



METAL COMPOSITE PANELS MONARC®



3A Composites USA, Inc.

ENVIRONMENTAL PRODUCT DECLARATION

ISO 14025:2006 and ISO 21930:2017

3A Composites is pleased to present this Environmental Product Declaration (EPD) for their MONARC® panels. This EPD was developed in compliance with ISO 14025 and ISO 21930 and has been verified by Lindita Bushi, Ph.D., Athena Sustainable Materials Institute.

The LCA and EPD were prepared by Vertima Inc. The EPD includes cradle-to-gate life cycle assessment (LCA) results.

For more information about 3A Composites USA, Inc., visit www.3acompositesusa.com.

For any explanatory material regarding this EPD, please contact the program operator.



1. GENERAL INFORMATION

PCR GENERAL INFORMATION			
Reference PCR	UL Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels, UL 10010-5, October 2018 to October 2026 (validity period, extended). UL Part A: Life Cycle Assessment calculation Rules and Report Requirements, UL10010, March 2022 to March 2027 (validity period).		
The PCR review was conducted by:	<i>Thomas Gloria, Ph.D.</i> (chair), Industrial Ecology Consultants <i>t.gloria@industrial-ecology.com</i>	<i>Lindita Bushi, Ph.D.</i> Athena Sustainable Materials Institute <i>lindita.bushi@athenasmi.org</i>	<i>Bob Zabcik, P.E., LEED AP BD+C</i> NCI Building Systems <i>BobZ@ncigroup.com</i>
EPD GENERAL INFORMATION			
Program Operator	ASTM 100 Barr Harbor Drive, West Conshohocken PA 19428 USA www.astm.org		
General Program Instructions	ASTM International, ASTM Program Operator Rules, v.8.0, 2020		
Declared Product	Monarc®: 3mm aluminum composite panel with fire retardant core intended primarily for decorative building interior applications.		
EPD Registration Number EPD #1283	EPD Date of Issue October 15, 2026	EPD Period of Validity October 15, 2026 to October 14, 2031	
EPD Recipient Organization	3A Composites USA, Inc. 721 Jetton Street, Suite 325 Davidson NC 28036 USA www.3acompositesusa.com		
EPD Type/Scope and Declared Unit Product-specific cradle-to-gate EPD with declared unit (100 m ²) according to the description above for declared product.			Year of Reported Manufacturer Primary Data 2025
Geographical Scope North America	LCA Software Open LCA v.2.6.1	LCI Databases Ecoinvent 3.12 Allocation Cut-off System Model and US LCI	LCIA Methodology IPCC AR6, TRACI 2.2, and CED, LHV, v1.0
This LCA and EPD were prepared by:		Vertima Inc. www.vertima.ca	
This EPD and LCA were independently verified in accordance with ISO 14025:2026, ISO 14040:2006 and ISO 14044:2006, as well as UL "Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels" and UL "Part A: Life Cycle Assessment calculation Rules and Report Requirements," which is based on ISO 21930:2017. ☐ Internal ☒ External		 Lindita Bushi, Ph.D. Athena Sustainable Materials Institute.	

The owner of the declaration shall be liable for the underlying information and evidence; ASTM, or its affiliates, shall not be liable with respect to manufacturer information, life cycle assessment data, and evidence.



LIMITATIONS

Environmental declarations within the same product category but from different programs may not be comparable [1]. This EPD meets all comparability requirements stated in ISO 14025:2006 [1]. However, differences in certain assumptions, data quality, and variability between LCA datasets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers or programs, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the construction works level per ISO 21930:2017 guidelines [2]. The results of this EPD reflect an average performance by the products and their actual impacts may vary on a case-to-case basis [3].

2. PRODUCT SYSTEM DESCRIPTION

3A Composites USA, Inc., manufactures composite panels and materials, while offering a unique product and service range for its respective target market.

2.1. PRODUCT DESCRIPTION

The metal composite panel (MCM) consists of two sheets of smooth metal continuously thermo-bonded to a solid fire-retardant (FR) core under precise temperature, pressure, and tension. MCM is manufactured with coil-coated or uncoated anodized finish. MCM panels correspond to CSI MasterFormat code 07 42 13 – Metal Wall Panels. When metal is aluminum, the MCM panels are named ACM panels.

MONARC® Interior Wall Panels

MONARC® is brand of aluminum composite material (ACM) panels that are manufactured using a specialized proprietary process that allows for the production of high-quality finishes on 3-mm (0.012") nominal thickness composite wall panels. MONARC® panels—for interior application only—can be used in the design and construction of shower and bath enclosures, feature walls, backsplashes, lobbies, and other interior spaces. The premium properties of MONARC® panels ensure an extremely flat, lightweight, waterproof panel that offer easy installation and deliver a striking visual appearance inspired by natural elements. Product details can be found on 3A Composites' website (<https://www.alucobondusa.com/product/monarc/>). As a brand of interior wall panel for distribution purposes, the MONARC® panel is listed under CSI MasterFormat code 09 78 13 – Metal Interior Wall Paneling.

2.2. PRODUCT TECHNICAL DATA

MONARC® panels are available in variety of sizes, colors, and finishes.

Specification	Unit	MONARC®
Nominal Thickness of Aluminum Skin	mm (inch)	0.305 (0.012")
Nominal Thickness of Product	mm (inch)	3 (0.118")
Standard Length	mm (inch)	2432.0 (80")
Standard Width	mm (inch)	1219.2 (48")
Nominal Weight	kg/m ² (lbs./ft ²)	5.61 (1.15)
Nominal Density	kg/m ³	1.87E+03

2.3. PERFORMANCE STANDARDS

MONARC® panels have been evaluated in accordance with the referenced Standard Test Methods, with the following results reported. For more information on applicable performance standards, please refer to the MONARC® Product Data Sheet at <https://www.alucobondusa.com/downloads.html>.

Standard Test Method*	Description	Category	3mm panel
ASTM D-1781	Bond Integrity	Bond Integrity	> 100.1 N (or > 22.5 in-lb/in)
ASTM D-570	Water Absorption	Physical	0.04%
ASTM E-84	Surface Burning Characteristics (Flame Spread)	Fire Performance	< 25
ASTM E-84	Surface Burning Characteristics (Smoke Development)	Fire Performance	< 450
ASTM D-4060	Abrasion	Physical	0.0035 grams

*The ASTM (American Society for Testing & Materials) Standard Test Method defines the way a test is performed and the precision of the result. The result of the test is then used to assess compliance with a standard specification.

2.4. PRODUCT APPLICATION

MONARC® panels are manufactured by 3A Composites USA in a range of sizes and finishes. MONARC panels are designed for interior applications only, including shower and bath enclosures, feature walls, backsplashes, and lobbies.

2.5. MATERIAL COMPOSITION

The raw material inputs for MONARC® panels are presented in Table 1. Aluminum coil represents metal sheet. The core material includes mineral fire-retardant filler and thermoplastic polymers.

Table 1: Material composition of MONARC® panels

Material	MONARC®
Aluminum coil	30.5%
Core	69.5%
TOTAL	100.00%

2.6. MANUFACTURING

A proportion of the 3-mm ACM panels (specialized for MONARC®) that are manufactured at the Benton (KY) plant are transported to Statesville (NC) by truck, where they undergo “a specialized, proprietary manufacturing process that allows for the production of high-quality finishes on MONARC® composite wall panels” and are branded as MONARC® products. Finally, MONARC® panels are masked and stacked for inspection and final packaging. Aluminum and panel scrap generated during manufacturing are sent to the recycling center.

2.7. PACKAGING

MONARC® interior wall panels are packaged using wooden pallets, cardboard, and plastic banding.



3. LCA CALCULATION RULES

3.1. DECLARED UNIT AND REFERENCE FLOWS

The declared unit (DU) for metal composite panels (MCM) is coverage of 100 m² (1076.4 ft²) with metal product. The coverage area refers to the projected flat area covered by the product as output by the final manufacturing process step, and does not account for losses due to overlap and scrap during installation, consistent with the declared unit defined in the applicable PCR [3].

Results represent 12 months (11/01/2024 to 10/31/2025) of production of MONARC® (3-mm) panels at the Benton, Kentucky, facility. Then, the MONARC® panels undergo a “proprietary finishing process” at the Statesville, North Carolina, facility. The LCA results thus represent a product-specific, facility-specific EPD. No product is considered as an average of multiple products.

Table 2 presents the products targeted by this report and the respective DU.

Table 2: Declared unit (DU) and properties of MONARC® panels as delivered

	MONARC®	Unit
Declared Unit (DU)	100	m ²
Mass	5.42E+02	kg
Conversion Factor	1.85E-01	m ² /kg

3.2. SYSTEM BOUNDARIES

Consistent with UL’s PCR Part B, the system boundaries are **cradle-to-gate**, i.e., only cover the production life cycle module as illustrated in the table below. Within this life cycle stage, three (3) modules are considered, namely A1) Extraction and Upstream Production, A2) Transport to Factory and A3) Manufacturing. Construction (A4; A5), Use (B1 to B7) and End-of-life (C1 to C4) stages are not included in this study. Figure 1 presents the process flow diagram. Neither green power nor CO₂ credits are used in the framework of this project.

Table 3: Description of the system boundary life cycle stages and related information modules

PRODUCTION STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END-OF-LIFE STAGE			
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
Extraction and Upstream Production	Transport to Factory	Manufacturing	Transport to Site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction / Demolition	Transport to Waste Processing or Disposal	Waste Processing	Disposal of Waste
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Key: X = included; MND = module not declared (excluded)

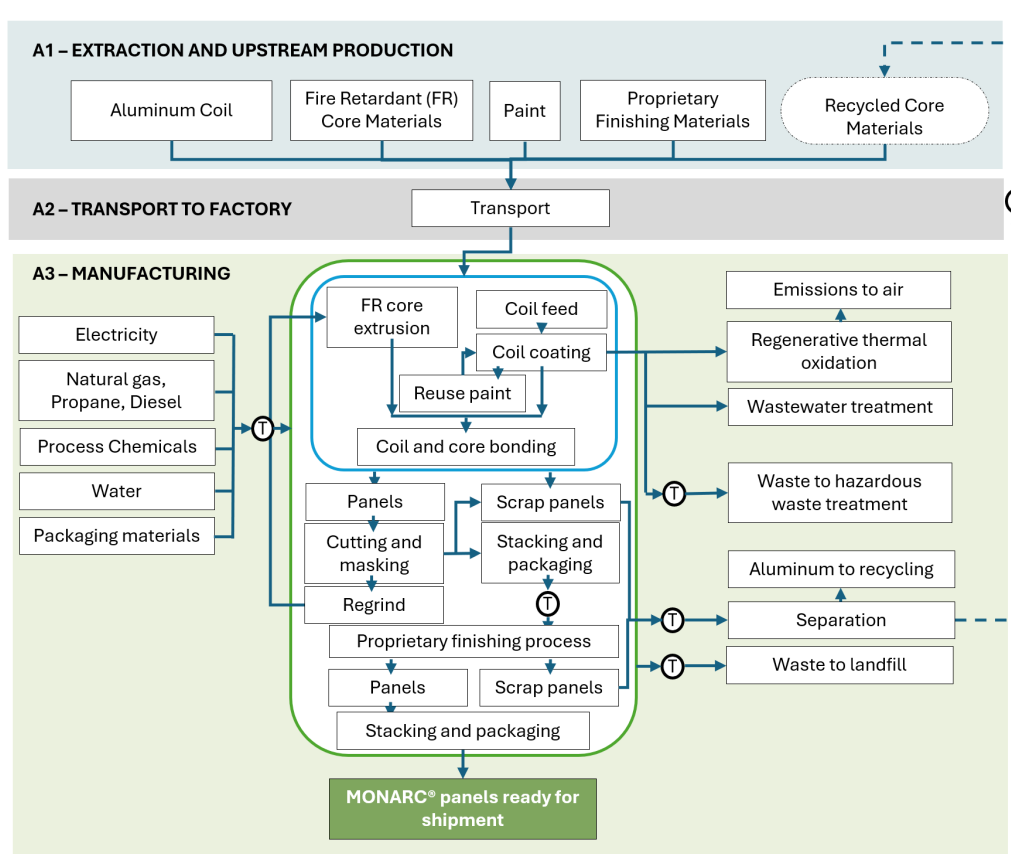


Figure 1: System boundaries of cradle-to-gate LCA of MONARC®, ACM panels. “T” refers to transport.

Extraction and upstream production (A1): This module includes the extraction and processing of raw materials used in the manufacturing of the ACM system panels.

Transport to factory (A2): This module includes the transportation of raw materials from the suppliers to the 3A Composites manufacturing facilities.

Manufacturing (A3): This module covers the 3-mm ACM panels (specialized for MONARC®) manufacturing processes, aluminum and core bonding, cutting, masking, and packaging, as well as the proprietary MONARC® finishing process. Energy use, water consumption, and waste production which is recycled or sent to local landfill are included. Moreover, direct emissions to air or to water from the manufacturing facilities have been reported.

Finally, packaging materials to make products ready for shipment and their transport from suppliers to the respective manufacturing facilities are also covered by this stage.

3.3. CUT-OFF CRITERIA

According to the PCR [3], cut-off rules shall not be applied in order to hide data. 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% non-renewable 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 [2, 4]. The only exceptions to these criteria are substances with hazardous and toxic properties, which must be listed even when the given process unit is under the cut-off criterion of 1% of the total mass.

No known flows are deliberately excluded from this EPD.

For this study, no data on the construction, maintenance, or dismantling of the capital assets, daily transport of the employees, office work, business trips, or other activity from 3A Composites USA, Inc.'s employees was included in the model. The model only takes into account the processes associated with infrastructures that are already included in the ecoinvent unit processes.

3.4. ALLOCATION

As stated by the PCR, in cases where allocation cannot be avoided, the following hierarchy of allocation methods is preferred:

- mass, or other biophysical relationship; and
- economic value.

Allocation was performed based on the yearly production mass of each product under study.

Energy data were provided for the entire manufacturing plant; therefore, **mass allocation** was applied to assign the corresponding share of factory energy consumption to the product under study.

Waste processing of material flows undergoing recycling is included up to the system boundary defined by the end-of-waste state. In other words, a cut-off approach was applied, since further processing of the recycled material is considered part of the raw material preparation of another product system (open-loop recycling).

No burdens are allocated across the system boundary with secondary material, secondary fuel or recovered energy flows arising from waste.

3.5. CALCULATION METHOD

OpenLCA software v2.6.1 [5], an open-source software, was used to calculate the inventory and to assess potential environmental impacts associated with the inventoried emissions.

3.6. DATA SOURCES AND QUALITY REQUIREMENTS

Data Quality Parameter	Data Quality Discussion
Source of manufacturing data:	Manufacturing data was collected from 3A Composites USA, Inc.'s manufacturing plants located in Benton, Kentucky, and Statesville, North Carolina. Data represents annual average values for 12 months (11/01/2024 to 10/31/2025). This data included: total annual mass of products produced at the manufacturing plant; specific product composition; raw materials and fuels entering the product production process; transport distance of materials and fuels; electricity consumption; water consumption; waste treatment; and packaging at each manufacturing facility.
Source of secondary data:	Background data was taken from ecoinvent 3.12 "cut-off" datasets representative of the United States or North America. When appropriate, the grid mix was changed for the grid mix of the state or country where production takes place. Otherwise, ecoinvent data representative of the global market or the "rest-of-the-world" was selected as proxies. In addition, the aluminum sheet is modelled using Aluminum Association EPD results [6] because, during the reference period (11/01/2024 to 10/31/2025), the aluminum sheet used to manufacture the MONARC®-declared products was sourced exclusively from suppliers located in North America.
Geographical representativeness	Electricity consumption is based on the relevant grid mixes for the US state of Kentucky and North Carolina, respectively, while natural gas consumption reflects the USA supply mix. Geographical correlation of the material supply and the selected datasets are largely representative of the same area. When this was not possible, datasets representing a larger geographical area were used.
Temporal representativeness	Primary data was collected to be representative of the full production year based on the annual average values for 12 months (11/1/2024 to 10/31/2025). Datasets selected from ecoinvent were not always published within the last ten years. Nevertheless, ecoinvent and US LCI remain the primary reference LCI databases.
Technological representativeness	Primary data, obtained from the manufacturer, is representative of the current technologies and materials used by this company.
Completeness	All relevant process steps were considered and modelled to satisfy the goal and scope. No known flows were cut-off.

4. LIFE CYCLE ASSESSMENT RESULTS

4.1. DISCLAIMER

It should be noted that Life Cycle Impact Assessment (LCIA) results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins, or risks.

4.2. RESULTS TABLES

The tables below present the LCIA results according to the product declared unit of 100 m² (1076.4 ft²) using the TRACI 2.2 methodology (GWP from IPCC AR5, which is replaced by IPCC AR6), as well as primary energy consumption, consumption of renewable and non-renewable materials, water consumption, and waste generation.

LCI and LCIA Indicator acronyms

TRACI 2.2 and CML potential impact indicators

GWP: Global Warming Potential; **ADP-ff:** Abiotic Resource Depletion Potential of Non-Renewable (Fossil) Energy Resources; **AP:** Acidification Potential; **EP:** Eutrophication Potential; **SFP:** Smog Formation Potential; **ODP:** Ozone Layer Depletion Potential.

Resource use

RPR_E: Renewable Primary Resources Used as Energy Carrier (Fuel); **RPR_M:** Renewable Primary Resources with Energy Content Used as Material; **RPR_T:** Renewable Primary Resources Total; **NRPR_E:** Non-Renewable Primary Resources Used as Energy Carrier (Fuel); **NRPR_M:** Non-Renewable Primary Resources with Energy Content Used as Material; **NRPR_T:** Non-Renewable Primary Resources Total; **SM:** Secondary Materials; **RSF:** Renewable Secondary Fuels; **NRSF:** Non-Renewable Secondary Fuels; **RE:** Recovered Energy; **FW:** Use of Net Fresh Water Resources.

Output flows and waste categories

HWD: Hazardous Waste Disposed; **NHWD:** Non-Hazardous Waste Disposed; **HLRW:** High-Level Radioactive Waste, Conditioned, to Final Repository; **ILLRW:** Intermediate and Low-Level Radioactive Waste, Conditioned, to Final Repository; **CRU:** Components for Re-Use; **MFR:** Materials for Recycling; **MER:** Materials for Energy Recovery; **EE:** Exported Energy.

Table Notes – TRACI 2.2 and CML

- (1) GWP 100, includes biogenic CO₂ removals and emissions associated with biobased products and packaging; 100-year time horizon. GWP factors are provided by the IPCC 2021 Sixth Assessment Report (AR6).
- (2) GWP 100, excludes biogenic CO₂ removals and emissions associated with biobased products and packaging; 100-year time horizon. GWP factors are provided by the IPCC 2021 Sixth Assessment Report (AR6).
- (3) ADP_{FF}, in MJ, from CML method is not to be mixed with FFD (fossil fuel depletion) TRACI v2.1 indicator.

Table Notes – Resource Use

- (4) $RPR_E = RPR_T - RPR_M$, where RPR_T is equal to the value for renewable energy obtained using the CED LHV methodology.
- (5) Calculated as per ACLCA ISO 21930 Guidance, 6.2 Renewable primary resources with energy content used as a material, RPR_M .
- (6) $NRPR_E = NRPR_T - NRPR_M$, where $NRPR_T$ is equal to the value for non-renewable energy obtained using the CED LHV methodology.
- (7) Calculated as per ACLCA ISO 21930 Guidance, 6.4 Non-renewable primary resources with energy content used as a material, $NRPR_M$.
- (8) Represents the use of net fresh water calculated from life cycle inventory results, i.e., water consumption using impact method EN15804+A2 (EF3.1).

Table Notes – Output Flows and Waste Categories

- (9) Significant data limitations currently exist within the LCI data used to generate waste metrics for Life Cycle Assessments and Environmental Product Declarations. The waste metrics were calculated in a way conformant with the requirements of ISO

21930:2017, but these values represent rough estimates and are for informational purposes only. As such, no decisions regarding actual cradle-to-gate waste performance between products should be derived from these reported values.

(10): Calculated from life cycle inventory results, based on datasets classified under “treatment and disposal of hazardous waste.”
The manufacturer does not generate hazardous waste during the manufacturing process.

(11): Calculated from life cycle inventory results, based on waste that is neither “hazardous” nor “radioactive.”

(12): Calculated from life cycle inventory results, based on ecoinvent waste flow “high-level radioactive waste for final repository.”
The manufacturer does not generate HLRW.

(13): Calculated from life cycle inventory results, based on ecoinvent waste flow “low-level radioactive waste for final repository.”
The manufacturer does not generate ILLRW.



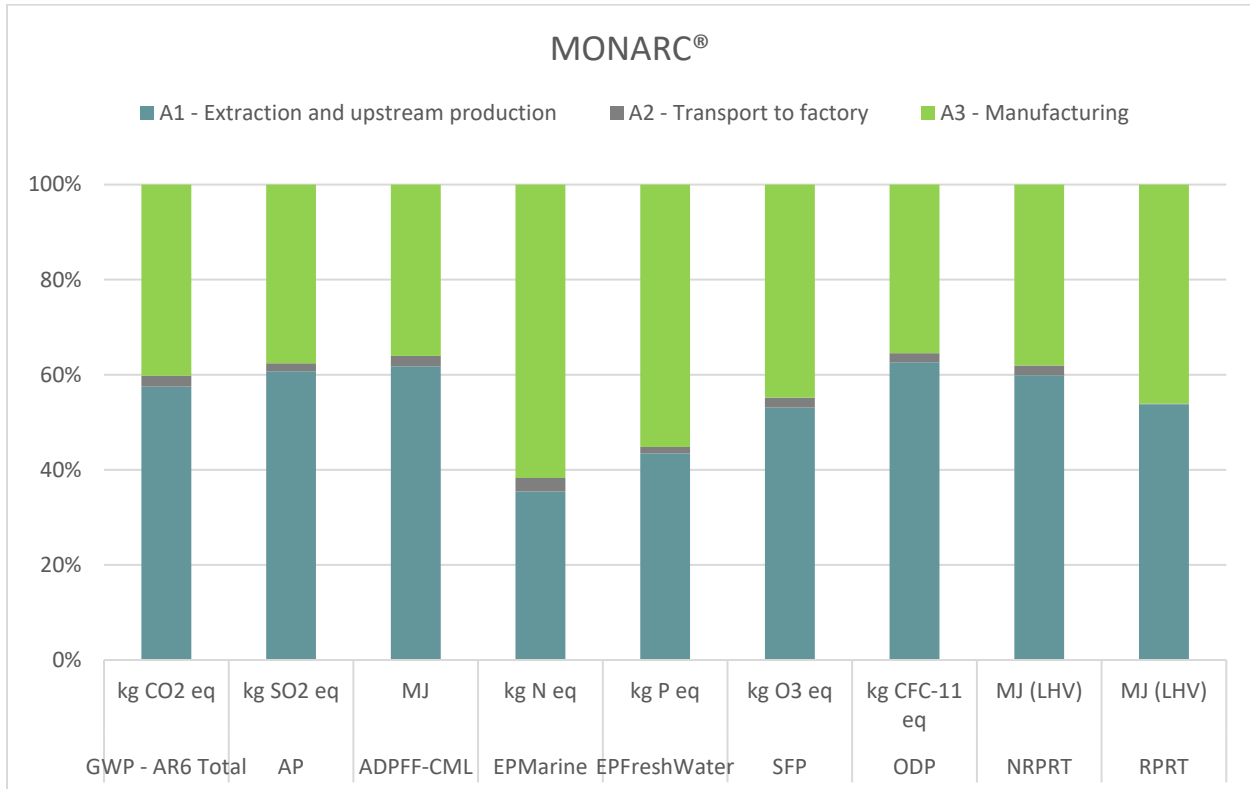
[Photo courtesy of 3A Composites USA, Inc.]

Results for MONARC® per 100 m² declared unit (DU)

Environmental Indicator		Unit	MONARC® – LCIA per Declared Unit (DU)			
			A1	A2	A3	A1 - A3
			(per DU)	(per DU)	(per DU)	(per DU)
TRACI 2.2	GWP ₁₀₀ -AR6 ⁽¹⁾	kg CO ₂ eq.	1.23E+03	4.84E+01	8.60E+02	2.14E+03
	GWP ₁₀₀ -AR6 ⁽²⁾	kg CO ₂ eq.	1.23E+03	4.84E+01	8.33E+02	2.11E+03
	AP	kg SO ₂ eq.	4.15E+00	1.13E-01	2.57E+00	6.83E+00
	ADP _{FF} – CML Method ⁽³⁾	MJ	1.97E+04	7.01E+02	1.15E+04	3.19E+04
	EP _{Freshwater}	kg P eq.	1.60E-01	5.06E-03	2.03E-01	3.68E-01
	EP _{Marine}	kg N eq.	1.05E+00	8.38E-02	1.83E+00	2.97E+00
	SFP	kg O ₃ eq.	5.17E+01	2.03E+00	4.37E+01	9.74E+01
	ODP	kg CFC-11 eq	2.60E-05	8.04E-07	1.47E-05	4.15E-05
Resource Use	RPR _E ⁽⁴⁾	MJ, LHV	3.88E+03	9.94E+00	3.32E+03	7.21E+03
	RPR _M ⁽⁵⁾	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	RPR _T	MJ, LHV	3.88E+03	9.94E+00	3.32E+03	7.21E+03
	NRPR _E ⁽⁶⁾	MJ, LHV	2.08E+04	7.10E+02	1.33E+04	3.48E+04
	NRPR _M ⁽⁷⁾	MJ, LHV	5.64E+01	0.00E+00	0.00E+00	5.64E+01
	NRPR _T	MJ, LHV	2.09E+04	7.10E+02	1.33E+04	3.48E+04
	SM	MJ, LHV	1.98E+02	0.00E+00	0.00E+00	1.98E+02
	RSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NRSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	RE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	FW ⁽⁸⁾	m ³	8.28E+02	1.04E-01	5.71E+00	8.34E+02
Output flows and waste	HWD ^(9,10)	kg	2.22E+02	4.56E+00	1.36E+02	3.63E+02
	NHWD ^(9,11)	kg	3.73E+03	9.01E+01	2.20E+03	6.01E+03
	HLRW ^(9,12)	kg	2.84E-03	4.13E-05	5.52E-03	8.40E-03
	ILLRW ^(9,13)	kg	1.32E-02	1.00E-04	2.02E-02	3.36E-02
	CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	MFR	kg	3.47E+01	0.00E+00	7.06E+01	1.05E+02
	MER	kg	8.76E-01	0.00E+00	0.00E+00	8.76E-01
	EE	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

4.3. CONTRIBUTION ANALYSIS

This section details the contribution to the potential environmental impacts and resource use of the different production life cycle modules. As can be seen from the contribution graphs, the extraction and upstream production module (A1) is the main contributor across the assessed environmental impact categories, as well as in the consumption of both renewable and non-renewable primary energy resources, except for marine and freshwater eutrophication potential, where the manufacturing module (A3) is the dominant contributor.



GWP: Global Warming Potential; **AP:** Acidification Potential; **EP:** Eutrophication Potential; **SFP:** Smog Formation Potential; **ODP:** Ozone Layer Depletion Potential; **NRPRT:** Non-Renewable Primary Resources – Total; **RPRT:** Renewable Primary Resources - Total.

4.4. LCA INTERPRETATION

The overall impacts are driven by raw material extraction and upstream production (A1). Aluminum sheet is the primary driver across the majority of the indicators. Although some raw materials are transported large distances and using multiple modes, the transport module (A2) contributes modestly to the overall impacts.

5. ADDITIONAL ENVIRONMENTAL INFORMATION

5.1. CONTENT OF REGULATED HAZARDOUS SUBSTANCES

Please refer to the product safety data sheet for more information, available at alucobondusa.com.

5.2. RELEASE OF DANGEROUS SUBSTANCES FROM THE CONSTRUCTION PRODUCT

MONARC® panels are not considered to be a health hazard in the form in which they are sold (sheet, panel). However, if these products are abraded, melted, welded, cut, or processed in any manner that causes release of fumes or dust, hazardous levels of fumes or dust may be generated from this product.

Please consult the link for the MONARC® Health Product Declaration: <https://hpdrepository.hpd-collaborative.org/Pages/Results.aspx>

5.3. FUTHER INFORMATION

For more information, please refer to <https://3acompositesusa.com/sustainability.html>

and <https://www.alucobondusa.com/>.

6. RÉFÉRENCES

- [1] International Organization for Standardization (ISO), "ISO 14025 Environmental labels and declarations — Type III environmental declarations — Principles and procedures," 2006.
- [2] International Organization for Standardization (ISO), "ISO 21930 : 2017 (E) Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services," 2017.
- [3] UL Environment, "PCR Guidance for Building-Related Products and Services Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels, UL 10010–5," 2022.
- [4] UL Environment, "PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements," 2022.
- [5] Open LCA, "Downloads Open LCA," 2026. [Online]. Available: <https://www.openlca.org/download/>. [Accessed May 2026].
- [6] The Aluminum Association, "EPD - Aluminum Sheet - Industry Average Aluminum Sheet Manufactured in North America," September 2022.
- [7] ASTM, "ASTM Program Operator Rules. Version: 8.0, Revised 04/29/20," 2020. [Online]. Available: www.astm.org.
- [8] Vertima, "Life Cycle Assessment of 3A Composites USA, Inc., for ALUCOBOND PLUS® and MONARC®," 06/2026.
- [9] International Organization for Standardization (ISO), "ISO 14044:2006/Amd1:2017/Amd2:2020/ Environmental management — Life cycle assessment — Requirements and Guidelines," 2006.
- [10] International Organization for Standardization (ISO), "ISO 14040:2006/Amd1:2020/ Environmental management — Life cycle assessment — Principles and framework," 2006.



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