their level of comfort. These submitted data are then reviewed by the Program Operator, which then confers with the industry association to reach consensus as to whether the manufacturer can be added. That said, the LCA report submitted to the Program Operator by the LCA practitioner must contain the uncertainty ranges for key LCI manufacturing and product data in order to make this determination. *EXAMPLE PART B RETROACTIVE PARTICIPATION SECTION: A manufacturer requiring retroactive inclusion in the industry-average EPD shall provide the manufacturing and product data information submitted in the original industry average EPD to the LCA practitioner. The LCA practitioner will then recommend to the Program Operator a determination for inclusion in the industry average on the basis of results validation for any impact category. The maximum and minimum results should be reported in the LCA background report for each impact category based on the highest and lowest impact product within the original industry-wide LCA.* *When determining a manufacturer's participation eligibility, the EPD Program Operator shall follow the recommendations of the primary sponsor(s) of the industry average EPD and participating manufacturers unless the Program Operator has information to the contrary, in which case the Program Operator, LCA practitioner, primary sponsor of the industry average EPD, and manufacturer shall confer in an effort to reach consensus.* * LCI data sources shall be consistent between the manufacturer-specific EPD and the industry- average benchmark EPD as it pertains to:* *o Background life cycle inventory data sets and reference year:* *• If a manufacturer-specific EPD is developed using the same LCI dataset(s) and version as the industry-average, then no recalculation is required and comparison may proceed.* *• If the LCI dataset(s) used in the industry-average and manufacturer-specific EPDs are different, the industry average EPD results shall be recalculated using the LCI dataset(s) used for manufacturer-specific EPD.* *o Priority of primary and secondary data sources.*			

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			o Specific primary, non-life cycle inventory data (e.g. transportation distances and modes) *A data quality check should be based on a plausibility check.* *LCA modelling software and version shall be consistent:* *o If a manufacturer-specific EPD is developed using the same LCA software platform and version as the industry-average, then no recalculation is required and comparison may proceed.* *o If the LCA software platforms used in the industry-average and manufacturer-specific EPDs are different, the industry average EPD results shall be recalculated using the software platform and version used for manufacturer-specific EPD.* *Life Cycle Impact Assessment method and version shall be consistent between the manufacturer-specific EPD and the industry-average benchmark EPD.* *The life cycle stages considered shall be consistent between the manufacturer-specific EPD and the industry-average benchmark EPD. If the scope of the PCR allows for optional reporting of modules not included in the industry-average EPD, they may not be included for benchmarking purposes.* *Manufacturer-specific use phase calculations in the Project Report shall be consistently applied between the manufacturer-specific EPD and the industry-average benchmark EPD as outlined in the sub-category Part B PCR.* *End of life assumptions in module C shall be consistently applied as specified in the core and sub-category Part B PCR between the manufacturer-specific EPD and the industry average benchmark EPD.* *Cut-off criteria for inclusion of mass and energy flows shall be consistently applied as specified in this Part A PCR between the manufacturer-specific EPD and the industry-average benchmark EPD.* *A comparison with the values reported in the Best Available Technology (BAT) document (gate-to-gate) and other available data sources (cradle-to-gate data from commercial databases and confidential sources) should be done as well as plausibility checks.* *When claiming impact reductions for green building schemes using this Part A, results are significant as defined by at least a 5% or greater reduction in any given impact category with the exception of Ozone Depletion Potential (ODP). In the case of ODP, a 10% or greater reduction in impact qualifies as significant.* *Specifically for LEED v4.1, MR Credit: Environmental Product Declarations41, the following GWP reductions and point values apply*			

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			when comparing a product-specific EPD and an industry average EPD baseline: *o <10% reduction in GWP = 1 product* *o 10%+ reduction in GWP = 1.5 products*			
TE139			**PCR Specific Part A (§10.3) Part B (§3.10) Manufacturer-Specific Benchmarking and Comparability** *When a manufacturer-specific EPD is benchmarked against an existing manufacturer-specific EPD from the same manufacturer, the following requirements shall be met in addition to the comparability requirements listed in ISO 21930, Section 5.5.:* * The life cycle stages considered for benchmarking in each EPD shall be consistent.* * Data sources shall be consistent as it pertains to:* *o Priority of primary and secondary data sources* *o Application of background LCI data sets and version. If LCI dataset method updates occur between the publication of the benchmark EPD and updated EPD, the benchmark EPD results shall be recalculated using the most recent LCI datasets and used for benchmarking with the updated EPD.* *o Application of specific secondary, non-LCI data.* * LCA modelling software and version used shall be consistent. If LCA software updates occur between the publication of the benchmark EPD and updated EPD, the benchmark EPD results shall be recalculated using the most recent software version and used for benchmarking with the updated EPD.* * Cut-off criteria for inclusion of mass and energy flows shall be consistently applied.* * Product specific use phase calculations in the Project Report shall be consistently applied as outlined in this Part A PCR or the sub-category Part B PCR* * End of life assumptions in Module C shall be consistently applied as specified in this Part A PCR or sub-category Part B PCR* * Providing they do not conflict with existing confidentiality agreements, sources of deviation from the benchmark EPD shall be documented and quantified, including but not limited to:* *o Number of manufacturing locations considered* *o Sourcing changes* *o Product design changes implemented* *o Process changes implemented* *o Processing waste treatment changes*	N/A		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			o End of life pathway changes *When claiming impact reductions for green building schemes, results according to this Part A are significant as defined by at least a 5% or greater reduction in any given impact category with the exception of Ozone Depletion Potential (ODP). In the case of ODP, a 10% or greater reduction in impact qualifies as significant.* *Specifically for LEED v4.1, MR Credit: Environmental Product Declarations42, the following reductions and point values apply when comparing a product-specific EPD with a product-specific EPD baseline:* *o <10% reduction in GWP = 1 product* *o 10%+ reduction in GWP = 1.5 product* *o 20%+ reduction in GWP and 5%+ reduction in two additional impact categories = 2 products* *EXAMPLE: In 2022, the company estimates a 10% improvement in climate change from 2017. To ensure comparability, the 2017 benchmark EPD results shall be recalculated using the most recent LCA software version and used for benchmarking with the 2022 updated EPD.* ***Part B 3.10 Comparability and Benchmarking*** *Comparison of EPD results between non-competitive products may be included in this section per the requirements in Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Section 9.*			
TE140			**PCR Specific Part A (§11) Digitized EPDs** *According to ISO 14025, EPDs are intended to be comparable between products fulfilling the same function and facilitate more informed decision making. However, due to the largely static nature of EPD reporting in pdfs, meaningful comparison of EPD data has been limited to-date. A lack of digitized EPD data creates a problem for creating and using EPD data at scale.* *When available, EPD information should be digitized according to the latest open source, consensus-based standards to facilitate information sharing. PCR Part Bs developed in accordance with this Part A should keep that digitization process in mind when structuring content to be reported.*	N/A		Closed
TE141			**PCR Specific Part B (§8) Supporting Documentation**	Requirement met.		Closed

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			The Project Report Content, Structure, and Accessibility requirements to support an EPD created using this document are provided in Part A: Section 2. Project Report elements include general information (Part A: Section 2.1), study goal (Part A: Section 2.2), study scope (Part A: Section 2.8), and the life cycle inventory analysis, impact assessment, and interpretation (Part A: Section 3, 4, and 5). Additionally, the Project Report shall include additional required supporting documentation specified in this sub-category Part B and according to Part A: Section 6. *If relevant to the scope of the declared product, or due to the product material composition, it is recommended to provide sufficient supporting documentation in the EPD and Project Report. When providing documentation, testing protocols and other relevant information shall be indicated. If supporting documentation is not provided, the reasons shall be indicated in the EPD and Project Report.* *As a general rule, all statements shall be documented with measured data (presented by the corresponding test certificates). In the case of non-verifiable substances, the limit of detection shall be included in the declaration.* *Interpreting statements such as "… free of …" or "… are entirely harmless …" are not permissible.*			
TE142			**PCR Specific Part B (§9) References** *The literature referred to in the Environmental Product Declaration shall be quoted in full from the following sources.* *Standards and standards relating to evidence and/or technical features already fully quoted in the EPD do not need to be listed here. This Part B PCR document shall be referenced.*	Requirement met.		Closed
TE143			**PCR Specific Part A – Annex A Additional Requirements in Conformance with EN 15804-A2**	N/A		Closed
TE144			**PCR Specific Part A (§2.4) EN 15804+A2/AC (§6.3.2) – Functional Unit** *The functional unit shall specify:* *• the reference quantity for the functional unit when integrated in the construction works* *• the quantified key properties, when integrated into a building,*	N/A		Closed

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			for the functional use, quantified performance characteristics or minimum performance of the construction product, taking into account the functional equivalent of the building; *• the minimum performance characteristics under defined conditions shall be fulfilled over the defined time period of the functional unit;* *• a specified period of time under reference in-use conditions considering the RSL. If the functional unit uses a different time period than the RSL, the RSL shall be given as technical information in the EPD (see EN 15804 6.3.4).* *• for the development of scenarios, for example for transport and disposal, conversion factors to mass per declared or functional unit shall be provided.* **6.3.2 Functional unit** **6.3.2.1 #General** *The functional unit defines the way in which the identified functions or performance characteristics of the product are quantified. The primary purpose of the functional unit in LCA studies according to ISO 14044 is to provide a reference by which material flows, LCA results and any other information are normalized to produce data expressed on a common basis. This allows comparison with other product systems which have been assessed to fulfil the same functional unit* *.* *NOTE 1 Comparisons of construction products with the same functional unit follow the rules in 5.3.* *The functional unit of a construction product shall specify:* *— the application of a product or product groups covered by the functional unit;* *— the reference quantity for the functional unit when integrated in the construction works;* *— the quantified key properties, when integrated into a building, for the functional use, quantified performance characteristics or minimum performance of the construction product, taking into account the functional equivalent of the building;* *— the minimum performance characteristics under defined conditions shall be fulfilled over the defined time period of the functional unit;* *— a specified period of time under reference in-use conditions considering the RSL. If the functional unit uses a different time period than the RSL, the RSL shall be given as technical information in the*			

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			EPD (see 6.3.4). *For the development of scenarios, for example for transport and disposal, conversion factors to mass per declared or functional unit shall be provided.* *For development of c-PCR, product CEN/TCs and other users of this standard shall specify performance characteristics and reference in-use conditions to be included in any functional unit.* *NOTE 2 Guidance on the development of a functional unit is given in EN ISO 14040:2006, 5.2.2.* *NOTE 3 Guidance on describing in-use conditions is given in Product Standards and ISO 15686-1, -2, -7 and -8.* *NOTE 4 If no recognized and appropriate test methods exist, RSL can be developed in accordance with ISO 15686 by product CEN/TCs or allow the use of independent empirical evidence.* ***6.3.2.2 Performance in a functional unit*** *The future function of the product within the building or construction works is often uncertain, as the full functionality of a product may not be required at the building level. It is therefore difficult to define a complete functional unit, including information on the required technical performance of the product within the building or construction works over the full life cycle.* *Nevertheless, for a cradle to grave EPD with a functional unit, a default (typical) application and the key functionalities shall be defined. These are normally required from the product or products in this application and provide other functional information as additional technical information.* *The declared technical performance shall be based on specifications for determination or calculation of this performance given in the relevant European harmonized technical specification (harmonized European Standard and European Assessment Document) if available.*			

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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TE145			**PCR Specific Part A (§2.4) EN 15804+A2/AC (§6.3.3) – Declared Unit** *Conversion factors to mass per declared unit shall be provided. Product standards or a c-PCR [Part B] may require additional conversion factors, for example to volume, for specific products.* ***6.3.3 Declared unit*** *#The declared unit shall be applied if a functional unit cannot be defined, e.g. since a function of the product cannot unequivocally be described because it can be used in many different ways in the context of construction works, or when the precise function of the product or scenarios at the building level is not stated or is unknown. The declared unit may also be used as an alternative to the functional unit.* *An EPD based on a declared unit may cover all modules of the life cycle (i.e. cradle to grave) and module D. The declared unit shall relate to the typical applications of products and their RSL.* *The declared unit in the EPD shall be declared applying one of the unit types listed below. A different unit may be declared for reasons that shall be explained. In such case, information shall be provided on how to convert this unit to one or more of the required unit types.* *— An item (piece), an assemblage of items, e.g. 1 brick, 1 window (dimensions shall be specified);* *— Mass (kg), e.g. 1 kg of cement;* *— Length (m), e.g. 1 m of pipe, 1 m of a beam (dimensions shall be specified);* *— Area (m2), e.g. 1 m2 of wall elements, 1 m2 of roof elements (dimensions shall be specified);* *— Volume (m3), e.g. 1 m3 of timber, 1 m3 of ready-mixed concrete.* *For the development of scenarios, for example for transport and disposal, conversion factors to mass per declared unit shall be provided. Product standards or a c-PCR may require additional conversion factors, for example to volume, for specific products.* *An EPD based on a declared unit may provide one or more alternative scenarios for its information modules.* *NOTE 1 Reasons for declaring units other than those listed include the need to use units normally used for design, planning, procurement and/or sale.* *NOTE 2 CEN Technical Committees for product standards are expected to harmonize the declared unit to be used for their product families.$*	N/A		Closed

Type of comment: **GE** = general **TE** = technical **ED** = editorial

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TE146			**PCR Specific Part A (§2.8.1) EN 15804+A2/AC (§5.2) – Types of EPDs** *All construction products and materials shall declare modules A1-A3, modules C1-C4 and module D. Only products which fulfil all three of the conditions below shall be permitted to be exempt from this requirement:* *• the product or material is physically integrated with other products during installation so they cannot be physically separated from them at end of life, and* *• the product or material is no longer identifiable at end of life as a result of a physical or chemical transformation process, and* *• the product or material does not contain biogenic carbon.* *If a product is found to be exempt, it may still meet EN15804 provided it meets all other requirements in 15804+A2 Section 5.2."* ***Continuation of (§5.2):*** *NOTE 1 This means any product containing biogenic carbon cannot omit the declaration of modules C1–C4 and module D.* *Construction products and materials that are identified as exemptions may omit the declaration of modules C1–C4 and module D. Any omission of modules C1–C4 and module D shall be justified.* *EPD not declaring modules C1–C4 and module D shall provide information on where to find scenarios for the end of life modules.* *EXAMPLE End of life scenarios for cement can be found in EPD for concrete and mortar.* *Types of EPD that may be provided are (see Figure 1):* *— cradle to gate with modules C1–C4 and module D (A1–A3, C and D).* *These stages are the minimum to be declared for the default type of EPD. They shall be based on a declared unit;* *— cradle to gate with options, modules C1–C4, and module D (A1–A3, C, D and additional modules.* *The additional modules may be A4 and/or A5 and/or B1–B7). This type of EPD shall be based on a functional unit or declared unit. If B-modules*	N/A		Closed

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			and use scenarios are not declared the EPD shall be based on a declared unit; *— cradle to grave and module D (A, B, C and D). This declaration shall be based on a functional unit or declared unit;* *— cradle to gate (A1–A3). These stages are the minimum to be declared for all construction products that are exempt from declaring modules C and D and shall be based on a declared unit. This type of EPD is not allowed for products containing biogenic carbon;* *— cradle to gate with options (A1–A3 and additional modules. The additional modules may be A4 and/or A5). This type of EPD is only possible for construction products that are exempt from declaring modules C and D. This type of EPD shall be based on a functional unit or declared unit.* *This type of EPD is not allowed for products containing biogenic carbon.* *NOTE 2 Information modules can supply information for processes for which there is no EPD available, e.g. a cleaning process.* *NOTE 3 A module contains, in addition to the indicator results, the values of the technical information underlying the quantification of pre-determined indicators, relevant technical information for further calculation of the environmental performance and the scenarios for further calculation of the indicator results.* *NOTE 4 It is possible to have an EPD for a substance or preparation (e.g. cement), for a product (e.g. window), for a construction service (e.g. cleaning service as part of maintenance) and for an assemblage of products and/or a construction element (e.g. wall) or technical equipment (e.g. lift).* ***See Figure 1 — Types of EPD with respect to life cycle stages covered and life cycle stages and modules for the construction works assessment***			
TE147			**PCR Specific Part A (§2.8.2) EN 15804+A2/AC (§6.3.4) – RSL** *RSL information to be declared in an EPD covering the use stage shall be provided by the manufacturer.* *Additional reporting requirements for RSL per EN 15804 Section 6.3.4.1 and 6.3.4.2 shall be included, where relevant.*	N/A		Closed

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			6.3.4 Reference service life (RSL) **6.3.4.1 General** *RSL information to be declared in an EPD covering the use stage shall be provided by the manufacturer.* *The RSL shall be specified under defined reference in-use conditions. The RSL shall refer to the declared technical and functional performance of the product within construction works. The RSL shall be established in accordance with any specific rules given in European product standards or, if not available, a c-PCR, and shall take into account ISO 15686-1, -2, -7 and -8. Where European product standards or a c-PCR provide guidance on deriving the RSL, such guidance shall have priority.* *Information on the product's RSL requires specification of compatible scenarios for the product stage, construction process stage and use stage. RSL is dependent on the properties of the product and reference in-use conditions. The RSL shall be declared together with the reference in-use conditions and it shall be stated that the RSL applies for the reference in-use conditions only.* *The reference in-use conditions for achieving the declared technical and functional performance and the declared RSL shall include the following, where relevant:* *— declared product properties (at the gate) and those of any finishes, etc.;* *— design application parameters (if instructed by the manufacturer), including references to any appropriate requirements and application codes;* *— an assumed quality of work;* *— external environment, (for outdoor applications), e.g. weathering, pollutants, UV and wind exposure, building orientation, shading, temperature;* *— internal environment (for indoor applications), e.g. temperature, moisture, chemical exposure;* *— usage conditions, e.g. frequency of use, mechanical exposure;* *— maintenance, e.g. required frequency, type and quality and replacement of replaceable components.* *The RSL shall be justified and verifiable.*			

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			Requirements and guidance on the RSL are given in normative Annex A. ***6.3.4.2 Scenarios for RSL and functional unit*** *For EPD based on functional units, the reference in-use conditions used to define the RSL, functional unit and any scenarios shall be consistent.* *A declared RSL for a construction product shall relate to its declared technical performance and to any maintenance or repair necessary to provide the declared performance during the RSL. Therefore, any scenario included for A4, A5 and B1–B7 shall be based on the specific reference in-use conditions for the RSL. Scenarios for all modules for a cradle to grave EPD shall also be consistent with the reference in-use conditions of the RSL (e.g. if a certain location is assumed for the construction stage, this assumption shall be reflected consistently for all declared subsequent modules i.e. the use stage, end of life stage and module D).*			
TE148			**PCR Specific Part A (§2.8.4) EN 15804+A2/AC (§ 6.3.9, 7.3.1) – Developing Product Level Scenarios** *For EPDs that declare any or all modules beyond the production stage, the technical information describing the scenarios for these modules is required together with the quantified environmental impacts of the modules based on them. See also EN 15804 Section 7.3.* *For an EPD covering cradle to gate with options (modules A1-A3, C1-C4, D, and optional modules (A4, A5 and/or any of B1–B7)), optional modules shall be calculated and the LCA derived indicators reported. Alternatively, in this type of EPD, a manufacturer may choose to declare additional technical information for the optional modules without calculating or reporting the optional life cycle stages to ensure proper understanding of a product's function in a building and thus support proper scenario development at the building level.* ***6.3.9 Developing product level scenarios*** *Scenarios shall be provided only for the environmental assessment. A scenario shall be based on the relevant technical information defined in this standard (see 5.4 and 7.3, for additional information). The*	N/A		Closed

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			kind of technical information the scenario is based on, is described in 7.3. With the help of the scenario, the predetermined #indicators$ of the EPD are derived by applying the calculation rules given in this standard. *Scenarios shall support the calculation of information modules covering processes that deal with any one or all of the life cycle stages of the construction product except for modules A1–A3; scenarios shall support the assessment of the environmental performance of a building in its life cycle stages "construction, use stage, end of life" (see Figure 1).* *A scenario shall be realistic and representative of one of the most probable alternatives. (If there are, e.g. three different applications, the most representative one, or all three scenarios shall be declared).* *Scenarios shall not include processes or procedures that are not in current use or which have not been demonstrated to be practical.* *EXAMPLE 1 A recycling system is not practical if it includes a reference to a return system for which the logistics have not been established.* *EXAMPLE 2 Energy recovery needs to be based on existing technology and current practice.* *Scenarios are communicated in accordance with 5.4. For EPD that declare any or all modules beyond the production stage, the technical information describing the scenarios for these modules is required together with the quantified environmental impacts of the modules based on them. See also 7.3.* ***7.3 Scenarios and additional technical information*** ***7.3.1 General*** *Scenarios for certain life cycle stages should support the application of product related data in the corresponding life cycle stage of the building assessment.* *Additional technical information as defined in 7.3, Table 10 to Table 15 supports the consistent development of scenarios by which the LCA derived indicators defined in 7.2.3 and 7.2.4 are calculated and declared.*			

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			If an EPD claims to cover all life cycle stages, #all relevant mandatory and optional modules shall be calculated for specified scenarios and the LCA derived indicators shall be declared. *For an EPD covering cradle to gate with options, modules C1–C4, and module D (A1–A3 + C + D and additional modules where the optional modules may be A4 and/or A5 and/or any of B1–B7), the optional modules are calculated and the LCA derived indicators are declared. Alternatively, in this type of EPD, a manufacturer may choose to declare additional technical information without calculating the optional life cycle stages to ensure proper understanding of a product's function in a building and thus support proper scenario development at the building level.* *Additional technical information is declared in the module, to which it refers (e.g. technical information about the use of a product in the appropriate use stage modules B.)* *Any additional technical information shall be documented separately from the LCA derived indicators.* *If additional technical information is not complete at the product level as specified in 7.3, this shall be stated.* *The information in Tables 10 to 15 is not exhaustive with respect to the examples or units and scenario information given.*			
TE149			**PCR Specific Part A (§2.8.4) EN 15804+A2/AC (§ 6.3.9, 7.3.2) – Developing Product Level Scenarios** ***7.3.2 Construction process stage*** ***7.3.2.1 A4, Transport to the building site*** *If additional technical information is provided in the EPD for transport from the production gate to the construction site, the following information shall be provided to specify the transport scenarios used or to support development of the scenarios at the building level:* ***Table 10 — Transport to the building site***	N/A		Closed

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Scenario information	***Unit (expressed per functional unit or per declared unit)***
Fuel type and consumption of vehicle or vehicle type used for transport e.g. long distance truck, boat etc.	*Litre of fuel type per distance or vehicle type, Commission Directive 2007/37/EC (European Emission Standard)*
Distance	*km*
Capacity utilisation (including empty returns)	*%*
Bulk density of transported products	*kg/m3*
Volume capacity utilisation factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaged products)	*Not applicable*

NOTE 1 As an alternative to the bulk density the weight and volume of transported products may be specified.

NOTE 2 With the bulk density and the volume capacity utilisation factor, (complex) logistic scenarios (e.g. taking onto account the type of vehicle, transport distance, empty returns) at the building level can be considered.

NOTE 3 For the assessment at the building level more complex logistics may have to be considered.

7.3.2.2 A5, Installation in the building

If additional technical information is provided in the EPD for installation in the building, the following information shall be provided to specify the product's installation scenarios or to support development of the scenarios describing the product's installation at the level of the building assessment:

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			Table 11 — Installation of the product in the building Scenario information | Unit (expressed per functional unit or per declared unit) Ancillary materials for installation (specified by material); | kg or other units as appropriate Water use | m3 Other resource use | kg Quantitative description of energy type (regional mix) and consumption during the installation process | kWh or MJ Waste materials on the building site before waste processing, generated by the product's installation (specified by type) | kg Output materials (specified by type) as result of waste processing at the building site e.g. of collection for recycling, for energy recovery, disposal (specified by route) | kg Direct emissions to ambient air, soil and water | kg			
TE150			**PCR Specific Part A (§2.8.4) EN 15804+A2/AC (§ 6.3.9, 7.3.3) – Developing Product Level Scenarios** ***7.3.3 B1-B7 use stage*** ***7.3.3.1 B1-B5 use stage related to the building fabric***	N/A		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			B1: Environmental aspects and impacts connected to the normal (i.e. anticipated) use of products, not including those related to energy and water use, which are dealt with in B6 and B7) e.g. release of substances from the facade, roof, floor covering, walls and other surfaces (interior or exterior) are reported as additional information (see 7.4). *B2-B5, if additional technical information is provided in the EPD for products requiring maintenance, repair, replacement, refurbishment the following information shall be provided to specify the scenarios or to support the development scenarios of these modules at the building level. Information given for Table #12$ shall be consistent with the #RSL$ data given in Table #13$:* ***Table #12$ — Use stage related to the building fabric***			

Scenario information	***Unit (expressed per functional unit or per declared unit)***
B2 Maintenance	
Maintenance process	*Description or source where description can be found*
Maintenance cycle	*Number per RSL or year a*
Ancillary materials for maintenance, e.g. cleaning agent, specify materials	*kg / cycle,*
Waste material resulting from maintenance (specify materials)	*kg*
Net fresh water consumption during maintenance	*m3*

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			Energy input during maintenance, e.g. vacuum cleaning, energy carrier type, e.g. electricity, and amount, if applicable and relevant	*kWh*			
			B3 Repair				
			Repair process	*Description or source where description can be found*			
			Inspection process	*Description or source where description can be found*			
			Repair cycle	*Number per RSL or year*			
			Ancillary materials Materials e.g. lubricant, specify materials	*kg or kg / cycle*			
			Waste material resulting from repair, (specify materials)	*kg*			
			Net fresh water consumption during repair	*m3*			
			Energy input during repair, e.g. crane activity, energy carrier type, e.g. electricity, and amount	*kWh / RSL, kWh / cycle*			
			B4 Replacement				
			Replacement cycle	*Number per RSL or year*			
			Energy input during replacement e.g. crane activity, energy carrier type, e.g. electricity and amount if applicable and relevant	*kWh*			

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			Exchange of worn parts during the product's life cycle, e.g. zinc galvanised steel sheet, specify materials — *kg* ***B5 Refurbishment*** *Refurbishment process* — *Description or source where description can be found* *Refurbishment cycle* — *Number per RSL or year* *Energy input during refurbishment e.g. crane activity, energy carrier type, e.g. electricity, and amount if applicable and relevant* — *kWh* *Material input for refurbishment, e.g. bricks, including ancillary materials for the refurbishment process e.g. lubricant, (specify materials)* — *kg or kg / cycle* *Waste material resulting from refurbishment (specify materials)* — *kg* *Further assumptions for scenario development, e.g. frequency and time period of use, number of occupants* — *Units as appropriate* *a Not applicable if only B2 is declared.*			
TE151			**PCR Specific Part A (§2.8.4) EN 15804+A2/AC (§ 6.3.9, 7.3.3.2) – Developing Product Level Scenarios** ***7.3.3.2 Reference service life***	N/A		Closed

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			The description of the RSL (see also Annex A) may be based on data collected as average data or at the beginning or end of the service life. The #reference in-use conditions$ for achieving the declared technical and functional performance and the declared RSL shall include the RSL data as described in Table #13$, where relevant: ***Table 13 — Reference Service Life***			

*#**RSL information**$*	***Unit (expressed per functional unit or per declared unit)***
Reference Service Life	*Years*
Declared product properties (at the gate) and finishes, etc.	*Units appropriate as*
Design application parameters (if instructed by the manufacturer), including the references to the appropriate practices and application codes	*Units appropriate as*
An assumed quality of work, manufacturer's instructions when installed in accordance with the manufacturer's instructions	*Units as appropriate.*
Outdoor environment, (for outdoor applications), e.g. weathering, pollutants, UV and wind exposure, building orientation, shading, temperature	*Units appropriate as*
Indoor environment (for indoor applications), e.g. temperature, moisture, chemical exposure	*Units appropriate as*

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			Usage conditions, e.g. frequency of use, mechanical exposure — *Units appropriate as* *Maintenance e.g. required frequency, type and quality and replacement of components* — *Units appropriate as*			
TE152			**PCR Specific Part A (§2.8.4) EN 15804+A2/AC (§ 6.3.9, 7.3.1) – Developing Product Level Scenarios** ***7.3.3.3 B6, use of energy and B7, use of water*** *If additional technical information is provided in the EPD for building integrated technical systems using energy or water related to the operation of the building, the following information shall be provided to specify the scenarios or to support the development of the use of energy and use of water scenarios at the building level:* ***Table 14 — Use of energy and use of water*** ***Scenario information*** — ***Unit (expressed per functional unit or per declared unit)*** *Ancillary materials specified by material* — *kg or units as appropriate* *Net fresh water consumption* — *m3* *Type of energy carrier, e.g. electricity, natural gas, district heating* — *kWh* *Power output of equipment* — *kW*	N/A		Closed

(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted	(7) Open/ Closed
			Characteristic performance, e.g. energy efficiency, emissions, variation of performance with capacity utilisation etc. — *units as appropriate* *Further assumptions for scenario development, e.g. frequency and period of use, number of occupants* — *units as appropriate*			
TE153			**PCR Specific Part A (§2.8.4) EN 15804+A2/AC (§ 6.3.9, 7.3.4) – Developing Product Level Scenarios** ***7.3.4 End-of-life*** *If additional technical information is provided in the EPD about end-of-life processes, the following information shall be provided for all construction products to specify the end-of-life scenarios used or to support development of the end-of-life scenarios at the building level. Scenarios shall only model processes e.g. recycling systems that have been proven to be economically and technically viable.* ***Table 15 — End-of-life*** ***Processes*** — ***Unit (expressed per functional unit or per declared unit of components products or materials and by type of material)*** *Collection process specified by type* — *kg collected separately*; *kg collected with mixed construction waste* *Recovery system specified by type* — *kg for re-use*; *kg for recycling*; *kg for energy recovery*	N/A		Closed

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**	(7) **Open/ Closed**
			Disposal specified by type — *kg product or material for final deposition* *Assumptions for scenario development, e.g. transportation* — *units as appropriate*			
TE154			**PCR Specific Part A (§2.8.4.1.2) EN 15804+A2/AC (§6.3.5.2) – Coproduct Allocation** *ISO 21930 and EN 15804 have different approaches on the treatment of waste, as provided below. ISO 21930 does not allow for usable output flows to be considered as co-products and therefore no allocation may be performed to secondary materials, fuels, or recovered energy. However, EN 15804 states that flows leaving the system at the end-of-waste boundary of the production state (A1-A3) shall be allocated as coproducts.* *Loads and benefits from allocated coproducts shall not be declared in Module D.* *The output of waste during this life cycle stage may reach the end-of-waste state43 when it complies with the conditions described in EN 15804 Section 6.3.5.5, end-of-life stage. Flows are then allocated as co-products as EN 15804 Section 6.4.3.2.* *Additionally, information modules that generate any input or output flows considered in the declaration of module D shall also be declared. The project report shall include details around how net impacts are calculated in module D.* ***6.3.5.5 End-of-life stage*** *The end-of-life stage of the construction product starts when it is replaced, dismantled or deconstructed from the building or construction works and does not provide any further functionality. It can also start at the end-of-life of the building, depending on choice of the product's end-of-life scenario.*	N/A		Closed

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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			During the end-of-life stage of the product or the building, all output from dismantling, deconstruction or demolition of the building, from maintenance, repair, replacement or refurbishing processes, all debris, all construction products, materials or construction elements, etc. leaving the building, are at first considered to be waste. This output however reaches the end-of-waste state when it complies with all the following criteria: *— the recovered material, product or construction element is commonly used for specific purposes;* *— a market or demand, identified e.g. by a positive economic value, exists for such a recovered material, product or construction element;* *— the recovered material, product or construction element fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;* *— the use of the recovered material, product or construction element will not lead to overall adverse environmental or human health impacts.* *NOTE 1 The "specific purpose" in this context is not restricted to the function of a certain product but can also be applied to a material serving as input to the production process of another product or of energy.* *The criterion for "overall adverse environmental or human health impacts" shall refer to the limit values for pollutants set by regulations in place at the time of assessment and where necessary shall take into account adverse environmental effects. The presence of any hazardous substances exceeding these limits in the waste or showing one or more properties as listed in existing applicable legislation, e.g. in the European Waste Framework Directive, prevents the waste from reaching the end-of-waste state.* *The end-of-life system boundary of the construction product system to module D is set where outputs, i.e. secondary materials or fuels, have reached the "end-of-waste" state (see 6.4.3.3).* *The end-of-life stage includes the modules:* *— C1 deconstruction, including dismantling or demolition, of the product from the building, including initial on-site sorting of the materials;* *— C2 transportation of the discarded product as part of the waste processing, e.g. to a recycling site and transportation of waste e.g. to final disposal;*			

Type of comment: **GE** = general **TE** = technical **ED** = editorial

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			— C3 waste processing e.g. collection of waste fractions from the deconstruction and waste processing of material flows intended for reuse, recycling and energy recovery. Waste processing shall be modelled and the elementary flows shall be included in the inventory. Materials for energy recovery are identified based on the efficiency of energy recovery with a rate higher than 60 % without prejudice to existing legislation. Materials from which energy is recovered with an efficiency rate below 60% are not considered materials for energy recovery. *NOTE 2 Only when materials have reached the end-of-waste-state can they be considered as materials for energy recovery, provided the energy recovery process has an energy efficiency rate higher than 60%.* *— C4 waste disposal including physical pre-treatment and management of the disposal site.* *NOTE 3 In principle waste processing is part of the product system under study. In the case of materials leaving the system as secondary materials or fuels, such processes as collection and transport before the end-of-waste state are, as a rule, part of the waste processing of the system under study. However after having reached the “end-of-waste” state further processing may also be necessary in order to replace primary material or fuel input in another product system. Such processes are considered to be beyond the system boundary and are assigned to module D. Secondary material having left the system can be declared as substituting primary production in module D, when it has reached functional equivalence of the substituted primary material.* *The degradation of a product’s biogenic carbon content in a solid waste disposal site, declared as GWP-biogenic, shall be calculated without time limit. Any remaining biogenic carbon is treated as an emission of biogenic CO2 from the technosphere to nature. For the time period applicable to all other disposals see 6.3.8.2.* *NOTE 4 Waste disposals for products containing biogenic carbon declared as GWP-biogenic are modelled as closely to reality as possible based on current practices.* *Loads, (e.g. emissions) from waste disposal in module C4 are considered part of the product system under study, according to the “polluter pays principle”. If however this process generates energy such*			

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			as heat and power from waste incineration or landfill the potential benefits from utilisation of such energy in the next product system are assigned to module D and are calculated using current average substitution processes. ***6.3.5.6 Benefits and loads beyond the product system boundary in module D*** *Information module D aims at transparency for the environmental benefits or loads resulting from reusable products, recyclable materials and/or useful energy carriers leaving a product system e.g. as secondary materials or fuels.* *Any declared net benefits and loads from net flows (for calculation of the net amounts see 6.4.3.3) leaving the product system that have passed the end-of-waste state shall be included in module D, except those which have been allocated as co-products.* *Avoided impacts from allocated co-products shall not be included in Module D.* *The information in module D shall contain technical information as well as the declared indicators, as described in Clause 7.* ***6.4.3 Allocation of input flows and output emissions*** ***6.4.3.1 General*** *Most industrial processes produce more than the intended product. Normally more than one input is needed to produce one product and sometimes products are co-produced with other products. As a rule the material flows between them are not distributed in a simple way. Intermediate and discarded products can be recycled to become inputs for other processes. When dealing with systems involving multiple products and recycling processes, allocation should be avoided as far as possible. Where unavoidable, allocation should be considered carefully and should be justified.* *In this standard, the rules for allocation are based on the guidance given in EN ISO 14044:2006, 4.3.4.* *However, the basic procedures and assumptions used in EN ISO 14044 have been refined in order to reflect the goal and scope of this standard and EN 15643-2.*			

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			The use of upstream data, which does not respect the allocation principles described in this standard shall be clearly stated and justified in the project report. These data shall be in line with EN ISO 14044 allocation rules. *The principle of modularity shall be maintained. Where processes influence the product's environmental performance during its life cycle, they shall be assigned to the module in the life cycle where they occur (see Figure 1).* *The sum of the allocated inputs and outputs of a unit process shall be equal to the inputs and outputs of the unit process before allocation. This means no double counting or omission of inputs or outputs through allocation is permitted.* *Irrespective of the allocation approach chosen for a co-production process or for secondary flows crossing the system boundary between product systems, specific inherent properties of such coproducts or flows, for example calorific content, composition [biogenic carbon content, CaO/Ca(OH)2 content, etc.], shall not be allocated but always reflect the physical flows.* ***6.4.3.2 Co-product allocation*** *Allocation shall be avoided as far as possible by dividing the unit process to be allocated into different sub-processes that can be allocated to the co-products and by collecting the input and output data related to these sub-processes.* *— If a process can be sub-divided but respective data are not available, the inputs and outputs of the system under study should be partitioned between its different products or functions in a way which reflects the underlying physical relationships between them; i.e. they shall reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system;* *In the case of joint co-production, where the processes cannot be sub-divided, allocation shall respect the main purpose of the processes studied, allocating all relevant products and functions appropriately. The purpose of a plant and therefore of the related processes is generally declared in its permit and should be taken into account.*			

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			Processes generating a very low contribution to the overall revenue may be neglected. Joint co-product allocation shall be allocated as follows: *— Allocation shall be based on physical properties (e.g. mass, volume) when the difference in revenue from the co-products is low;* *— In all other cases allocation shall be based on economic values;* *— Material flows carrying specific inherent properties, e.g. energy content, elementary composition (e.g. biogenic carbon content), shall always be allocated reflecting the physical flows, irrespective of the allocation chosen for the process.* *NOTE 1 Contributions to the overall revenue of the order of 1% or less is regarded as very low. A difference in revenue of more than 25 % is regarded as high.* *NOTE 2 A common position on the definition on the most appropriate allocation rule needs to be defined together with other relevant sectors.* *NOTE 3 Products and functions are the outputs and/or services provided by the process, having a positive economic value.* *NOTE 4 In industrial processes there may be a wide variety of different types of materials produced in conjunction with the intended product. In business vocabulary, these may be identified as by-products, coproducts, intermediate products, non-core products or sub-products. In this standard these terms are treated as being equivalent. However for the allocation of environmental aspects and impacts a distinction between coproducts and products is made in this standard.* ***6.4.3.3 Allocation procedure of reuse, recycling and recovery*** *The end-of-life system boundary of the construction product system is set where outputs of the system under study, e.g. materials, products or construction elements, have reached the end-of-waste state. Therefore, waste processing of the material flows (e.g. undergoing recovery or recycling processes) during any module of the product system (e.g. during the production stage, use stage or end-of-life stage) are included up to the system boundary of the respective module as defined above.* *Where relevant (see 6.3.5.5 and 6.3.5.6), information module D declares potential loads and benefits of secondary material, secondary fuel or recovered energy leaving the product system. Module D*			

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			recognises the "design for reuse, recycling and recovery" concept for buildings by indicating the potential benefits of avoided future use of primary materials and fuels while taking into account the loads associated with the recycling and recovery processes beyond the system boundary. *NOTE 1 Module D also contains benefits from exported energy from waste disposal processes declared in module C4.* *Where a secondary material or fuel crosses the system boundary e.g. at the end-of-waste state and if it substitutes another material or fuel in the following product system, the potential benefits or avoided loads can be calculated based on a specified scenario which is consistent with any other scenario for waste processing and is based on current average technology or practice.* *If today's average is not available for the quantification of potential benefits or avoided loads, a conservative approach shall be used.* *In module D the net impacts are calculated as follows:* *— by adding all output flows of a secondary material or fuel and subtracting all input flows of this secondary material or fuel from each sub-module first (e.g. B1-B5, C1-C4, etc.), then from the modules (e.g. B, C), and finally from the total product system thus arriving at net output flows of secondary material or fuel from the product system;* *— by adding the impacts connected to the recycling or recovery processes from beyond the system boundary (after the end-of-waste state) up to the point of functional equivalence where the secondary material or energy substitutes primary production and subtracting the impacts resulting from the substituted production of the product or substituted generation of energy from primary sources;* *— by applying a justified value-correction factor to reflect the difference in functional equivalence where the output flow does not reach the functional equivalence of the substituting process.* *In module D substitution effects are calculated only for the resulting net output flow.* *The amount of secondary material output, which is for all practical purposes able to replace one to one the input of secondary material as closed loop is allocated to the product system under study and not to module D.*			

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			NOTE 2 Avoided impacts from allocated co-products are not part of Module D information, see 6.3.5.6.			
TE155			**PCR Specific Part A (§3.1.1 & 3.1.2) EN 15804+A2/AC (§6.3.8) – Data Quality** *The quality of the data used to calculate an EPD shall be addressed in the project report.* *The following specific requirements apply (for the project report)* *• the documentation format and data sets for the LC inventory data used in the LCA modelling shall use the current ILCD format and nomenclature as defined in the document, "International Reference Life Cycle Data System (ILCD) Handbook - Nomenclature and other conventions";* *NOTE 1 The elementary flow list is available at the following web-link: http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml.* *The elementary flow list is available both in ILCD structure and as Excel file and it is identified by the name EN_15804.* *• guidance for the selection and use of generic data is provided in CEN/TR 15941; [See EN 15804 Section 6.3.8] Section 6.3.8.3 Generic data shall include data quality assessment information according to ISO 14044, 4.2.3.6. The data quality assessment information shall cover at least the following elements: time related coverage, geography coverage, technology coverage.* *The Data Quality Assessment shall be based on either of the two systems described in EN 15804, Annex E.* *The quality of the life cycle inventory data established for the EPD shall also be assessed accordingly.* *For the relevant generic datasets used in the EPD as well as for the relevant life cycle inventory data established for the EPD, the type of data quality assessment system used and the data quality results shall be documented in the project report.* *The term "relevant data" is understood as data with a major contribution, contributing together to at least 80% of the absolute impact of any core*	N/A		Closed

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			environmental indicators included in the EPD, considered over the full life cycle, excluding module D, or across those modules of the life cycle assessed in the EPD. The data quality of module D shall also be assessed. **6.3.8 Data quality** **6.3.8.1 General** *The quality of the data used to calculate an EPD shall be addressed in the project report (see Clause 8 and EN ISO 14044:2006, 4.2.3.6).* **6.3.8.2 Data quality requirements** *The following specific requirements apply:* *— the documentation format and data sets for the LC inventory data used in the LCA modelling shall use the current ILCD format and nomenclature as defined in the document, "International Reference Life Cycle Data System (ILCD) Handbook - Nomenclature and other conventions";* *NOTE 1 The elementary flow list is available at the following web-link: http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml. The elementary flow list is available both in ILCD structure and as Excel file and it is identified by the name EN_15804.* *— guidance for the selection and use of generic data is provided in CEN/TR 15941;* *— generic data shall be checked for plausibility;* *NOTE 2 Plausibility can be checked by mass balance, energy balance, comparison of indicators to those of data sets reviewed or verified according to this standard, or comparison of flows or indicators to other relevant sources of information.* *— data sets shall be complete according to the system boundary within the limits set by the criteria for the exclusion of inputs and outputs (see 6.3.6);* *— data shall be as current as possible. Data sets used for calculations shall be valid for the current year and represent a reference year within 10 years for generic data and 5 years for producer specific data;* *— the reference year refers to the year which the overall inventory represents best, considering the*			

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			age/representativeness of the various specific and background data included, i.e. not automatically *the year of modelling, calculation or publication year. Validity of data sets refers to the date to which the inventory is still judged sufficiently valid with the documented technological and geographical representativeness;* *— data sets shall be based on 1 year averaged data; deviations shall be justified;* *— the time period over which inputs to and outputs from the system shall be accounted for is 100 years from the year for which the data set is deemed representative. However, for solid waste disposal of products containing biogenic carbon declared as GWP-biogenic, see 6.3.5.5;* *— the technological coverage shall reflect the physical reality for the declared product or product group by as far as possible taking into account:* *— representativeness for the technology mix and location type stated in the documentation;* *— the geographical coverage shall reflect the physical reality for the declared product or product group by as far as possible taking into account:* *— technology representativeness for the region/country;* *— input materials representativeness for the region/country;* *— input energies representativeness for the region/country.* **6.3.8.3 Data quality assessment schemes applied on generic and specific data used and established in the EPD** *Generic data (see Table 1) shall include data quality assessment information according to EN ISO 14044:2006, 4.2.3.6. The data quality assessment information shall cover at least the following elements:* *— time-related coverage;* *— geography coverage;* *— technology coverage.* *It shall be based on either of the two systems described in Annex E. The quality of the life cycle inventory data established for the EPD shall also be assessed accordingly.* *For the relevant generic datasets used in the EPD as well as for the relevant life cycle inventory data established for the EPD, the type of data quality assessment system used and the data quality results shall be documented in the project report.*			

Independent Review of LCA study of Insulation based on:

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL E 10010 v.4.0, Part B: Building Envelope Thermal Insulation EPD Requirements UL E 10010-1 v.3.0, ISO 14025:2006, ISO 14040:2006/Amd1 2020; ISO 14044:2006/Amd 2:2020, ISO 21930:2017, EN 15804:2012+A2:2019/AC:2021

Date: 24.11.27	Doc.: Spray Polyurethane Foam Insulation Products, EPD Background Report, 24.11.08 v1.0 by Sphera Solutions on behalf of the Spray Polyurethane Foam Alliance (SPFA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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			The term "relevant data" is understood as data with a major contribution, contributing together to at least 80 % of the absolute impact of any core environmental indicators included in the EPD, considered over the full life cycle, excluding module D, or across those modules of the life cycle assessed in the EPD. *The data quality of module D shall also be assessed.*			
TE156			**PCR Specific Part A (§3.3) EN 15804:2012+A2:2019 (6.4.3.1) – Allocation of specific inherent properties of coproduct/flows** *Irrespective of the allocation approach chosen for a co-production process or for secondary flows crossing the system boundary between product systems, specific inherent properties of such coproducts or flows, for example calorific content, composition [biogenic carbon content, CaO/Ca(OH)2 content, etc.], shall not be allocated but always reflect the physical flows.*	N/A		Closed
TE157			**PCR Specific Part A (§4) EN 15804+A2/AC (§8.1) – Environmental Impact Indicators into project report** *Requirement to include results of all environmental impact indicators in the project report.*	N/A		Closed
TE158			**PCR Specific Part A (§4 Table 6) EN 15804+A2/AC (§7.2.4) – Life Cycle Indicators** *EN 15804 Section 7.2.4 requires the additional reporting of parameters RPRT (Total use of renewable primary resources with energy content) and NRPRT (Total non-renewable primary resources with energy content).* *RPRT = RPRE + RPRM, and NRPRT = NRPRE + NRPRM.*	N/A		Closed
TE159			**PCR Specific Part A (§4.2) EN 15804+A2/AC (§6.4.4) – Information on biogenic carbon content** *For conformance with EN 15804, the biogenic carbon content quantifies the amount of biogenic carbon in a construction product leaving the factory* *gate, and it shall be separately declared for the product and for any accompanying packaging according Table 12 (see EN 15804 Section*	N/A		Closed

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			6.4.4 and 7.2.5). The project report shall provide an overview of the transfers, emissions, and removals of biogenic carbon in the different modules, between the system under study, nature and other product systems and of the biogenic carbon content of the functional or declared unit at factory gate (see EN 15804 Sections 6.4.4, Table 9 and C.2) ***Table 12. Information describing the biogenic carbon content at the factory gate*** **Biogenic carbon content** — **Unit** Biogenic carbon content in product — Kg C Biogenic carbon content in accom-panying packaging — Kg C *NOTE The biogenic carbon content of wood-based products may be measured or calculated according to EN 16449, Wood and wood-based products — Calculation of the biogenic carbon content of wood and conversion to carbon dioxide.* *If the mass of biogenic carbon containing materials in the product is less than 5% of the mass of the product, the declaration of biogenic carbon content may be omitted.* *If the mass of biogenic carbon containing materials in the packaging is less than 5% of the total mass of the packaging, the declaration of the biogenic carbon content of the packaging may be omitted.* *The mass of packaging shall always be declared.*			
TE160			**PCR Specific Part A (§4.8) EN 15804+A2/AC (§ 6.5.2; 7.2.3.1) – Core environmental impact indicators** *Core environmental impact indicators shall be listed using characterization factors from EC-JRC available from http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml.* *The indicators, disclaimers and other requirements in Section 7.2.3 (for environmental impacts based on the LCIA) and Section 7.2.4 (for resource use, waste, etc.) of EN 15804:2012+A2:2019 shall be used.*	N/A		Closed

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			EN 15804:2012+A2:2019 specifies the unit for the Eutrophication aquatic freshwater indicator shall be kg PO4 eq, although the given reference provides the indicator in a unit of kg P eq (EUTREND model, Struijs et al. 2009b, as implemented in ReCiPe). While this is likely a typo expected to be corrected in the future, EPD results for this indicator shall be given in both kg PO4 eq and kg P eq. For both methods, the EUTREND model as implemented in ReCiPe shall be used, as this method gives results in kg P eq. Results in kg PO4 eq may be calculated by multiplying the kg P eq results by a factor of 3.07. **[Note: EN 15804+A2/AC has updated the units for eutrophication aquatic freshwater and only the kg P eq. is required.]**			
TE161			**PCR Specific Part A (§4.8) EN 15804+A2/AC (§ 6.5.3; 7.2.3.2)- Additional environmental impact indicators** *The indicators, disclaimers and other requirements in Section 7.2.3 (for environmental impacts based on the LCIA) and Section 7.2.4 (for resource use, waste, etc.) of EN 15804:2012+A2:2019 shall be used*	N/A		Closed
TE162			**PCR Specific Part A (§7) EN 15804+A2/AC (§7.2.2) – Rules for declaring LCA information per module** *The information on environmental impacts and aspects relating to modules* *A1–A3, C1–C4 and D shall be included in all EPD, see EN 15804 Section 5.2. Information modules that generate any input or output flows considered in the declaration of module D shall also be declared.* *EXAMPLE The declaration of benefits of material and energy recovery in module D from packaging recovery in A5 is only possible if optional module A5 has been declared, including all related processes.* *The EPD shall specify which EPD-type is declared (see 5.2 and Figure 1):* *a) cradle to gate with modules C1–C4 and module D (A1–A3, + C + D);* *b) cradle to gate with options, modules C1–C4, and module D (A1–A3 + C + D and additional modules. The additional modules may be one or more selected from A4 to B7);* *c) cradle to grave and module D (A + B + C + D);* *d) cradle to gate (A1–A3);* *e) cradle to gate with options (A1–A3 and additional modules. The additional modules may be A4 and A5).*	N/A		Closed

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			Modules and indicators not declared shall be marked as "ND". If an indicator value has been calculated to be "zero" or if the value of "zero" is plausible for this indicator e.g. there is no activity in the scenario, then "0" is declared for this indicator. The declaration of "-" is not allowed. *If an indicator is declared, it shall be declared in all the chosen modules.* *If an optional module is declared, all the chosen indicators shall be declared.*			
TE163			**PCR Specific Part A (§7.5) EN 15804+A2/AC (§7.2.3.3) – Disclaimers to core and additional environmental indicators** *Disclaimers shall be reported for certain environmental indicators as required in Section 7.5 of this document.*	N/A		Closed
TE164			**PCR Specific Part A (§2.8.4.6, 4.2, 4.7, 4.8, 4.9, 5) EN 15804+A2/AC (§8.2) LCA related elements of the project report.** *System boundary:* *Assumptions about the system boundaries should be included where relevant including how the net impacts are calculated in module D (see EN 15804 Section 6.4.3.3 and D.3.4)* *Life cycle inventory analysis: An overview should be given of the transfers, emissions, and removals of biogenic carbon in the different modules, between the system under study, nature, and other product systems and of the biogenic carbon content of the functional or declared unit at the factory gate (see EN 15804 Section 6.4.4, Table 9, and C.2)* *Life cycle impact assessment:* *The project report shall document all LCIA procedures, calculations and results of the study including all additional environmental impact indicator results.* *Life Cycle interpretation:* *The project report shall include the assumptions and limitations associated with the interpretation of results as declared in the EPD and for the results of the additional impact indicators, both methodology and data related.*	N/A		Closed
			ISO 14044:2006/Amd 1:2017 Annex C - Footprints			

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TE165			**ISO 14044:2006/Amd 1:2017 Annex C - C.2 Reporting** *Further to the requirements specified in Clause 5 on the reporting of LCA, this annex provides clarification about the interface between footprint quantification and communication. Footprint reports should include a statement indicating, for example, that the analysis is limited and does not address other impacts, which can be as important. If any footprint information is not communicated to third parties, the reporting requirements of 5.1.1 shall apply. If any footprint information is intended to be communicated to third parties, a third-party report in accordance with 5.1.2 and 5.2 c) shall be prepared and shall become the footprint study report, regardless of the chosen footprint communication. This third-party report shall serve as an input for the development of any footprint communication formats that might have to fulfil additional requirements in accordance with the relevant International Standards on environmental labels and declarations developed by ISO/TC 207/SC 3.* *Footprints are limited to only one environmental aspect or a limited set of impact category indicators. Footprints shall be named in a way that accurately reflects the area of concern or reflects the potential environmental impacts assessed. Where an area of concern has only been partially assessed, an alternative name descriptive of the narrower scope shall be applied.* *A footprint addresses one area of concern. This can conflict with the comprehensiveness principle of LCA. Therefore, the report of the footprint quantification shall document the limitations with regard to selected environmental impact categories in a transparent manner. While the selected footprint study can quantify an important environmental aspect or a potential environmental impact of a product or an organization, the LCIA profile, as specified in 4.4.1, includes results for a broader set of other impact category indicators. An objective of LCA is to allow an informed decision regarding a comprehensive set of potential environmental impacts. As a result, footprints shall not be used in comparative assertions intended to be disclosed to the public. A comprehensive evaluation of environmental performance of a product or an organization cannot be achieved through an analysis that considers only a single area of concern or a non-comprehensive set of potential environmental impacts or aspects. Decisions about product or organizational impacts that are only based on a single or few environmental issue(s) can conflict with goals and objectives related to other environmental issues.*	N/A		Closed

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TE166			**ISO 14044:2006/Amd 1:2017 Annex C - C.3 Critical Review** *Further to the requirements specified in Clause 6 on the critical review of LCA, this annex provides clarification about the interface between footprint quantification and communication.* *When an organization decides to use a footprint study report as a basis of a footprint communication, this footprint study report shall be publicly available in accordance with 5.2.* *When a critical review is performed, it shall be in accordance with Clause 6 or ISO/TS 14071.*	N/A		Closed
			ISO 14044:2006/Amd 2:2020 Annex D – Allocation Procedures			
TE167			**ISO 14044:2006/Amd 2:2020 Annex D – D.2 Expanding the product system** *Expanding the product system to include additional functions related to the co-products (see 4.3.4.2, step 1, option 2) can be a means of avoiding allocation.* *NOTE 1 The concept of expanding the product system to include additional functions related to the co-products can also be referred to as system expansion or expanding the system boundary.* *Therefore, the product system that is substituted by the co-product is integrated in the product system under study. In practice, the co-products are compared to other substitutable products, and the environmental burdens associated with the substituted product(s) are subtracted from the product system under study (see Figure 1). The identification of this substituted system is done in the same way as the identification of the upstream system for intermediate product inputs. See also ISO/TR 14049:2012, 6.4.* *The application of system expansion involves an understanding of the market for the co-products. Decisions about system expansion can be improved through understanding the way co-products compete with other products, as well as the effects of any product substitution upon production practices in the industries impacted by the co-products.* *Important considerations relating to the identification of product systems substituted by co-products include whether:* *— specific markets and technologies are affected;* *— the production volume of the studied product systems fluctuates in time;* *— a specific unit process is affected directly.*	N/A		Closed

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			If applicable, when the inputs are delivered through a market, it is also important to know: *— whether any of the processes or technologies supplying the market are constrained, in which case their output does not change in spite of changes in demand;* *— which of the unconstrained suppliers/technologies has the highest or lowest production costs and, therefore, is the supplier/technology affected when the demand for the supplementary product is generally decreasing or increasing, respectively.* *EXAMPLE A fuel combustion process produces co-products of heat that is used for district heating as well as electricity. The inventory, i.e. inputs and outputs, of the avoided electricity can be subtracted from the inventory of the fuel combustion process to determine the inventory of the heat.* *System expansion avoids allocation by integrating a functionally equivalent product system, that is assumed to be substituted by the co-product (product B), within the system boundary. The inputs and outputs associated with the substituted product system are assumed to be avoided by the production of the co-product (product B), as illustrated by the example in Figure D.1.* *Since the substituted system has a negative sign, the addition of this system is mathematically the same as a subtraction. There is an additional example of this in ISO/TR 14049:2012, Figures 15 and 16.* *NOTE 2 Figure D.1 shows how to avoid allocation when the investigated product system has two products: product A (the product system under study) and product B (here, an energy product).* *In the case of recycling, one way to avoid allocation can be by calculating a recycling credit based on the technical substitutability of the secondary material(s), i.e., taking into account any changes to the inherent properties and quality of the secondary material versus the substituted primary material. If the secondary material X from the product system under study substitutes a primary material Y, then the recycling credit corresponds to subtracting the inventory associated with the acquisition of the primary material Y from the inventory calculated for the product system under study. If an input to a product system is a recycled material that has previously implied a credit to the product system that the recycled material comes from, such recycled material carries the credit as a potential environmental impact to the product system that it enters.*			

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TE168			**ISO 14044:2006/Amd 2:2020 Annex D – D.3 Allocation that reflects the underlying physical relationships** **D.3.1 General** *Physical allocation can be applied when a physical, i.e. causal, relationship can be identified between the inputs, outputs and co-products of the multifunctional process. Such a relationship exists when the amounts of the co-products can be independently varied. How the amounts of inputs and outputs (emissions and waste) change following such a variation can be used to allocate the inputs and outputs to the varied co-product.* *This allocation procedure (step 2, 4.3.4.2) is applicable when: a) the relative production of co-products can be independently varied through process management, and b) this has causal implications for the inputs required, emissions released or waste produced.* *EXAMPLE 1 When aqueous ammonia (NH3) reacts with ethylene oxide (C2H4O), three co-products are produced: monoethanolamine (H2NCH2CH2OH), diethanolamine (HN(CH2CH2OH)2) and triethanolamine (N(CH2CH2OH)3). The relative production volume of the three co-products can be controlled by changing the proportion of the reactants in the solution, which means the amounts of the co-products can be varied independently, and all products are therefore determining products, independently of each other. Therefore, this combined production can be described for each product separately based on the stoichiometric requirements of each product, with the limiting group being hydroxyl (OH). To make 1 kg monoethanolamine, 0,279 kg ammonia and 0,721 kg ethylene oxide are needed. To identify these masses, the following formula is used:* *m = n×M* *where* *m mass (in kg);* *n amount of substance (in mol);* *M molar mass (in kg/mol).* *EXAMPLE 2 ISO/TR 14049:2012, 7.3.1, provides another example where transportation fuel consumption is allocated between a packaging material and a commodity based on the proportion of payload used.*	Requirement met.		Closed
TE169			**ISO 14044:2006/Amd 2:2020 Annex D – D.4 Allocation methods reflecting other relationships** **D.4.1 General**	Requirement met.		Closed

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			According to 4.3.4.2, step 3, inputs and outputs can also be allocated between co-products reflecting other relationships between them, e.g. in proportion to the economic value of co-products (economic allocation). *The most common form of economic allocation is based on the revenue obtained from the co-products.* *EXAMPLE 1 A dairy cow produces 70 % of its revenue through milk and 30 % through animals sold (calves and dairy cow at the end of life). This ratio can be used to allocate all inputs and outputs that can neither be directly attributed to the milk nor to the animals sold.* *EXAMPLE 2 Another example is given in ISO/TR 14049:2012, 7.3.2.*			
			Are the methods used to carry out the study scientifically and technically valid?			
GE 1			The methods used to carry out the study are scientifically and technically valid.			Closed
			Are the data used appropriate and reasonable in relation of the goal of the study?			
GE 2			The data used to carry out the study are appropriate and reasonable in relation to the goal of the study.			Closed
			Do the interpretations reflect the limitations identified and the goal of the study			
GE 3			The study in general reflects the limitations identified.			Closed
			Is the report transparent and consistent?			
GE 4			The report is transparent and consistent.			Closed
			Verification of the data per ISO 14025 §8.1.3			
GE5			a) conformance with the PCR;	The study project report conforms to the PCR.		Closed
GE6			b) conformance with the ISO 14040 series of standards;	The study conforms to the ISO 14040 series of standards.		Closed
GE7			c) conformance with general programme instructions for the Type III environmental declaration;	The study conforms to the general program instructions for ASTM International.		Closed
GE8			d) that data evaluation includes coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty;	The data evaluation is complete.		Closed
GE9			e) the plausibility, quality and accuracy of the LCA-based data;	The plausibility, quality and accuracy of the LCA-based data are reasonable.		Closed

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GE10			f) the quality and accuracy of additional environmental information;	The additional environmental information is of acceptable quality and accuracy.		Closed
GE11			g) the quality and accuracy of the supporting information.	The supporting information is of acceptable quality and accuracy.		Closed
			Editorial comments			
ED1	All		Provide a PDF version of the report for the next round to be able to review any editorial issues – e.g., formatting and any errors associated with bookmarks and references. There's a bookmark reference error on page 4 of the TOC and on p. 28 sec. 2.4.3, second to last paragraph.		Done **Acknowledged.**	Closed
ED2	p. 31	Sec. 3.3.1	There are difference versions referenced for the MLC – 2024.1 and 2023. Are these correct? Or should they all be the latest, 2024.1? The EPDs only reference MLC 2024.1.		Updated database to latest 2024.2 version. **Acknowledged.**	Closed
ED3	p. 32	Sec. 3.3.3	Table 3-8 references EPA SmartWay for the truck types used in the modeling. Please provide additional detail regarding how the SmartWay data (most current as noted is 2023), is used in conjunction with the above references to 2002 census data and 2007 emissions standards.		Elaborated more in Section 3.3.3. Previous statement was outdated. **Acknowledged.**	Closed
ED4	Sec. 4.1		For results tables, provide the basis of the analysis, as in "per Functional Unit".		Done **Acknowledged.**	Closed
ED5	p. 46	Table 4-7	Small issue – the reference flows among the five products are not related to each other and their values should not be represented by a line. They are point values related to each specific product type.		Changed line to points with data labels. **Acknowledged.**	Closed

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