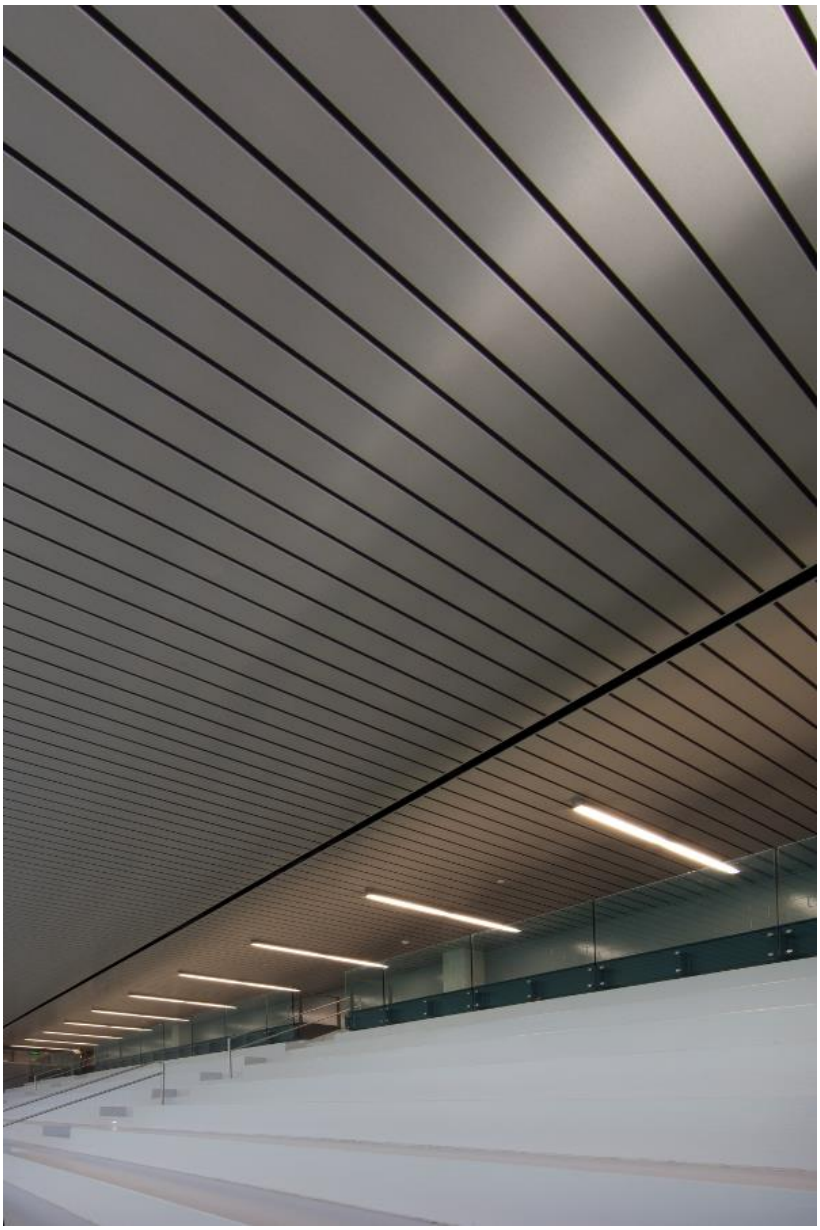
ENVIRONMENTAL PRODUCT DECLARATION

# ALUMINUM SPECIALTY PRODUCTS

AN INDUSTRY-AVERAGE ENVIRONMENTAL PROFILE



Aluminum specialty products include ceiling and wall systems, trims, and column covers.

CISCA
Ceilings & Interior Systems Construction Association

Increasing attention is paid to the environmental impact and sustainability of raw material sourcing, production, usage, and disposal of building products.

The Ceilings & Interior Systems Construction Association (CISCA) is the industry leading organization for metal specialty companies in the manufacture of aluminum and steel ceilings, walls, and associated specialty products in the building products segment.

In an effort to support and inform the market, CISCA pulled together its leading metal specialty building product member companies to provide industry-average EPDs covering metal specialty materials sold and installed in North America.

UL CERTIFIED
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# ENVIRONMENTAL PRODUCT DECLARATION

CISCA Ceilings & Interior Systems Construction Association

CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION ULCOM/EPD

**ALUMINUM SPECIALTY PRODUCTS**
AN INDUSTRY-WEIGHTED ENVIRONMENTAL PROFILE

**According to ISO 14025, EN 15804, and ISO 21930:2017**

| | |
|---|---|
| EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE | UL Environment 333 Pfingsten Road Northbrook, IL 60611 https://www.ul.com/ https://spot.ul.com |
| GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER | General Program Instructions v.2.1 2017 |
| MANUFACTURER NAME AND ADDRESS | Ceilings and Interior Systems Construction Association (CISCA) 1010 Jorie Blvd, Suite 30, Oak Brook, IL 60523 |
| DECLARATION NUMBER | 4789389053.101.1 |
| DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT | 1 kg of aluminum specialty products |
| REFERENCE PCR AND VERSION NUMBER | Part B: Metal ceiling and interior wall panel system EPD requirements, ed. 1, UL 10010-12 |
| DESCRIPTION OF PRODUCT APPLICATION/USE | Metal ceiling and wall systems, trims, and column covers |
| PRODUCT RSL DESCRIPTION (IF APPL.) | N/A |
| MARKETS OF APPLICABILITY | North America |
| DATE OF ISSUE | April 1, 2020 |
| PERIOD OF VALIDITY | 5 Years |
| EPD TYPE | Industry-average |
| RANGE OF DATASET VARIABILITY | Industry-average only |
| EPD SCOPE | Cradle to gate with options (installation and end-of-life) |
| YEAR(S) OF REPORTED PRIMARY DATA | 2018 |
| LCA SOFTWARE & VERSION NUMBER | GaBi ts 9.2.0 |
| LCI DATABASE(S) & VERSION NUMBER | GaBi 2019 (service pack 39) |
| LCIA METHODOLOGY & VERSION NUMBER | TRACI 2.1 |

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

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

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

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

# 1. Product Definition and Information

## 1.1. Description of Organization

The Ceilings and Interior Systems Construction Association (CISCA) is the global premier authority for the interior construction, acoustical ceilings and acoustical treatment industry. CISCA fosters and enables professional development and exchanges for and between association members and industry professionals. The organization's expertise is available 24/7/365 via diverse and state-of-the-art communication channels, interactive opportunities and regional and national events. Furthermore, CISCA is committed to identifying and addressing trends, diversity and growth of the industry and its participants.

The following CISCA members contributed to this declaration:

- Accent Ceilings and Walls www.accentceilings.com
- Armstrong Ceiling Solutions www.armstrongceilings.com
- CertainTeed Ceilings Corporation www.CTSpecialtyceilings.com
- Gordon, Inc. www.gordon-inc.com
- Lindner www.lindner-group.com
- Rockfon www.rockfon.com
- USG & USG Ceilings Plus, LLC www.usg.com

## 1.2. Product Description

**Product Identification**

This declaration represents an industry-average of aluminum specialty products, sold and installed in North America by CISCA members. These specialty products include ceiling and wall systems, extruded trims, brake-formed shapes, column covers, and acoustical treatments. This study does not include attachments to the structure or primary structural systems of the building (as per the Metal Ceilings product category rule (PCR) (UL Environment, Jan 2020)). Relevant product codes are as follows:

*Construction Specifications Institute*

- 05 75 30 Column covers
- 07 42 13 Metal wall panels
- 07 42 93 Metal soffit / ceiling panels
- 09 51 33 Acoustical metal pan ceilings
- 09 51 33 13 Acoustical snap-in metal pan ceilings
- 09 54 00 Specialty ceilings
- 09 54 05 Specialty ceilings
- 09 54 23 Linear metal ceilings
- 09 78 13 Metal interior wall paneling

*UNSPSC*

- 30161602 Ceiling panels

### Product Specification

Technical specifications are provided in Section 1.6 and product characteristics in Section 1.7.

### Flow Diagram

Aluminum specialty products are manufactured from metal coil or sheet. The metal is perforated and shaped to customer specifications. Depending on the application, the aluminum may be coated or laminated with additional materials. A manufacturing flow diagram is detailed in Figure 1.

## 1.3. Product Average

This EPD is intended to represent an industry-average for aluminum specialty products. Each member's production is scaled to 1 kg of product and weighted by the mass of product manufactured by that member to arrive at the industry average. CISCA represents the majority of the North American aluminum ceiling and wall specialty products industry. Use of this EPD is limited to CISCA member companies.

## 1.4. Application

The specialty products included in this declaration have a wide variety of applications. Common uses for metal specialty products include ceiling panels, wall coverings, and column coverings. Metal specialty products may be chosen for both durability and aesthetic reasons.

## 1.5. Material Composition

The material content of aluminum specialty products is based upon the material type and usage as reported by the CISCA member companies. Therefore, the materials listed in Table 1 do not represent any specific product, whether real or hypothetical, but rather an industry-average material composition across all aluminum specialty products covered by the declaration. The composition in Table 1 is specified by mass percentage.

**Table 1: Industry-weighted, average material composition**

| Component Description | Material | Mass % |
|---|---|---|
| Metal | Coated, cold-rolled aluminum | 44% |
| Metal | Extruded aluminum | 21% |
| Metal | Bare, cold-rolled aluminum | 30% |
| Metal | Anodized, cold-rolled aluminum | 3% |
| Metal | Laminated, cold-rolled aluminum | <1% |
| Acoustic fleece | Non-woven fabric | <1% |
| Insulation | Mineral wool | <1% |
| Insulation | Other | <1% |

No substances required to be reported as hazardous are associated with the production of this product. Furthermore, the products do not release dangerous or regulated substances that affect health or environment.

## 1.6. Technical Requirements

Typical standards to which metal specialty products conform are listed below.

- **ASCE 7-10:** Minimum Design Loads for Buildings and Other Structures
- **ASTM B209:** Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- **ASTM C423:** Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- **ASTM C635:** Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
- **ASTM C636:** Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
- **ASTM D1002:** Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
- **ASTM E1264:** Standard Classification for Acoustical Ceiling Products
- **ASTM E1477:** Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
- **ASTM E488:** Standard Test Methods for Strength of Anchors in Concrete Elements
- **ASTM E580:** Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
- **ASTM E84:** Standard Test Method for Surface Burning Characteristics of Building Materials
- **CISCA Metal Ceilings Technical Guidelines**

Ranges for construction data are provided detailed in Table 2. Other standards are either not applicable (e.g., those for radiant ceilings) or targeted at the European market. Additional details for specific products are available directly from the participating manufacturers.

**Table 2: Ranges for construction data for aluminum specialty products**

| | VALUE |
|---|---|
| Noise reduction coefficient (ASTM C423) | 0.65 to 0.95 |
| Average weight | 1.4 to 13 kg/m$^2$ |

### 1.7. Properties of Declared Product as Delivered

Due to the range of products covered by this declaration, it is not meaningful to declare a single dimensional or quantitative delivery status for aluminum specialty products. Common panel dimensions are provided in Table 3.

**Table 3: Common panel sizes for aluminum specialty products**

| | Panel Sizes |
|---|---|
| Common thicknesses (in.) | 0.020, 0.032, 0.040, 0.063, 0.090, 0.125, 0.188 |
| Common dimensions (in.) | 2, 4, 6, 8, 12-in. wide × 144-in. length<br>12 to 48-in. wide × 24 to 120-in. length |

## 2. Life Cycle Assessment Background Information

A “cradle-to-gate with options” life cycle assessment (LCA) was conducted for this EPD. The analysis was done according to UL’s product category rule (PCR) for metal ceilings (UL Environment, Jan 2020) and for building products (UL Environment, Dec 2018). The analysis follows LCA principles, requirements, and guidelines laid out in the ISO 14040/14044 standards (ISO, 2009) (ISO, 2006). EPDs of construction products may not be comparable if they do not comply with the same PCR or if they are from different programs.

While the intent of the PCR is to increase comparability, there may still be differences among EPDs that comply with the same PCR (e.g., due to differences in system boundaries, background data, etc.).

### 2.1. Declared Unit

The declared unit for this EPD is 1 kg of aluminum specialty product. Due to the participation of multiple manufacturers and the often-customized nature of the products, it is not meaningful to declare a reference panel that is representative of all participating manufacturers. Therefore, mass was chosen as the extensive property to normalize energy, materials, and impact assessment results.

### 2.2. Declared Unit Properties

The CISCA member companies were surveyed and a conversion from mass to area of sample panels of various thicknesses of aluminum is provided in Table 4. This is provided as a sample conversion, as the weight of aluminum specialty products can vary between 0.28 and 2.6 pounds per square foot.

**Table 4: Example conversions from mass to area**

| Example Panel Thickness (in.) | Sheet weight per sq. ft. ($lbs./ft^2$) | Sheet weight per sq. m ($kg/m^2$) | Area per 1 kg of product ($m^2$) |
|---|---|---|---|
| 0.020 | 0.28 | 1.4 | 0.73 |
| 0.032 | 0.45 | 2.2 | 0.46 |
| 0.040 | 0.56 | 2.7 | 0.36 |
| 0.063 | 0.88 | 4.3 | 0.23 |
| 0.090 | 1.3 | 6.2 | 0.16 |
| 0.125 | 1.8 | 8.6 | 0.12 |
| 0.188 | 2.6 | 13 | 0.078 |

## 2.3. System Boundary

A cradle-to-installation with end-of-life system boundary was used for the analysis. Within these boundaries the following stages were included:

- Product stage: modules A1 to A3
- Construction stage: modules A4 and A5
- End-of-life stage: modules C1 to C4
- Benefits and loads beyond system boundaries: module D

Each module includes provision of all relevant materials, products and energy. Impacts and aspects related to wastage (i.e. production, transport and waste processing and end-of-life stage of lost waste products and materials) are considered in the module in which the wastage occurs. The end-of-life stage module C1 is declared as having zero impact as deconstruction is done manually. Consequently, there are no direct emissions associated with this module.

Per the PCR, capital goods and infrastructure flows are assumed to not significantly affect LCA results or conclusions and thus excluded from the analysis.

## 2.4. Product-Specific Calculations for Use Phase

The product use stage is not considered. Therefore, this section is not relevant to this declaration.

## 2.5. Reference Service Life and Estimated Building Service Life

The product use stage is not considered. Therefore, this section is not relevant to this declaration.

## 2.6. Allocation

Most of the manufacturers included in this declaration produce steel specialty products in addition to aluminum specialty products. Therefore, onsite energy, emissions, waste, and process materials were allocated by approximate panel area for module A3. Area was selected in place of mass to avoid over-burdening steel products (as this material is almost three times as dense as aluminum) and as the ultimate intention of these products is to cover a specified area. Aluminum raw materials and scrap did not need to be allocated as these were tracked for aluminum specialty product manufacturing.

The net scrap approach was used for modeling manufacturing wastes and end-of-life. Metal scrap produced during the production module (A3) is accounted for as materials for recycling. To calculate results for module D, the net amount of scrap leaving the product system (i.e., outputs from manufacturing and end-of-life, minus inputs into raw material production) is first calculated. All relevant recycling operations, such as remelting of scrap, are accounted for within the model.

The energy recovered from the disposal of manufacturing waste (A3) and packaging waste (A5) are accounted for in exported energy.

### 2.7. Cut-off Criteria

All known mass and energy flows were included where possible. If matching life cycle inventories were not available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts. Capital equipment production and maintenance were excluded under the assumption that the impacts associated with these aspects are small enough to become irrelevant when scaled down to the declared unit.

### 2.8. Data Sources

The LCA model was created using the GaBi ts software system (v.9.2.0) for life cycle engineering, developed by Sphera. The GaBi 2019 databases provided the life cycle inventory data for upstream and downstream processes of the background system. Proxy data used in the LCA model were limited to background data for raw material production and coil coating. Background data specific to the manufacturer's location were used whenever possible, with other locations substituted as proxies when necessary.

### 2.9. Data Quality

Data quality and representativeness are considered to be good. Foreground data were collected from CISCA members' manufacturing facilities. The LCI data sets from the GaBi 2019 databases are widely distributed and used with the GaBi ts software. The datasets have been used in LCA models worldwide in industrial and scientific applications in internal as well as in many critically reviewed and published studies. In the process of providing these datasets, they are cross-checked with other databases and values from industry and science. All background data used in this model have reference years between 2009 and 2018 and are considered sufficiently representative of current activities.

### 2.10. Period under Review

Primary data from CISCA members represents 12 continuous months of production during the 2018 calendar year.

### 2.11. Comparability and Benchmarking

No comparisons or benchmarking is included in this EPD. LCA results across EPDs can be calculated with different background databases, modeling assumptions, geographic scope and time periods, all of which are valid and acceptable according to the Product Category Rules (PCR) and ISO standards. Comparisons of EPDs need to meet the requirements of ISO 21930, section 5.5.

### 2.12. Estimates and Assumptions

The analysis uses the following assumptions:

- Aluminum specialty products are represented by 1 kg of an industry average material composition specified in Table 1.
- Metal scrap produced during aluminum specialty product manufacturing is produced at the same quality as scrap into the up-stream material processes and can be modeled as closed-loop recycling. All relevant recycling operations, such as remelting of scrap, are accounted for within the model.

## 3. Life Cycle Assessment Scenarios

Scenario assumptions for modules A4 through D are provided in this section (see Table 5 to Table 8). Items that are excluded from these tables (c.f., PCR Part B: Metal Ceiling and Interior Wall Panel Systems EPD Requirements (UL Environment, Jan 2020)) are assumed to be zero. Furthermore, the use stage (modules B1 to B7) is not considered so the modules are not associated with any activity.

### 3.1. Manufacturing

There are two basic processes used by CISCA members for manufacturing metal specialty products, coil-coating and post-painting. The major difference is whether the metal coil is coated before the product is manufactured, or whether the product is painted after it is shaped. The two processes are depicted in Figure 1.

Manufacturers typically receive the metal for their products in the form of master coil or pre-slit master coil, as shown in Figure 1. In the case of coil-coating, as depicted on the left of Figure 1, the coil is sent directly to a third party for coil coating or is coated by the metal specialty product manufacturer. The coated coil is then cut to size and depending on the product, perforated and a non-woven, acoustic insulation fused to the back. Encapsulated fiberglass pads or recycled cotton pads may also be used instead of non-woven fabric. Then the metal panel may be roll-formed, bent, or shaped in other ways to match the product or customer specifications. Finally, the product is packaged for shipping.

The post-painting manufacturing process, shown on the right of Figure 1, has many of the same steps as the coil-coating process. The major difference is that the metal is coated after it is formed into a product rather than before.

### 3.2. Packaging

Packaging materials are considered as part of this declaration. The specific packaging materials depend on the manufacturer, but in general cardboard, wooden crates, steel banding, plastic banding, and plastic film were included based upon the industry-weighted average usage. The packaging materials are assumed to be disposed according to PCR guidelines. The impacts of this disposal are reported in the installation module (A5); credits from recycling and energy recovery are included in module D.


**Figure 1: Typical aluminum specialty product manufacturing process, coil-coating (left) & post-painting (right)**

## 3.3. Transportation

Average transportation distances via truck and rail are included for the transport of the raw materials to production facilities. Transport of the finished product 800 km via truck within North America to the construction site is accounted for. If products are manufactured outside North America, additional transportation via ship is included. Construction wastes and the deconstructed product at end-of-life are modeled as transported 200 km via truck to disposal facilities. Additional information on module A4 is provided in Table 5.

**Table 5. Transport to the building site (A4)**

| NAME | VALUE | UNIT |
|---|---|---|
| Fuel type | Diesel | |
| Liters of fuel | 35 | l/100km |
| Vehicle type | Truck (trailer) | |
| Transport distance | 800 | km |
| Capacity utilization (including empty runs, mass based) | 78 | % |
| Gross density of products transported | 2,700 | kg/m$^3$ |
| Capacity utilization volume factor | 1 | - |

## 3.4. Product Installation

Products are assumed to be manually installed. The installation stage includes the production and disposal of any installation waste, as well as the disposal of packaging. Per the PCR, 7% installation waste is assumed and packaging

material fates are aligned with recommended assumptions.

The products covered under this declaration vary. As such, no information on environmental impact mitigation measures during installation is provided here.

**Table 6. Installation into the building (A5)**

| NAME | VALUE | UNIT |
|---|---|---|
| Product loss per functional unit | 0.07 | kg |
| Waste materials at the construction site before waste processing, generated by product installation | 0.45 | kg |
| Biogenic carbon contained in packaging | 0.54 | kg $CO_2$ |

## 3.5. Use

Due to the wide range of applications for metal specialty products, the use stage (B1-B7) is not considered for this declaration. Therefore, no conditions of use, environmental and health effects during use, and reference service life considerations have been made.

## 3.6. Disposal

**Table 7. End of life (C1-C4)**

| NAME | | VALUE | UNIT |
|---|---|---|---|
| Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation) | | | |
| Collection process (specified by type) | Collected separately | 1 | kg |
| | Collected with mixed construction waste | 0 | kg |
| Recovery (specified by type) | Reuse | 0 | kg |
| | Recycling | 0.85 | kg |
| | Landfill | 0.15 | kg |
| | Incineration | 0 | kg |
| | Incineration with energy recovery | 0 | kg |
| | Energy conversion efficiency rate | n/a | |
| Disposal (specified by type) | Product or material for final deposition | 1 | kg |
| Removals of biogenic carbon (excluding packaging) | | 0 | kg $CO_2$ |

### 3.7. Re-use Phase

Aluminum specialty products are mostly metal and can be recycled once they reach the end of their useful lifetime.

**Table 8. Reuse, recovery and/or recycling potentials (D), relevant scenario information**

| NAME | VALUE | UNIT |
|---|---|---|
| Net energy benefit from energy recovery from waste treatment declared as exported energy in C3 (R>0.6) | 0 | MJ |
| Net energy benefit from thermal energy due to treatment of waste declared as exported energy in C4 (R<0.6) | 0 | MJ |
| Net energy benefit from material flow declared in C3 for energy recovery | 0 | MJ |
| Process and conversion efficiencies | n/a | |
| Further assumptions for scenario development (e.g. further processing technologies, assumptions on correction factors) | Recovery of aluminum | |

## 4. Life Cycle Assessment Results

**Table 9. Description of the system boundary modules. X = included in EPD scope; MND = module not declared (i.e., excluded from EPD scope)**

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

Life cycle impact assessment and other results for 1 kg of aluminum specialty product are presented in Table 10 to Table 12. Per the PCR, impact assessment results are based upon the US EPA TRACI 2.1 Tool for the Reduction and Assessment of Chemical and other environmental Impacts. Results are shown for a cradle-to-installation with end-of-life system boundary. Module C1 is not associated with any impact. It is therefore declared as zero and excluded from the tables below.

Biogenic carbon is not reported in global warming potential (GWP) as metal ceiling products do not typically contain bio-based materials. As such, biogenic carbon dioxide emissions and removals are not declared.

## 4.1. Life Cycle Impact Assessment Results

**Table 10. North American Impact Assessment Results**

| TRACI v2.1 | A1-A3 | A4 | A5 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|
| Global warming potential, GWP 100 [kg $CO_2$ eq] | 8.83E+00 | 1.10E-01 | 8.35E-01 | 1.99E-02 | 0.00E+00 | 6.71E-03 | -2.85E+00 |
| Ozone depletion potential, ODP [kg CFC-11 eq] | 3.96E-08 | 0.00E+00 | 2.77E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -1.27E-10 |
| Acidification potential, AP [kg $SO_2$ eq] | 4.48E-02 | 4.08E-04 | 3.97E-03 | 5.83E-05 | 0.00E+00 | 3.67E-05 | -1.87E-02 |
| Eutrophication potential, EP [kg N eq] | 1.17E-03 | 3.48E-05 | 1.67E-04 | 5.53E-06 | 0.00E+00 | 4.12E-06 | -3.16E-04 |
| Photochemical ozone creation potential, POCP [kg $O_3$ eq] | 4.21E-01 | 9.16E-03 | 3.40E-02 | 1.30E-03 | 0.00E+00 | 6.06E-04 | -1.46E-01 |
| Abiotic depletion potential (fossil), $ADP_{fossil}$ [MJ, surplus] | 9.33E+00 | 2.21E-01 | 6.99E-01 | 3.78E-02 | 0.00E+00 | 1.32E-02 | -1.76E+00 |

## 4.2. Life Cycle Inventory Results

**Table 11. Resource Use**

| PARAMETER | A1-A3 | A4 | A5 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|
| Renewable primary resources used as energy carrier (fuel) $RPR_E$ [MJ, LHV] | 3.28E+01 | 5.07E-02 | 2.31E+00 | 8.80E-03 | 0.00E+00 | 8.03E-03 | -1.78E+01 |
| Renewable primary resources with energy content used as material, $RPR_M$ [MJ, LHV] | 5.19E+00 | 0.00E+00 | 3.63E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Non-renewable primary resources used as energy carrier (fuel), $NRPR_E$ [MJ, LHV] | 1.06E+02 | 1.66E+00 | 7.81E+00 | 2.84E-01 | 0.00E+00 | 1.05E-01 | -2.72E+01 |
| Non-renewable primary resources with energy content used as material, $NRPR_M$ [MJ, LHV] | 9.51E-01 | 0.00E+00 | 6.66E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Secondary materials, SM [kg] | 7.12E-01 | 0.00E+00 | 4.98E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Renewable secondary fuels, RSF [MJ, LHV] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Non-renewable secondary fuels, NRSF [MJ, LHV] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Recovered energy, RE [MJ, LHV] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Fresh water, FW [$m^3$] | 2.25E-01 | 1.97E-04 | 1.59E-02 | 3.41E-05 | 0.00E+00 | 1.25E-05 | -7.77E-02 |

**Table 12. Output Flows and Waste Categories**

| PARAMETER | A1-A3 | A4 | A5 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|
| Hazardous waste disposed, HWD [kg] | 3.54E-03 | 1.33E-08 | 2.48E-04 | 2.30E-09 | 0.00E+00 | 3.69E-10 | -2.67E-04 |
| Non-hazardous waste disposed, NHWD [kg] | 1.89E+00 | 6.20E-05 | 3.51E-01 | 1.07E-05 | 0.00E+00 | 1.50E-01 | -9.00E-01 |
| High-level radioactive waste, HLRW [kg] | 2.74E-06 | 4.43E-09 | 1.95E-07 | 7.60E-10 | 0.00E+00 | 1.28E-09 | -4.00E-07 |
| Intermediate- & low-level radioactive waste, ILLRW [kg] | 2.21E-03 | 3.67E-06 | 1.57E-04 | 6.29E-07 | 0.00E+00 | 1.02E-06 | -3.17E-04 |
| Components for reuse, CRU [kg] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Materials for recycling, MR [kg] | 1.75E-01 | 0.00E+00 | 1.48E-01 | 0.00E+00 | 8.50E-01 | 0.00E+00 | 0.00E+00 |
| Materials for energy recovery, MER [kg] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Exported energy, electrical EEE [MJ, LHV] | 0.00E+00 | 0.00E+00 | 1.17E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Exported energy, thermal EET [MJ, LHV] | 0.00E+00 | 0.00E+00 | 5.18E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

## 5. LCA Interpretation

The raw material module (A1) is associated with the largest potential impact relative to the other modules across all impact categories. Aluminum production accounts for over 95% of raw material potential impact. Inbound transportation (A2) is almost negligible across all impact categories. For the manufacturing module (A3), energy usage—specifically electricity usage and fossil fuel combustion—is the primary driver of potential impact. The one exception is ozone depletion potential, for which corrugate production is the main driver due to background dataset choices (as the datasets do not fully account for the continuing phase-out of ozone-depleting emissions). Otherwise, the production of packaging materials is a key contributor to module A3 (although not as significant as for ozone depletion potential).

The installation module (A5) includes not only the disposal of packaging from installing 1 kg of product, but also the environmental impact associated with producing, transporting, and disposing (either to landfill or material recovery) 0.07 kg of installation scrap. At end-of-life, 85% of the product is assumed to be recycled and the remainder landfilled. Credits associated with scrap metal crossing the system boundary from modules A5 (installation) and C3 (waste processing) are presented in module D.

## 6. Additional Environmental Information

### 6.1. Environment and Health During Manufacturing

This represents an industry-average; therefore company-specific environmental and health practices are not included in this declaration.

### 6.2. Environment and Health During Installation

There should be no release of harmful substances or emissions during the installation and use of aluminum specialty products.

### 6.3. Extraordinary Effects

**Fire**

Fire performance for aluminum specialty products is determined in accordance with UL 723, NFPA 255, ASTM E-84, or ICC's IBC 803.1.1 standards. Manufacturer-specific details are not provided here but can be obtained from participating manufacturers.

**Water**

There are no known effects on the environment in the event of flooding or other water damage to the product.

**Mechanical Destruction**

There are no known effects on the environment in mechanical destruction.

## 7. References

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## 8. Contact Information

### 8.1. Study Commissioner

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