An Environmental Product Declaration

According to ISO 14025:2006 and ISO 21930:2017

A Corporate Average Cradle-to-gate EPD for Standard, Medium and High & Ultra High-Density Spray-applied Fire-Resistive Materials (SFRMs)

This EPD has been prepared in conformance with ISO 14025, 14040, 14044 standards and according to the requirements of ISO 21930:2017 and ASTM International's EPD program operator rules. This EPD was commissioned by the GCP Applied Technologies and is verified by ASTM International to conform to the requirements of ISO 14040, 14044, 14025 and 21930.

ASTM International	Date of issue: 04.15.2022
West Conshohocken, PA	Period of validity: 5 years
www.astm.org	Declaration #: EPD 060

Environmental Product Declaration Summary

General Summary	
Owner of the EPD	**GCP Applied Technologies Inc.** (GCPAT) 2325 Lakeview Parkway Suite 450, Alpharetta, GA 30009 U.S.A. Link (URL): https://gcpat.com With roughly 2,000 employees and 50 manufacturing facilities worldwide, GCP Applied Technologies serves customers in more than 100 countries. GCPAT was formed in February 2016 by the spin-off of W. R. Grace & Co.'s construction products segment and its packaging technologies business. The owner of the declaration is liable for the underlying information and evidence.
SFRM Manufacturing Facilities	**Ajax, Canada** 294 Clements Rd. West Ajax, Ontario L1S 3C6 **Irondale, United States** 2601 Commerce Blvd. Irondale, Alabama 35210 **Santa Ana, United States** 2500 & 2502 S. Garnsey Street Santa Ana, California 92707
Product Group and Name	Spray-applied Fire-Resistive Material (SFRM), UN CPC 54650.
Product Description	SFRM is composed primarily of binding agents such as cement or gypsum and often contains other materials such as mineral wool, quartz, perlite, vermiculite, or bauxite along with various other ingredients
Reference Product Category Rules (PCR)	ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.
Certification Period	04.15.2022 - 04.15.2027
Declared Unit	1,000 kg of SFRM
Declaration Number	EPD 060

EPD and Project Report Information	
Program Operator	ASTM International
Declaration Holder	GCP Applied Technologies Inc.

Declaration Type

A "Cradle-to-gate" EPD (Production stage) of GCPAT's production of standard, medium and high & ultra-high-density spray-applied fire-resistive material. The declaration presents a weighted average profile for all three North American facilities operated by GCP Applied Technologies Inc. that manufacture SFRMs. Product activities covered include the raw material supply, transport, and manufacturing (modules A1 to A3). The declaration is intended for Business-to-Business (B-to-B) communication.

Applicable Countries

United States and Canada

Product Applicability

SFRMs are used as part of a building's passive fire resistance strategy. SFRMs have thermal and acoustical properties and assists in controlling condensation. However, its main use is in insulating steel, metal decking and other assemblies from the high temperatures found during a fire. SFRMs are used to delay (or prevent) the weakening of steel and the spalling of concrete in structures that are exposed to the high temperatures found during a fire. They do this by thermally insulating the structural members to keep them below the temperatures that cause failure.

Content of the Declaration

This declaration follows *Section 9*; *Content of an EPD*, ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.

This EPD was independently verified by ASTM in accordance with ISO 14025 and the core PCR ISO 21930:2017: **Internal** — **External**: X	Tim Brooke, ASTM International
The Project Report *Note that the Project Report is not part of the public communication (ISO 21930, 10.1).*	A Cradle-to-Gate Life Cycle Assessment of GCP Applied Technologies Standard, Medium and High & Ultra High-Density Spray-applied Fire-Resistive Materials (SFRMs). April 2022.
Prepared by Athena Sustainable Materials Institute	Lindita Bushi, PhD, Mr. Jamie Meil and Mr. Grant Finlayson Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, Ontario, Canada K1P 5G8 info@athenasmi.org www.athenasmi.org
This EPD project report was independently verified by in accordance with ISO 14025, ISO 14040/44, and the core PCR ISO 21930:2017:	Thomas P. Gloria, Ph. D. Industrial Ecology Consultants

1 PRODUCT IDENTIFICATION

1.1 PRODUCT DEFINITION

Spray-applied fire-resistive materials (UN CPC 54650) are composed primarily of binding agents such as cement or gypsum and often contain other materials such as quartz or bauxite along with various other ingredients. The other materials are used to help lighten the solution or to add air as an insulator. Chemical hardeners are sometimes used to either speed up hardening or to make the final fireproofing harder than the original.

Passive fire protection materials (commonly referred to as fireproofing) are used to prevent or delay the failure of steel and concrete structures exposed to fire. These materials are intended to insulate the structural members during the event of a fire, delaying any loss of the integrity of the structural members. There is an array of available fireproofing materials that can be used depending upon the specific application. Applied fireproofing is available as a wet or dry formula. It is typically sprayed but can also be troweled on. The fireproofing is generally delivered as a dry powder in bag, which is then mixed with water in the field. Modern formulas are asbestos-free and don't contain free crystalline silica. This is a company-specific EPD representing an array of available SFRMs produced at three of GCPAT's facilities located in North America and produced to various specifications as noted in Table 1. Table 1 summarizes key technical data for GCPAT SFRMs for the 2019 reference year (12 months). GCPAT SFRMs are classified in three major sub-categories based on the dry density minimum average values in pcf (pound per cubic foot). Full material selection guide and literature and the material safety data sheets are available for each of these fireproofing materials at https://gcpat.com.

Table 1. Technical Data for GCPAT SFRMs

Primary Binding Agent	GCPAT SFRM-Sub-category	Dry density, minimum average-in kg/m^3 (pcf)	GCPAT Brand Names
Gypsum - based	Standard density	240 (15)	MK Patch (GF Pail), MK-10/HB EXT SET WHITE, MK-10/HB EXT SET, MK-10/HB WHITE, MK-1000/HB, MK-1000/HB EXT SET, MK-10/HB, MK-10/HB EXT SET, MK-6 EXT SET, MK-6/GF, MK-6/HY, MK-6/HY EXT SET, MK-6/HY CE, MK-6/HY EXT SET, MK-6S, MK-6S CE, RG, Z-3306/G
Cement- or gypsum-based or a blend	Medium density	352 (22)	SK-3, Z-106/G, Z-106/HY, Z-3306, Z-3306 Gray, Z-3306 White
Cement- based	High & ultra-high density	640 (40)	Z-146, Z-146PC, Z-146T, Z-156, Z-156PC, Z-156T

1.2 PRODUCT STANDARD

The physical characteristics of SFRM are determined according to various ASTM standards such as, but not limited to:

- E736/E736M-19, Standard Test Method for Cohesion/Adhesion of Sprayed Fire- Resistive Materials Applied to Structural Members
- E605/E605M-19, Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material Applied to Structural Members
- E759/E759M-92(2020)e1 Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members
- E760/E760M-92(2020)e1 Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members
- E761/E761M-92(2020)e1 Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members
- E859/E859M-93(2020)e1 Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRMs) Applied to Structural Members
- E937/E937M-93(2020)e1 Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.

2 DECLARED UNIT

The declared unit is 1,000 kg, 1 metric ton) of spray-applied fire-resistive materials (SFRM).

3 MATERIAL CONTENT

Table 2 shows the weighted average generic formulations for all three sub-categories of GCPAT fireproofing materials as produced at GCPAT's three manufacturing locations. For reasons of confidentiality a portion of each SFRM is reported as "additives".

Table 2: Weighted Average Generic Formulations for Standard, Medium, High & Ultra High Density SFRMs

Standard Density		Medium Density		High & Ultra High Density	
Material composition	**%**	**Material composition**	**%**	**Material composition**	**%**
Stucco ($CaSO_4$ ½H_2O)	87%	Stucco ($CaSO_4$ ½H_2O)	54%	Bauxite	49%
Recovered paper	5%	Portland cement	31%	Portland cement	41%
Limestone	3%	Clay	6%	Clay	3%
Rest- additives	5%	Rest- additives	9%	Rest- additives	6%
Total	100%	Total	100%	Total	100%

Table 3 shows the amount of packaging materials per 1,000 kg of GCPAT SFRMs. Paper sacks are used for transporting fireproofing materials. The sacks are typically made of high-quality and weight kraft paper, usually virgin fiber.

Table 3: Packaging Materials for GCPAT SFRMs

Packaging materials	Quantity	Units (per 1,000 kg SFRM)
Paper Sacks	22.00	kg
Cardboard Core	0.30	kg

4 PRODUCTION STAGE

For this EPD, the boundary is "cradle-to-gate" or the *Production stage*, which includes the extraction of raw materials (cradle) through the manufacture of SFRM packaged ready for shipment (gate). Downstream activity stages - Construction, Use, End-of-life, and Optional supplementary information beyond the system boundary - are excluded from the system boundary (Figure 1).

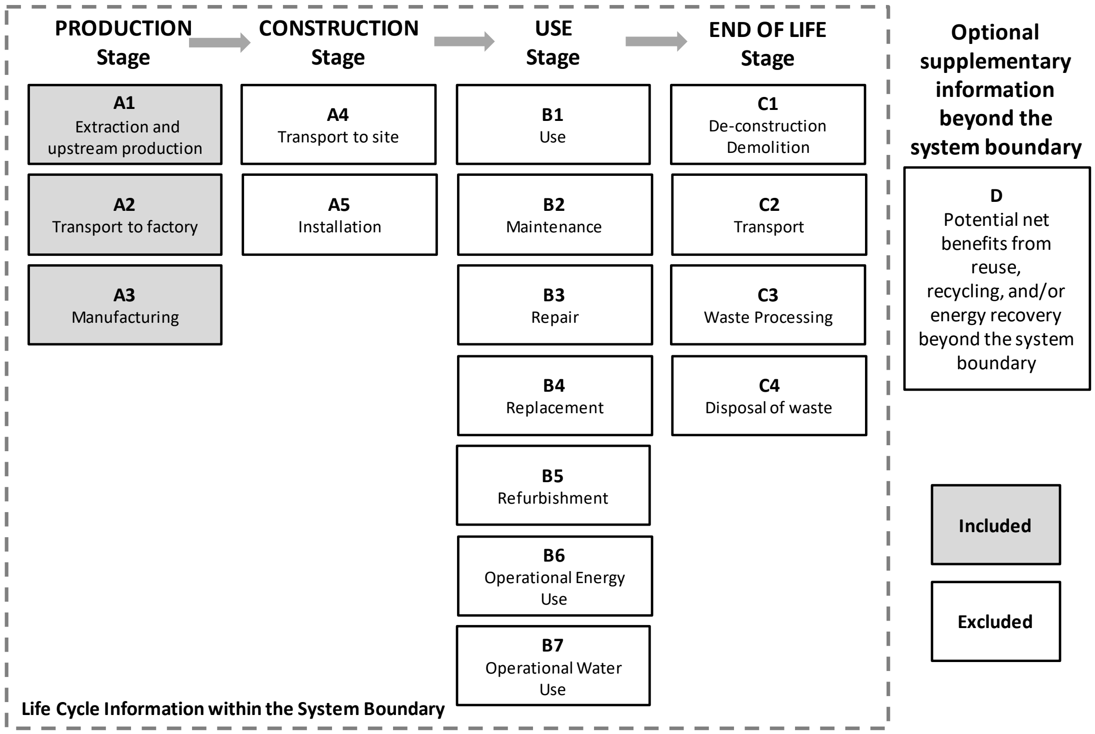

Figure 1 Common four life cycle stages and their information modules for construction products and the optional supplementary module [2]

The **Production stage** (modules A1 to A3) includes the following processes:

A1 Extraction and upstream production: Extraction and processing of input raw materials used in the production of standard, medium, high & ultra-high-density SFRMs, including fuels used in extraction and transport within the process.

A2 Transportation to factory: Transportation of input raw materials (including recovered materials) from extraction site or source to manufacturing facilities, including empty backhauls.

A3 Manufacturing: Manufacturing of the SFRMs, including all on-site energy and ancillary materials required and emissions to air, water and land and wastes produced. This also includes transportation from manufacturing site to landfill for on-site wastes, including empty backhauls and the waste disposal process. The A3 module includes grinding, mixing, blending, pneumatic conveying, high-speed auger packaging, lighting and heating, ventilation and air conditioning, operation of environmental equipment (baghouses and bin vents), on-site transportation (loading and unloading) and storage of SFRMs.

5 LIFE CYCLE INVENTORY

5.1 DATA COLLECTION, SOURCE AND CALCULATIONS

LCI data collection was based on a customized survey of all three GCPAT's SFRM manufacturing sites. All facility specific LCI data were weighted based on facility level total annual production to calculate the weighted average LCI profile for each product type (per 1,000 kg). Data calculation procedures follow ISO 14044. Per ISO 21930, 7.2.2 the net calorific value (lower heating value) of fuels is applied according to scientifically based and accepted values specific to the combustible material.

5.2 DATA QUALITY REQUIREMENTS AND ASSESSMENTS

A detailed description of collected data and the data quality assessment regarding the core PCR requirements and ISO 14044 is provided in the LCA report. Data quality is assessed based on its representativeness (technology coverage, geographic coverage, time coverage), completeness, consistency, reproducibility, transparency, and uncertainty (Table 4).

Table 4 Data Quality Requirements and Assessments

Data Quality Requirements	Description
Technology Coverage	Data represents the prevailing company technology in use in U.S. and Canada. Whenever available, for all upstream and core material and processes, North American typical or average industry LCI datasets were utilized. *Technological representativeness is characterized as "high".*
Geographic Coverage	The geographic region considered is U.S. and Canada. The geographic coverage of all LCI databases and datasets is given in in the LCA background report. *Geographical representativeness is characterized as "high".*
Time Coverage	Activity data are representative as of 2019. - SFRM manufacturing process- primary data collected from 3 facilities: reference year 2019 (12 months); - In-bound/ out-bound transportation data- primary data collected from 3 facilities: reference year 2019 (12 months); - Generic data: the most appropriate LCI datasets were used as found in the US LCI Database, ecoinvent v.3.7.1 database, 2021. *Temporal representativeness is characterized as "high".*
Completeness	All relevant, specific processes, including inputs (raw, secondary, ancillary, and packaging materials, and energy flows) and outputs (emissions and production volume) were considered and modeled to provide a weighted average for the SFRM products of interest. The relevant background materials and processes were taken from the US LCI Database, ecoinvent v 3.7.1 LCI database, and modeled in SimaPro v9.2.0.2, 2021. The completeness of the cradle-to-gate process chain in terms of process steps is rigorously assessed for SFRM products of interest and documented in the LCA background report.

Data Quality Requirements	Description
Consistency	To ensure consistency, the LCI modeling of the production weighted input and output LCI data for the SFRM product of interest used the same LCI modeling structure across the 3 facilities, which consisted of input raw, secondary, ancillary, and packaging materials, energy flows, water resource inputs, product outputs, co-products, by-products, emissions to air, water and soil, and solid and liquid waste disposal. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the facility level and selected process levels to maintain a high level of consistency.
Reproducibility	Internal reproducibility is possible since the data and the models are stored and available in *GCPAT_SFRM_LCI database* developed in SimaPro, 2021. A high level of transparency is provided throughout the report as the weighted average LCI profile is presented for each of the declared products as well as major upstream inputs. Key primary (manufacturer specific) and secondary (generic) LCI data sources are summarized in Annex C. External reproducibility is also possible as a high level of transparency is provided throughout the Project Report and LCI data and sources are also summarized.
Transparency	Activity and LCI datasets are transparently disclosed in the project report, including data sources.
Uncertainty	A *sensitivity check* was conducted to assess the reliability of the EPD results and conclusions by determining how they are affected by uncertainties in the data or assumptions on calculation of LCIA and energy indicator results. The sensitivity check includes the results of the *sensitivity analysis* and *Monte Carlo uncertainty analysis* both of which are summarized in the LCA report.

5.3 ALLOCATION AND CUT-OFF RULES

“Mass” was deemed as the most appropriate physical parameter for allocation used for the SFRMs manufacturing system to calculate the input energy flows (electricity, natural gas, and propane), packaging materials and waste flows per declared unit of 1,000 kg of SFRM. LCI modeling accounts for the plant specific fabrication yields in accordance with ISO 14044, 4.3.4.2.

Secondary materials such as hammermilled newsprint and post-industrial polystyrene are considered recovered materials. However, only the materials, water, energy, emissions, and other elemental flows associated with reprocessing, handling, sorting, and transportation from the generating industrial process to their use in the production process are considered. Any allocated burdens before reprocessing are allocated to the original product. Allocation related to transport are based on the mass of transported product.

The cut-off criteria as per ISO 21930, were followed for this EPD. All input/output data required were collected and included in the LCI modelling. No substances with hazardous and toxic properties that pose a concern for human health and/or the environment were identified in the framework of this EPD. Any data gaps for the reference year 2019 - e.g., packaging materials were filled in with plant generic data from previous years.

The Production Stage *excludes* the following processes:

- Capital goods and infrastructure;
- Human activity and personnel related activity (travel, furniture, office operations and supplies);
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location.

6 LIFE CYCLE ASSESSMENT

6.1 RESULTS OF THE LIFE CYCLE ASSESSMENT

This section summarizes the product stage life cycle impact assessment (LCIA) results including resource use and waste generated metrics based on the cradle-to-gate life cycle inventory inputs and outputs analysis. Table 5 presents the calculated results for each product density based on 1,000 kg (1 metric ton). *It is noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks* [2], [3].

Table 5 Production Stage (A1-A3), EPD Results for 1,000 kg standard, medium, high & ultra-high density SFRMs

Impact category and inventory indicators	Unit	Standard Density (min 15 pcf)	Medium Density (min 22 pcf)	High & Ultra High Density (min 40 pcf)
Global warming potential, GWP 100[1)], AR5	kg CO_2 eq	**210**	**493**	**621**
Ozone depletion potential, ODP[1)]	kg CFC-11 eq	**1.2E-04**	**1.3E-04**	**1.4E-04**
Smog formation potential, SFP[1)]	kg O_3 eq	**29.1**	**35.3**	**52.5**
Acidification potential, AP[1)]	kg SO_2 eq	**1.4**	**1.9**	**2.6**
Eutrophication potential, EP[1)]	kg N eq	**0.33**	**0.67**	**0.89**
ADP elements, CML[2)]	kg Sb eq	**1.0E-04**	**6.6E-04**	**1.8E-03**
ADP surplus, TRACI[1)]	MJ surplus	**515**	**607**	**683**
Renewable primary resources used as an energy carrier (fuel), RPR_E[3)]	MJ LHV	**166.9**	**405.6**	**450.3**
Renewable primary resources with energy content used as material, RPR_M[3)]	MJ LHV	**0**	**0**	**0**
Non-renewable primary resources used as an energy carrier (fuel), $NRPR_E$[3)]	MJ LHV	**3,849**	**5,051**	**5,833**
Non-renewable primary resources with energy content used as material, $NRPR_M$[3)]	MJ LHV	**0**	**0**	**0**
Secondary materials, SM[3)]	kg	**71**	**90**	**63**
Renewable secondary fuels, RSF[3)]	MJ LHV	**0.080**	**17**	**23**
Non-renewable secondary fuels, NRSF[3)]	MJ LHV	**0.77**	**167**	**218**
Recovered energy, RE[3)]	MJ LHV	**0**	**0**	**0**
Consumption of freshwater, FW[3)]	m^3	**0.31**	**0.62**	**0.64**
Hazardous waste disposed, HWD[3)]	kg	**0.035**	**0.027**	**0.009**
Non-hazardous waste disposed, NHWD[3)]	kg	**19.9**	**116.0**	**143.5**
High-level radioactive waste, conditioned, to final repository, HLRW[3)]	m^3	**9.8E-07**	**9.8E-07**	**1.0E-06**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW[3)]	m^3	**2.8E-06**	**3.3E-06**	**5.0E-06**
Components for re-use, CRU[3)]	kg	**0**	**0**	**0**
Materials for recycling, MR[3)]	kg	**0**	**0**	**0**
Materials for energy recovery, MER[3)]	kg	**0**	**0**	**0**
Recovered energy exported from the product system, EE[3)]	MJ LHV	**0.0029**	**0.62**	**0.81**
Global warming potential - biogenic, GWP-100 bio[3)4)]		1.1E-03	0.23	0.30
Emissions from calcination[3)4)]		0.71	152.3	200.0

Impact category and inventory indicators	Unit	Standard Density (min 15 pcf)	Medium Density (min 22 pcf)	High & Ultra High Density (min 40 pcf)
Emissions from combustion of waste from renewable sources3)4)		3.00E-04	0.064	0.085
Emissions from combustion of waste from non-renewable sources3)4)		0.072	15.5	20.3
Removals associated with biogenic carbon content of the bio-based product3)		-98.0	-66.2	-41.5
Removals associated with biogenic carbon content of the bio-based packaging3)		-40.9	-40.9	-40.9

Table Notes:

1) Calculated as per U.S EPA TRACI 2.1, v1.05, SimaPro v 9.2.0.2. GWP_{100}, excludes biogenic CO_2 removals and emissions; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5), TRACI 2.1, with AR5, v1.05.

2) Calculated as per CML-IA Baseline V3.05, SimaPro v 9.2.0.2.

3) Calculated as per ACLCA ISO 21930 Guidance, respective sections 6.2 to 10.8.

4) Applicable for Portland cement only, used in manufacturing of the GCPAT SFRM [11].

6.2 INTERPRETATION

The cradle-to-gate manufacture of **standard density SFRM** embodies about 4 GJ of primary energy (LHV) and emits 210 kg CO2 eq of greenhouse gases per ton of product. Around 96% of the total primary energy input is derived from non-renewable primary energy resources. Across the three standard density production information modules, Module A1 extraction and upstream production contributes the largest share of the LCIA and energy indicator results – accounting for between 60% ($NRPR_E$) and 54% (GWP-100) of the potential environmental burdens. Module A3 Manufacturing is generally the second largest contributor to the overall potential environmental impacts – accounting for 32% and 29% of GWP and non-renewable energy use, respectively. Except for acidification (26%) and smog potential impacts (35%), Module A2 Transportation is generally a minor contributor (<15%) to the overall potential environmental impacts of standard density SFRM production.

The cradle-to-gate manufacture of **medium density SFRM** embodies about 5.5 GJ of primary energy (LHV) and emits 493 kg CO2 eq of greenhouse gases per ton of product. About 93% of the total primary energy input is derived from non-renewable primary energy resources. Across the three medium density production information modules, Module A1 extraction and upstream production contributes the largest share of the LCIA and energy indicator results – accounting for 82% (GWP-100), 72% (NRPRE) and over 50% of both acidification and smog formation burdens. Unlike standard density SFRM, Module A3 Manufacturing is a more minor contributor to the overall potential environmental impacts of medium density SFRM – accounting for 17% of $NRPR_E$ and 9% of GWP-100. Module A2 Transportation is a significant contributor to SFP (37%), AP (27%) and GWP (9%) to the overall potential environmental impacts of medium density SFRM manufacture.

The cradle-to-gate manufacture of **high and ultra-high density SFRM** embodies about 6.3 GJ of primary energy (LHV) and emits 621 kg CO2 eq of greenhouse gases per ton of product. Almost 93% of the total primary energy input is derived from non-renewable primary energy resources. Across the three high and ultra-high density production information modules, Module A1 extraction and upstream production contributes the largest share of the key LCIA and energy indicator results – accounting for 80% (GWP-100), 67% (NRPRE) and 78% of eutrophication potential burden. Similar to medium density SFRM, Module A3 Manufacturing is a more minor contributor to the overall potential environmental impacts of high and ultra-high density SFRM – accounting for 15% of NRPRE and 13% of GWP-100. Module A2 Transportation is a significant contributor to SFP (53%), AP (39%) and GWP (9%) to the overall potential environmental impacts of high and ultra-high density SFRM manufacture.

7 ADDITIONAL ENVIRONMENTAL INFORMATION

Standard, medium and high & ultra-high density SFRMs use between 2% to 7% recovered materials (hammermilled newsprint and post-industrial polystyrene).

8 DECLARATION TYPE

GCPAT SFRM EPD is categorized as follows:
- A corporate specific product EPD, averaged across the manufacturer's plants.

This declaration presents a weighted average EPD for three SFRM North American facilities operated by GCPAT. Product activities covered include the raw material supply, transport and manufacturing (modules A1 to A3). The declaration is intended for Business-to-Business (B-to-B) communication.

9 DECLARATION COMPARABILITY LIMITATION STATEMENT

- Only EPDs prepared from cradle-to-grave life cycle results and based on the same function, RSL, quantified by the same functional unit, and meeting all the conditions for comparability listed in ISO 14025:2006 and ISO 21930:2017 can be used to comparison between products.

10 EPD EXPLANATORY MATERIAL

For any explanatory material, regarding this EPD please contact the program operator.
ASTM International
Environmental Product Declarations
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West Conshohocken,
PA 19428-2959,
http://www.astm.org

11 REFERENCES

1. ISO 14025:2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.
2. ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.
3. ISO 14040:2006/Amd 1:2020 Environmental management - Life cycle assessment - Principles and framework.
4. ISO 14044:2006/Amd1:2017/Amd2:2020 Environmental management - Life cycle assessment - Requirements and guidelines.
5 ASTM Program Operator Rules. Version: 8.0, Revised 04/29/20.
6 ISO 14021:2016 Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling).
7. PRé 2019.SimaPro LCA Software v9.2.0.2, 2021, https://simapro.com/
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9. LEED v4.1, Building Design and Construction Guide (BD+C), MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations, Option 2 Multi-attribute optimization (1 point). https://leeduser.buildinggreen.com/credit/NC-v4.1/MRc2#tab-credit-language.
10. ACLCA 2019, Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017. The American Centre for Life Cycle Assessment. May 2019. https://aclca.org/aclca-iso-21930-guidance/
11. PCA 2021, EPD, Portland Cement- Industry-wide. https://www.astm.org/products-services/certification/environmental-product-declarations/epd-pcr.html
12. Athena 2021, A Cradle-to-Gate Life Cycle Assessment of GCP Applied Technologies Standard, Medium and High & Ultra High-Density Spray-applied Fire-Resistive Materials (SFRMs), Final Report.