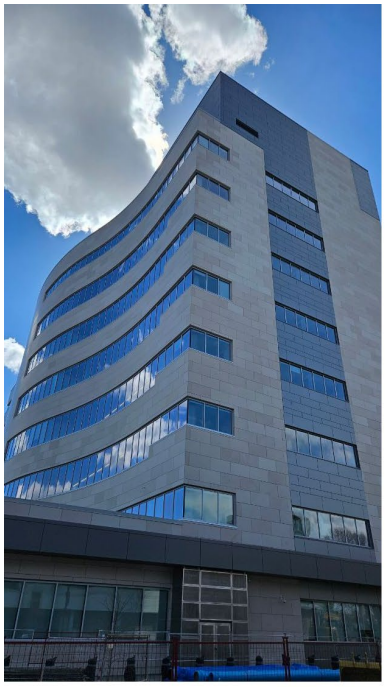
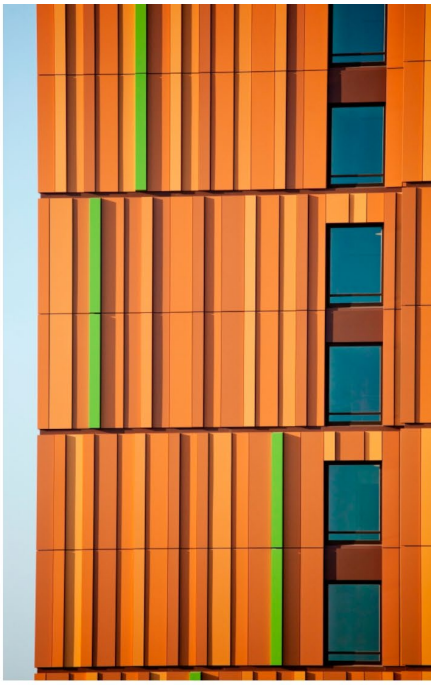
Environmental Product Declaration

Metal Composite Material

FIRE-RETARDANT (FR) CORE PANELS







The Metal Construction Association (MCA) is a non-profit organization formed in 1983 with the primary purpose of expanding the use of metal in construction. MCA unites diverse industry segments for the purpose of informing decision makers about the benefits of metal through awareness and education programs. MCA also supports third-party metal product research and testing. MCA and its members are committed to creating a cleaner, safer environment evidenced by the association's LCA program and support of similar initiatives.

Aluminum Composite Material (ACM) panels, a subset of Metal Composite Material (MCM) panels, are a major product category developed by MCA members. ACM is formed by joining two thin metal skins to a solid plastic core and then bonded under a precise temperature, pressure, and tension. This unique process makes ACMs lighter and more versatile and flexible than a solid metal of similar thickness.

This Environmental Product Declaration for MCM panels is one of several different product EPDs offered by MCA.

For more information visit
https://metalconstruction.org

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

Fire-Retardant (FR) Core Panels
Industry-Wide EPD

According to ISO 14025, ISO21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Solutions 333 Pfgingsten Rd, Northbrook IL, 60062 www.ul.com www.spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	UL Solutions Program Operator Rules v.2.7 2022
MANUFACTURER NAME AND ADDRESS	Metal Construction Association 1061 American Lane, Suite 310 Schaumburg, IL 60173
DECLARATION NUMBER	4792126919.103.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Fire Retardant Aluminum Composite Material (ACM) Panel; 100 m^2 coverage
REFERENCE PCR AND VERSION NUMBER	PCR Part A "Life Cycle Assessment Calculation Rules and Report Requirements" (UL Environment, 2022) and PCR Part B: "Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels" (UL Environment, 2018) (extended to Oct 31, 2026)
DESCRIPTION OF PRODUCT APPLICATION/USE	Metal composite material (MCM) panels are factory-manufactured panels with metal skins bonded to both sides of a solid plastic core.
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	August 11th, 2026
PERIOD OF VALIDITY	5 Years
EPD TYPE	Industry-average
EPD SCOPE	Cradle-to-gate
YEAR(S) OF REPORTED PRIMARY DATA	2023
LCA SOFTWARE & VERSION NUMBER	LCA FE v10.9 (formerly GaBi Software)
LCI DATABASE(S) & VERSION NUMBER	Managed LCA Content 2025.2 (formerly GaBi Database, CUP 2025.2)
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR6 + CML 2001 Aug 2016 + TRACI 2.2
The PCR review was conducted by:	UL Solutions PCR Review Panel pcr@ul.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Cooper McCollum, UL Solutions
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Sphera Solutions, Inc.
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas P. Gloria, Industrial Ecology Consultants

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: Environmental declarations from different programs (ISO 14025) may not be comparable. Comparison of the environmental performance of metal panel and cladding products 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 use phase as instructed under this PCR. Full conformance with the PCR for metal panels and cladding 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 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 upstream or downstream of the life cycle stages declared.

1. Product Definition and Information

1.1. Description of Company/Organization

The Metal Construction Association (MCA) is recognized as the leading advocate for the architectural metal products industry. Since it was formed in 1983, MCA has focused on promoting the use of metal in the building envelope through marketing, education, and action on public policies that affect the use of metal. MCA is a volunteer-led organization that works to eliminate barriers to using metal in construction by supporting product performance testing, initiating research, and monitoring and responding to codes and regulations that affect metal. Visit https://metalconstruction.org for more information.

Information in this document has been prepared by MCA technical staff and members of MCA's MCM Alliance who are volunteers representing the leading manufacturers of Metal Composite Material (MCM) and companies that provide premium fabricating services for MCM. The product configurations offered herein use ranges representative of all types of MCM based on specific products from the following MCA member companies:

3A COMPOSITES	3A Composites is a global leader and manufacturer of lightweight products, employing 4,200 people across Europe, the Americas and Asia. The company supplies materials to the architecture, visual communication, transportation, industrial and wind energy markets. Its well-known brand, ALUCOBOND®, is the category leader for aluminum composite material (ACM) in the markets served. This core product is supported by a family of complementary brands that includes AXCENT and ALUCOLUX flat sheet metal; together they provide non-combustible and cohesive design options for trim, soffits and metal wall cladding. 3A Composites is deeply committed to ensuring its products and production processes are environmentally sustainable. The company strategically reduces its carbon footprint by actively partnering with recyclers of ACM to promote material reuse and the circular economy. This commitment is further demonstrated by its status as a Gold Member of the US Green Building Council (USGBC), contributing multiple points to LEED certification for sustainable building projects. Learn more at www.alucobondusa.com.
alfrex Fire Resistant & Non-Combustible Cladding	Alfrex FR fire-retardant aluminum and metal composite material is manufactured in Buford, Georgia USA utilizing in-house manufactured FR core compound. Its product portfolio includes Alfrex FR Metal Composite Material, Matching 0.040″ Flat Sheet, pre-finished (non-combustible) Alfrex Aluminum Plate, and mill finish solid aluminum plate for post painting small lot, custom colors. It is the only domestic MCM manufacturer that offers a line of 3mm (nominal 1/8”) thick pre-painted plate to meet a growing need in the market for non-combustible architectural wall cladding solutions. Learn more at https://alfrexusa.com/.

MITSUBISHI CHEMICAL GROUP | ALPOLIC	Mitsubishi Chemical America (MCA) ALPOLIC division is part of the global Mitsubishi Chemical Group (MCG). ALPOLIC Americas has been redefining skylines from its manufacturing headquarters in Chesapeake, VA. ALPOLIC materials are known for their shine and durability, guaranteed for up to 35 years. Select "cool" colors feature high solar reflectance and increase project energy efficiency. MCA uses the ISO 9001-2015 Quality Management System, and its materials are UL-certified. For more information, visit www.alpolic-americas.com.
Architectural Image Systems, LLC	AIS Architectural Image Systems, LLC is a leader in fabrication and installation of ACM / MCM and metal panel systems we are second to none. Our EXPERIENCE in design, fabrication, and field installations combine to provide a seamless TURNKEY element for your project. Our ON-TIME record and pride in presenting a PRISTINE FINISHED PRODUCT have provided us impeccable referrals within the competitive network of general contractors. For more information, please see https://www.aisarchitecturalimagesystems.com/.

1.2. Product Description

Product Identification

MCM panels are factory-built composite assemblies composed of two metal skins laminated on either side of an extruded solid plastic core. The core is composed of either a thermoplastic or a mineral filled composite material. The latter core formulation is deemed by industry as fire resistant (FR) and is often required for façades over multi-story construction due to improved fire performance over a plain thermoplastic.

The panels are molded in a variety of styles and sizes depending on application. MCM skins can be composed of aluminum, zinc, copper, stainless steel, and titanium, but only aluminum is represented in this declaration. In this case, they are specifically referred to as Aluminum Composite Materials (ACMs), a subset of MCMs.

After initial manufacture, MCMs are typically transported to a fabricator where they are further modified into a panelized system for architectural applications. These systems are installed on interiors and as cladding for the outer shell of buildings, offering protection from the elements while providing a lasting aesthetic appeal. MCM panels may also be used in interior applications and canopies.

MCM panels are used in a multitude of building coverage applications and offer a wide range of benefits, including aesthetics, durability, rain screening, and reduced energy costs, with each product type offering its own unique properties. This EPD focuses on MCM products that are considered representative of common products manufactured by member companies, as seen in Table 1.

A flow diagram depicting the manufacturing process can be found in Figure 1. The EPD is intended to represent an industry average for ACM. The industry average was calculated using horizontal averaging, with manufacturer datasets weighted by production output expressed in area (100 m^2 of ACM) across participating facilities.

Product Specification

Table 1. ACM panel specification

PRODUCT	DESCRIPTION	PRIMARY PROCESSES
Aluminum Composite Material (ACM) Panels	Aluminum skin thickness: 0.25 and 0.5 mm FR core thickness: 3, 4, and 6 mm Primary product: Nominal 4 mm panels with 0.5 mm aluminum skins with a 3-4 mm thick solid FR core	• Continuous coil coating • ACM sheet manufacturing • ACM panel fabrication

Flow Diagram

Figure 1 displays the cradle-to-gate manufacturing process of MCM panels.

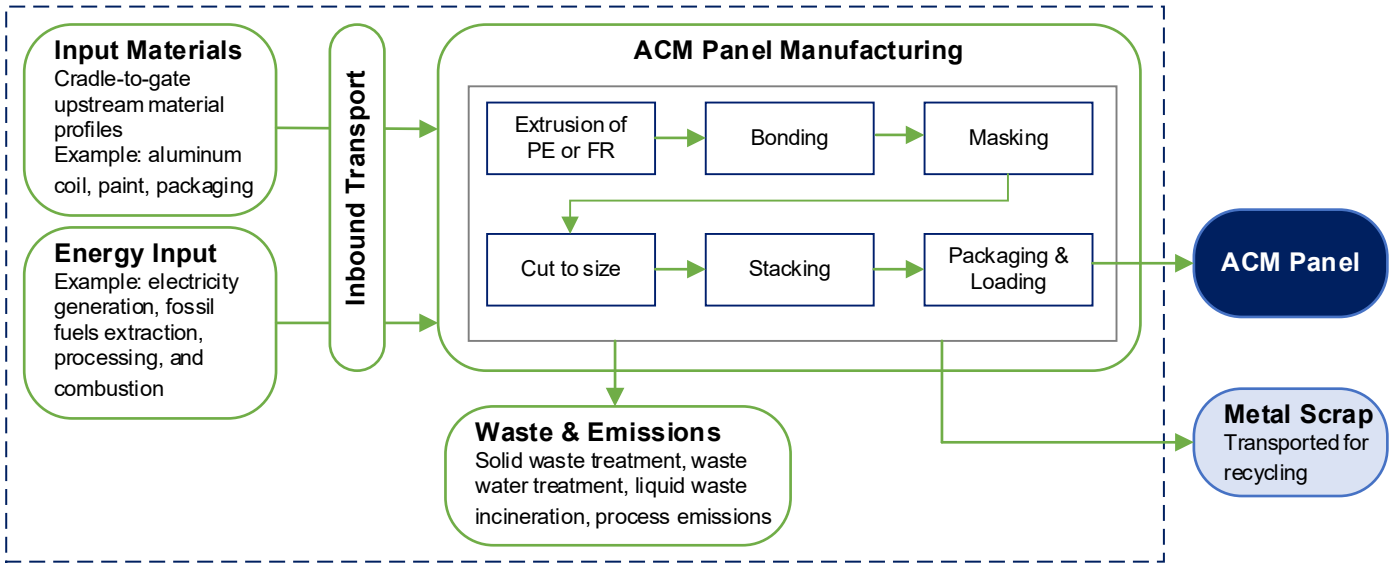


Figure 1. Cradle-to-Gate system boundary for ACM manufacturing

1.3. Application

MCM panels are used in residential, commercial, and industrial applications. They are commonly used as the building's exterior envelope, installed as wall cladding through systems such as rainscreens, and integrated with other façade materials and systems, including curtain walls. ACMs are available in a wide range of finishes to match the building's design requirements.

Compared to materials like precast concrete, granite, or brick, MCMs offer lower overall costs primarily because of quicker installation. Further, the lightweight properties of MCMs contribute to cost savings by minimizing the need for a support structure. On-going maintenance costs are reduced thanks to advancements in paints and protective coatings.

MCM cladding systems help buildings retain a modern, attractive appearance over time, minimizing pre-sale renovation costs. ACM systems are commonly and successfully applied in high-profile projects such as sports complexes, libraries, educational facilities, and civic buildings—offering long-lasting aesthetics and design flexibility.

1.4. Declaration of Methodological Framework

This EPD is “cradle-to-gate” covering the modules A1 to A3. This includes raw material extraction and upstream processing, secondary material production, inbound transportation, panel manufacturing, and subsequent fabrication into finished cladding products. This study excludes installation, use, and end-of-life stages as they are not required as per PCR. Module D has also been excluded as it is optional as per the PCR. Further details are described in MCA’s background report (Sphera, 2025).

Capital goods and infrastructure flows are excluded from this analysis due to the minimal extent to which they affect the LCIA results. For the manufacturing of MCM panels, capital goods and infrastructure last for decades with periodic replacement of key components as needed. All other impacts associated with the use stage of the building while the product is being produced and all human labor and commute have also been excluded.

No other known flows are deliberately excluded from this EPD.

1.5. Technical Requirements

Performance Standards – Air Tightness

ASTM E 283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

Performance Standards – Fire

ASTM D635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D1929	Standard Test Method for Determining Ignition Temperature of Plastics
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E162	Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
CAN/ULC S102	Surface Burning Characteristics of Building Materials and Assemblies
UL 1715	Fire Test of Interior Finish Material

Materials and Assemblies

NFPA 285	Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components
CAN/ULC S134	Standard Method of Fire Test of Exterior Wall Assemblies

Performance Standards – Structural

ASTM C 297	Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions
ASTM C 393	Standard Test Method for Core Shear Properties of Sandwich Constructions by Beam Flexure
ASTM C 481	Standard Test Method for Laboratory Aging of Sandwich Constructions
ASTM D 1002	Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
ASTM D 1781	Standard Test Method for Climbing Drum Peel for Adhesives
ASTM E 72	Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
ASTM E 228	Standard Test Method for Linear Thermal Expansion of Solid Materials with a Push-Rod Dilatometer
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

Performance Standards – Water Resistance

ASTM E 331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
AAMA 501.1	Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
AAMA 501.2	Quality Assurance and Water Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems
AAMA 508	Voluntary Test Method and Specification for Pressure Equalized Rainscreen Wall Cladding Systems
AAMA 509	Voluntary Test and Classification Method for Drained and Back Ventilated Rain Screen Wall Cladding Systems

Performance Standards – Finishes

AAMA 611	Specification for Anodized Architectural Aluminum
AAMA 2604	Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
AAMA 2605	Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
ASTM D 822	Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D 968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems

ASTM D 1735	Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
ASTM D 2244	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	Standard Test Methods for Rating Adhesion by Tape Test
ASTM D 3363	Standard Test Method for Film Hardness by Pencil Test
ASTM D 4145	Standard Test Method for Coating Flexibility of Prepainted Sheet
ASTM D 4212	Standard Test Method for Viscosity by Dip-Type Viscosity Cups
ASTM D 4214	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

1.6. Properties of Declared Product as Delivered

ACM panels are delivered and installed in a variety of sizes and configurations customized to the project's needs. This EPD is representative of the ACM panels produced by MCA members. Technical properties of the ACM panels under study is shown in Table 2.

Table 2. Product properties.

NAME	VALUE	UNIT
Length	2.4-6	m
Width	1-1.6	m
Thickness	4	mm (nominal)
Weight per area	7.0-7.8	kg/m²
Tensile Strength	48-55	MPa
Modulus of Elasticity	20,000-40,000	MPa

1.7. Material Composition

ACM panels are comprised of two aluminum skins laminated to either side of a mineral-filled thermoplastic core. Mass specifications of the base materials inside the panels is listed in Table 3.

Table 3. Base material mass by percentage for ACM panels, weighted average.

COMPONENT	MATERIAL	MASS COMPOSITION (%)
Face Sheets	Aluminum alloys	50
Core Material	Fire-retardant composite core	50

1.8. Manufacturing

ACM panels are formed by bonding two aluminum sheets to an extruded mineral-filled thermoplastic core positioned between them. The manufacturing process uses controlled temperature, pressure, and tension to produce a durable and stable metal composite panel. Manufacturing is generally a two-stage process. First, aluminum skin materials are painted in a continuous coating process. The coils are stocked until needed, then bonded to a core in a continuous process to create a composite assembly.

Continuous Aluminum Coil Coating

1. Aluminum coil is continuously unwound into the process from a pay-off reel. A coil stitcher mechanically notches two coils together, allowing for continuous production. The aluminum then travels through an accumulator tower and onto the finish coaters.
2. The finish coaters apply a layer of paint, which is then cured in ovens and subsequently cooled. This process is repeated for each required paint layer.
3. The painted aluminum passes through an exit accumulator tower and then rewound on a re-coiler. The painted aluminum coil is now ready for the lamination process.

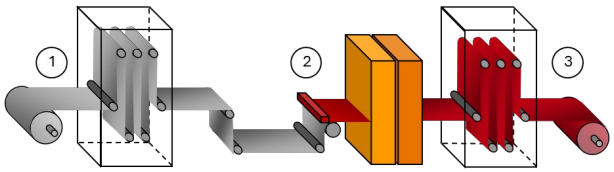


Figure 2. Continuous Coil Coating process

Finally, the ACM is finished with a primer system on both sides and a color coat on the outward-facing side to protect and beautify the aluminum skin. Some finishes also have an additional clear coat to enhance and preserve a special effect, such as a metallic or prismatic look. Another option is to brush, polish or anodize the aluminum surface itself to protect the resulting effect with a clear coat.

Continuous Lamination Process

1. The metal coils are introduced into the process from two pay-off reels.
2. The laminating rollers bond the metal to the continuously extruded thermoplastic core.
3. The laminated material then enters the cooling chamber and is constantly moved at a steady rate by the pulling rollers.
4. A protective masking film is applied to the ACM to protect the surface finish.
5. The ACM is trimmed to the required width, sheared to the required length, and stacked for inspection and final packaging.

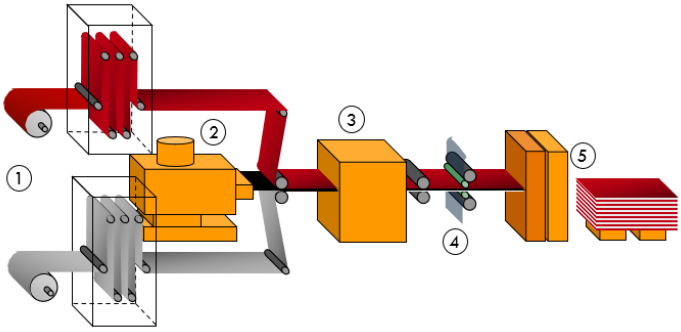


Figure 3. Continuous Lamination Process

1.9. Packaging

Packaging applied during the ACM panel manufacturing stage includes a protective film applied to the finish after manufacturing. Panels are then packaged in crates with oriented strand board sides and tops and wrapped with plastic banding for transportation to a fabricator.

1.10. Fabrication

At the fabricator, panels are cut to finished size/orientation, shaped and styled as required by project specifications, and fitted with the required anchors and panel stiffeners as required by the panel system design. This transforms them into a panelized system for easy installation. The finished cladding panels are repackaged for delivery using cardboard, additional plastic wrapping, and protective materials. All packaging materials used up to the factory gate are included in the LCA model under module A3.

1.11. Transportation

Average weighted distances and modes of transportation are included for the inbound transportation of raw materials, operating materials, and auxiliary materials to each ACM manufacturing and fabrication facility. Outbound transportation for external waste treatment has also been included.

1.12. Industry Average

This declaration represents a production-weighted industry average for ACM products manufactured by 3 different participating MCA member organizations at 3 manufacturing facilities in North America, as identified in Table 4. The declaration is intended to represent ACM products within the scope defined in this EPD and should not be used to represent products with substantially different material compositions, manufacturing technologies, or geographic production locations. The MCA has independently confirmed that the participating manufacturers represent more than 50% of the annual production volume for the ACM/MCM industry in North America. The median reference flow corresponds to 100 m^2 of ACM panel. Variability between manufacturers is primarily driven by aluminum source, core material type, coating specifications, facility scale, and regional electricity grid mixes.

Table 4: Manufacturers, manufacturing location and areal mass.

COMPANY	MANUFACTURING LOCATION	ACM
Alfrex	Buford, GA	784 kg/100m^2
Alpolic	Chesapeake, VA	749 kg/100m^2
3A Composite	Davidson, NC	686 kg/100m^2

2. Life Cycle Assessment Background Information

2.1. Functional or Declared Unit

The declared unit is coverage of 100 square meters (1076 square feet) with metal product. The coverage area refers to the flat, projected surface area of the product as measured after the final manufacturing step and does not include material losses from overlap and scrap during installation.

Table 5: Reference flow of ACM panels, weighted average basis.

NAME	ACM PANELS
Declared Unit [m^2]	100
Product mass [kg / 100 m^2]	712

2.2. System Boundary

This EPD is “cradle-to-gate” covering the production stage (modules A1 to A3). This includes raw material extraction and upstream processing, secondary material processing, inbound transportation, manufacturing and fabrication. The construction stage (modules A4 to A5), use stage (modules B1 to B7), and end-of-life stage (modules C1 to C4) are not included in this study.

Capital goods and infrastructure flows are excluded from this analysis due to the minimal extent to which they affect the LCIA results. The manufacturing of ACM panels, capital goods, and infrastructure last for 20 to 35 years with periodic replacement of key components identified during routine maintenance and predictive failure modeling. All other impacts associated with the use stage of the building while the product is being produced and all human labor and commute have also been excluded.

2.3. Estimates and Assumptions

This study is based on primary data collected from MCA member company facilities. Background datasets that are based on regional averages are used to represent the production of raw and auxiliary materials by upstream suppliers. When multiple datasets were available, a conservative approach was adopted where a dataset with the higher environmental impact was used.

2.4. Cut-off Criteria

The cut-off approach was adopted in the case of any post-consumer and post-industrial recycled content, which was assumed to enter the system burden-free. Only environmental impacts from the point of recovery and forward (e.g., inbound transport, remelting, subsequent processing, etc.) are considered. Additionally, the cut-off approach was applied to manufacturing (pre-consumer) scrap sent to external recycling. Transport of manufacturing scrap to the point of recovery is included, but no impacts are assigned to the recycling processes or future use of the material.

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

1. **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.
2. **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.
3. **Environmental relevance** – If a flow meets the above criteria for exclusion yet is thought to potentially have a significant environmental impact, it was included. Material flows which leave the system (emissions) and whose environmental impact is greater than 1% of the whole impact of an impact category that has been considered in the assessment must be covered. This judgment was made based on experience and documented as necessary.

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

Capital goods and infrastructure to produce ACM panels have also been excluded as they produce millions of units over the course of their life, so the impact on a single declared unit is minimal.

2.5. Data Sources

The LCA model was created using the LCA for Experts (LCA FE) software v10.9 system for life cycle engineering, developed by Sphera (Sphera, 2025). Background life cycle inventory data for raw materials and processes were obtained from the Sphera MLC 2025.2 database (CUP 2025.2). Primary manufacturing data was provided by ACM manufacturers who are MCA members.

2.6. Data Quality

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

Temporal coverage

Primary data is taken from the 2023 calendar year of continuous operation. These data were then used to calculate the weighted average production of MCA members. All secondary data were from Sphera's MLC 2025.2 data bases and are representative of the years 2011 – 2023. For OSB, the most recent LCI datasets are CORRIM 2011, specific to packaging applications. Alternative non-industry datasets were not used as proxies, as the environmental profile of this material is not expected to differ significantly in ways that would materially affect the study results.

Geographical coverage

Primary data for this study is based on site-specific data collected from MCA members' manufacturing facilities. Regionally specific datasets were used to represent energy consumption. Proxy datasets were used as needed for raw material inputs to address the lack of data for a specific material or a specific geographical region. These proxy

datasets were chosen for their technological representativeness of the actual materials.

Technological coverage

Manufacturing data were collected directly from MCA members. To that end, data on material composition, manufacturing, and transport were provided as primary data by the MCA members. The raw material inputs were based on total production output, bill of materials, and recycled content composition. Waste, emissions, and energy use were based on measured and calculated data during the reference year.

2.7. Period under Review

This EPD intends to represent production in 2023.

2.8. Allocation

Multi-output allocation follows the requirements of ISO 14044, section 4.3.4.2 (ISO, 2006a; ISO, 2006b). When allocation becomes necessary during the data collection phase, the allocation rule most suitable for the respective process step was applied. Energy output was allocated based on production mass. Material and waste were allocated based on engineering knowledge to assign appropriate input and outputs to different types of ACM panels.

3. Life Cycle Assessment Results

The included and excluded life cycle stages are summarized in Table 6.

Table 6. Description of the system boundary modules

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

MND = Module not declared | x = Declared

3.1. Life Cycle Impact Assessment Results

Table 7 presents the cradle-to-gate LCIA results (modules A1-A3) for ACM panels, normalized to 100 m^2 of installed product. GWP values reported here exclude biogenic CO_2. Biogenic carbon flows, such as carbon stored in packaging

materials, are reported separately under BCRK in module A3.

Abiotic depletion potential (fossil fuels) is calculated using the CML 2001 method. The impact categories included in this EPD are considered sufficiently mature for inclusion in Type III environmental product declarations, while additional indicators continue to be developed. LCIA results are relative expressions of potential environmental impacts and do not predict actual impacts on category endpoints, exceedance of thresholds, or safety margins. Results presented in this EPD shall not be used as the sole basis for comparative assertions.

Table 7. North American Impact Assessment Results, Resource Use, Waste and Output Flows, and Carbon Emissions and Removals per 100 m^2 of metal cladding.

INDICATORS	UNITS	A1	A2	A3	TOTAL
Impact Categories					
Global Warming Potential (GWP 100), IPCC 2021, AR6	kg CO_2 eq	3.21E+03	2.21E+02	8.47E+02	4.28E+03
Ozone Depletion Potential (ODP)	kg CFC 11 eq	1.22E-08	1.47E-10	1.13E-08	2.36E-08
Eutrophication Potential, Freshwater ($EP_{freshwater}$)	kg P eq	8.50E-04	1.41E-04	4.68E-04	1.46E-03
Eutrophication Potential, Marine (EP_{marine})	kg N eq	4.05E+00	1.16E+00	1.15E+00	6.36E+00
Acidification Potential (AP)	kg SO_2 eq	1.24E+01	1.46E+00	1.42E+00	1.53E+01
Smog Formation Potential (SFP)	kg O_3 eq	1.48E+02	3.62E+01	3.25E+01	2.16E+02
Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources (ADP_{fossil})	MJ, LHV	4.18E+04	2.75E+03	1.16E+04	5.62E+04
Resource Use					
RPR_e: Renewable primary resources used as energy carrier	MJ	1.80E+04	1.47E+02	1.91E+03	2.00E+04
RPR_m: Renewable primary resources with energy content used as material	MJ	0.00E+00	0.00E+00	1.24E+02	1.24E+02
$NRPR_e$: Non-renewable primary resources used as energy carrier	MJ	3.87E+04	2.82E+03	1.35E+04	5.51E+04
$NRPR_m$: Non-renewable primary resources with energy content used as material	MJ	6.55E+03	0.00E+00	6.58E+02	7.21E+03
SM: Secondary materials	kg	2.11E+02	0.00E+00	7.58E-01	2.11E+02
RSF: Renewable secondary fuels	MJ	-	-	-	0.00E+00
NRSF: Non-renewable secondary fuels	MJ	-	-	-	0.00E+00
RE: Recovered energy	MJ	-	-	-	0.00E+00
FW: Use of net fresh water resources	m^3	4.43E+01	1.68E-01	1.92E+00	4.64E+01
Waste Categories and Output Flows					
HWD: Hazardous waste disposed (HWD)	kg	-	-	-	**0.00E+00**
NHWD: Non-hazardous waste disposed	kg	0.00E+00	0.00E+00	2.98E+01	**2.98E+01**

HLRW: High-level radioactive waste, conditioned, to final repository	kg	8.34E-04	3.15E-05	1.10E-03	**1.97E-03**
ILLRW: Intermediate- and low-level radioactive waste, conditioned, to final repository	kg	1.24E+00	2.65E-02	9.21E-01	**2.19E+00**
CRU: Components for re-use	kg	-	-	-	**0.00E+00**
MFR: Materials for recycling	kg	0.00E+00	0.00E+00	2.39E+02	**2.39E+02**
MER: Materials for energy recovery	kg	0.00E+00	0.00E+00	3.85E+00	**3.85E+00**
EEE: Recovered electrical energy exported from the product system	MJ	0.00E+00	0.00E+00	5.92E+00	**5.92E+00**
EET: Recovered thermal energy exported from the product system	MJ	0.00E+00	0.00E+00	1.98E+01	**1.98E+01**
Carbon Emissions and Removals					
BCRP: Biogenic carbon removal from product	kg	-	-	-	**0.00E+00**
BCEP: Biogenic carbon emission from product	kg	-	-	-	**0.00E+00**
BCRK: Biogenic carbon removal from packaging	kg	0.00E+00	0.00E+00	1.45E+01	**1.45E+01**
BCEK: Biogenic carbon emission from packaging	kg	-	-	-	**0.00E+00**
BCEW: Biogenic carbon emission from combustion of renewable waste used in production	kg	-	-	-	**0.00E+00**
CCE: Calcination carbon emissions	kg	-	-	-	**0.00E+00**
CCR: Carbonation carbon removal	kg	-	-	-	**0.00E+00**
CWNR: Carbon emission from combustion of non-renewable waste used in production	kg	-	-	-	**0.00E+00**

4. LCA Interpretation

Figure 4 presents the breakdown of LCIA results by life cycle modules A1 to A3 for ACMs. The LCA results indicate that A1 (raw material supply) has the largest environmental impact, accounting for nearly 75% of total GWP footprint. This is primarily due to the significant contribution from aluminum, which alone accounts for 59% of the GWP. The aluminum is sourced from four global regions, Japan, Korea, Europe, and North America, highlighting the global nature of the supply chain and its associated emissions. The manufacturing process (A3) and transport of raw materials (A2) contribute much less at 20% and 5%, respectively. Key contributors to the A3 stage include electricity use during ACM panel production (5%), transport of panels to the fabrication facility (5%), and natural gas consumption during manufacturing processes (5%).

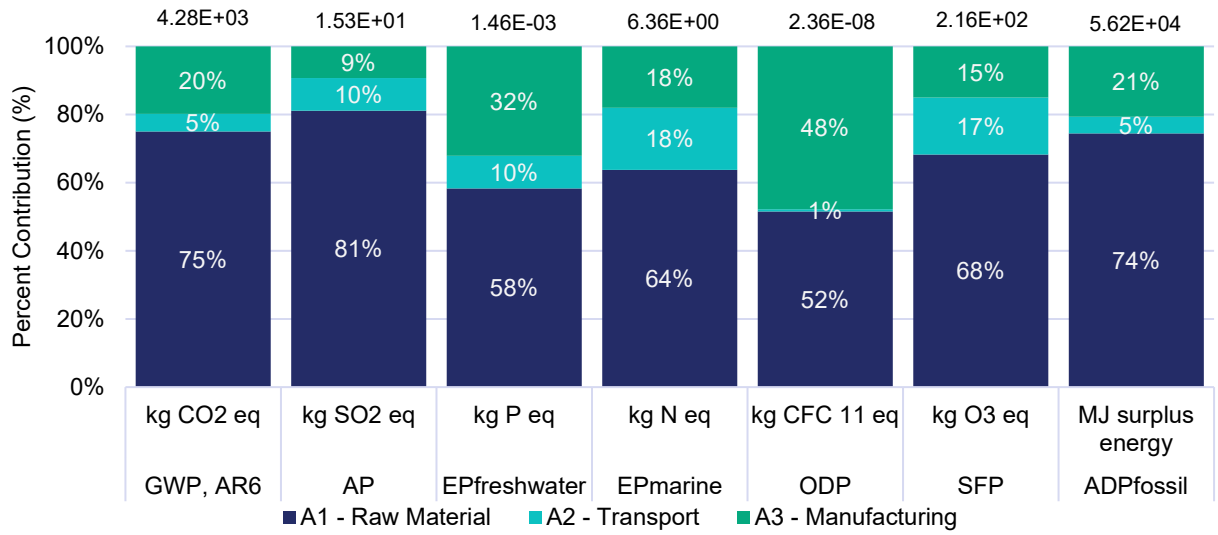


Figure 4. Contribution Analysis by Module of ACM Panels per 100 m^2 coverage (GWP100 results exclude biogenic CO_2).

5. Additional Environmental Information

5.1. Environment and Health During Manufacturing

The manufacturing process follows standard industry practices for worker health and environmental protection. Emissions and occupational exposures are managed in compliance with applicable health, safety, and environmental regulations. No substances required to be reported as hazardous are associated with the production of this product.

5.2. Extraordinary Effects

Fire

In a fire, the thermoplastic cores may combust, releasing heat, smoke and gases such as carbon monoxide and carbon dioxide. Therefore, most MCM cores include mineral fillers to reduce flammability. The metal face sheets may also help limit flame spread.

Effects of fire exposure varies by product configuration and installation. Fire performance is evaluated using standardized tests and criteria specified by the building code in effect at the project location. These tests are typically performed by independent laboratories using manufacturer-specific products and details. Therefore, performance data given in this document may not apply to all variants covered by this EPD.

Water

The product is not intended for prolonged submersion in water. Under extraordinary exposure (e.g., flooding), no hazardous substances, such as halogens or heavy metals, are expected to leach. The metal face sheets are corrosion-resistant under normal conditions.

Mechanical Destruction

In the event of mechanical destruction, the product may fracture or delaminate, exposing the core material. No hazardous substances are expected to be released. Fragments may include aluminum and thermoplastic residues, which should be handled in accordance with standard waste or demolition practices.

5.3. Delayed Emissions

No delayed emissions are expected during the use phase of the product. The materials used are stable under normal service conditions and do not release VOCs or other substances over time.

5.4. Environmental Activities and Certifications

This EPD represents an industry average product manufactured by multiple companies. Environmental and health-related certifications may vary by manufacturer and fabricator.

The following certifications may apply to some of the ACM products covered by this EPD:

- ISO 14001 – Environmental Management Systems
- UL GREENGUARD / GREENGUARD Gold – Low-emitting materials for indoor use
- LEED v4.1 Material Ingredient or EPD Credits
- LEED v5 MRp2 (Quantify and Assess Embodied Carbon), MRc2 (Reduce Embodied Carbon), and MRc4 (Building Product Selection and Procurement)
- Metal Construction Association Certified MCM System Fabricator

Details about these certification programs are available on the certifying bodies' websites. To verify which certifications apply to a specific ACM product or supplier, please contact the manufacturer or visit their website.

5.5. Further Information

More information can be found at www.metalconstruction.org

6. References

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UL Environment. (2018). *Product Category Rule Guidance for Building-Related Products and Services - Part B "Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels.*

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7. Contact Information

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