

ENVIRONMENTAL PRODUCT DECLARATION

ROLL FORMED STEEL PANELS

FOR ROOFS AND WALLS



The Metal Construction Association (MCA), Chicago, IL, is an organization of manufacturers and suppliers whose metal products are used in structures throughout the world. 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 metal's use.

MCA is a volunteer-led organization that works to eliminate barriers to using metal in construction through product performance testing, research, and monitoring and responding to codes and regulations that affect metal.

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.

Roll Formed Steel Panels are a major product category of MCA members. This Environmental Product Declaration for Roll Formed Steel Panels is one of several different product EPDs offered by MCA.

For more information visit

www.metalconstruction.org



ENVIRONMENTAL PRODUCT DECLARATION





Roll Formed Steel Panels Industry-Wide EPD

According to ISO 14025

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. 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, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.



PROGRAM OPERATOR	UL Environment	
DECLARATION HOLDER	Metal Construction Association (MCA)	
DECLARATION NUMBER	13CA56114.101.1	
DECLARED PRODUCT	Roll Formed Steel Panels	
REFERENCE PCR	Insulated Metal Panels & Metal Composite Panels, and Metal Cladding: Roof and Wall Panels (UL, October 2012)	
DATE OF ISSUE	February 5, 2014	
PERIOD OF VALIDITY	5 Years	
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications	
The PCR review was conducted by:		UL Environment Review Panel
		Thomas Gloria (Chairperson)
		35 Bracebridge Road Newton, MA 02459-1728 t.gloria@industrial-ecology.com
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories: <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL		 Wade Stout, UL Environment
		 Thomas Gloria, Life-Cycle Services, LLC
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:		





Description of organization and product

Organization Description

The Metal Construction Association (MCA), Chicago, IL, is an organization of manufacturers and suppliers whose metal products are used in structures throughout the world. 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 metal's use. 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 www.metalconstruction.org for more details.

Information in this document has been prepared by MCA technical staff and members of MCA's Roofing Council and its Wall Panel Council who are volunteers representing the leading manufacturers of metal products used in roof and wall applications. The product configurations offered herein use ranges representative of all types of roll formed metal panels based on specific products from the following MCA member manufacturers.



Since 1985, Drexel Metals has provided a full range of superior-quality engineered metal roofing systems, equipment and custom fabrication services for commercial, governmental, industrial, historical and architectural customers throughout the world. Headquartered in Louisville, KY, the company operates multiple sales, fabrication and distribution locations, in addition to its extended family of Regional Manufacturers (DM-ARM) network of authorized fabricators and certified contractors who further market Drexel Metals' proven-brand products, all fully backed and site certified by Drexel Metals' industry-leading warranty programs. Visit www.drexelmetals.com for more information.



Founded in 1967, Fabral is a widely recognized producer of metal roofing and wall panels for architectural, commercial, post frame, industrial, residential, transportation and agricultural applications. Fabral offers a wide variety of quality product offerings, advanced LEAN manufacturing processes and dedicated customer service values. In 1997, Fabral joined Euramax International, Inc., a producer of aluminum, steel, vinyl, copper and fiberglass products for original equipment manufacturers, distributors, contractors and home centers in North America and Western Europe. Visit www.fabral.com for more information.



Firestone Building Products is a leading manufacturer and supplier of a comprehensive "Roots to Rooftops" portfolio of products for commercial building performance solutions. By considering the entire building envelope, Firestone tailors solutions to individual customer and project needs for roofing, wall and landscape and lining systems. Headquartered in Indianapolis, IN., the company also offers outstanding technical services, an international network of roofing and wall contractors, distributors and field sales representatives, and superior warranty protection. Products include metal wall panels, insulation, cavity wall construction, commercial roofing systems, roofing accessories, green roofing, PV and daylighting systems, vegetative roofing systems, pond liners, geomembranes and stormwater management solutions. For more information visit www.firestonebpco.com.



ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels Industry-Wide EPD

According to ISO 14025



MBCI, an NCI company, is the leading manufacturer of metal roof and wall systems in North America. Its metal product solutions include insulated metal panel systems as well as the single skin metal panel roof and wall systems covered by this EPD. Originally founded in 1976, MBCI became a member of the NCI Building Systems family of companies in 1998. Thus, not only is MBCI the largest metal component manufacturer in the US, it also produces the metal components used by all of NCI building companies internally. With facilities strategically located across the United States and Canada coupled with the robust IAS AC472 accredited Quality Control program, MBCI has the capabilities of meeting all types of roof and wall metal cladding needs wherever they may be. For more information, visit www.mbc.com.



For over 40 years, Petersen Aluminum Elk Grove Village, IL has been a leading provider of architectural metal products. PAC-CLAD products provide unmatched aesthetics, performance and sustainability to any project. Where possible, Petersen products include a high percentage of recycled material. Additionally, these products offer a long life span, and at the end of their extended service life, are 100% recyclable. Most of the PAC-CLAD colors meet LEED®, ENERGY STAR® and cool roof certification requirements. For more information visit www.pac-clad.com or www.pacgreeninfo.com for the most current information on sustainable cool metal roofing.

Product Benefits

For decades roll-formed metal wall and roof panels have served building owners and architects as one of the best combinations of economy, service and design. The reasons are many. They offer a wide selection of profiles and a multitude of design options. Preformed metal wall panels are manufactured from a variety of metals, including steel, aluminum, copper and zinc. Ongoing development of coating technology continues to provide longer life spans for the metal panels, making them particularly a key part of mainstream commercial building design.



Color and finish options allow creative wall and roof designs while ensuring long-lasting performance.



Roll formed panels are custom made to fit the needs of the project such as this fire station in Florida.

ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels Industry-Wide EPD

According to ISO 14025



School systems choose roll formed steel panels for their long-term durability, ease of installation and low maintenance.



Metal wall panels provide high durability and aesthetic appeal to meet limited budgets for state universities.



Roll formed panels fulfill unique design needs in this transportation hub.



Corporate and light industrial facilities benefit from various design options with roll formed wall panels.



Metal panels offer economy, service and many design options for all sizes and types of projects.



This fine arts academy in Austin, TX created a dramatic look with silver panels installed in an alternating pattern.





Product Description

Panels are custom roll formed from coils of steel or natural metals to fit a variety of roof and wall applications. The panels can be factory-formed (Figure 1) or formed on the jobsite using a mobile roll former (Figure 2) or a combination of both. The metal panels offer long-term durability and come in a multitude of colors and finishes to allow for unlimited design options.

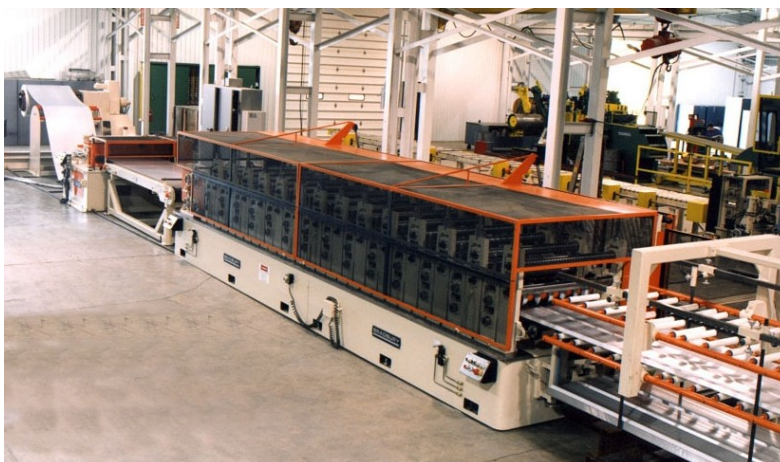


Photo Courtesy of The Bradbury Co. Inc.

Figure 1: Inline Roll Former



Figure 2: Mobile Roll Former

ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels Industry-Wide EPD

According to ISO 14025

Steel coils can be formed into a variety of profiles and sizes depending on needs of the project.

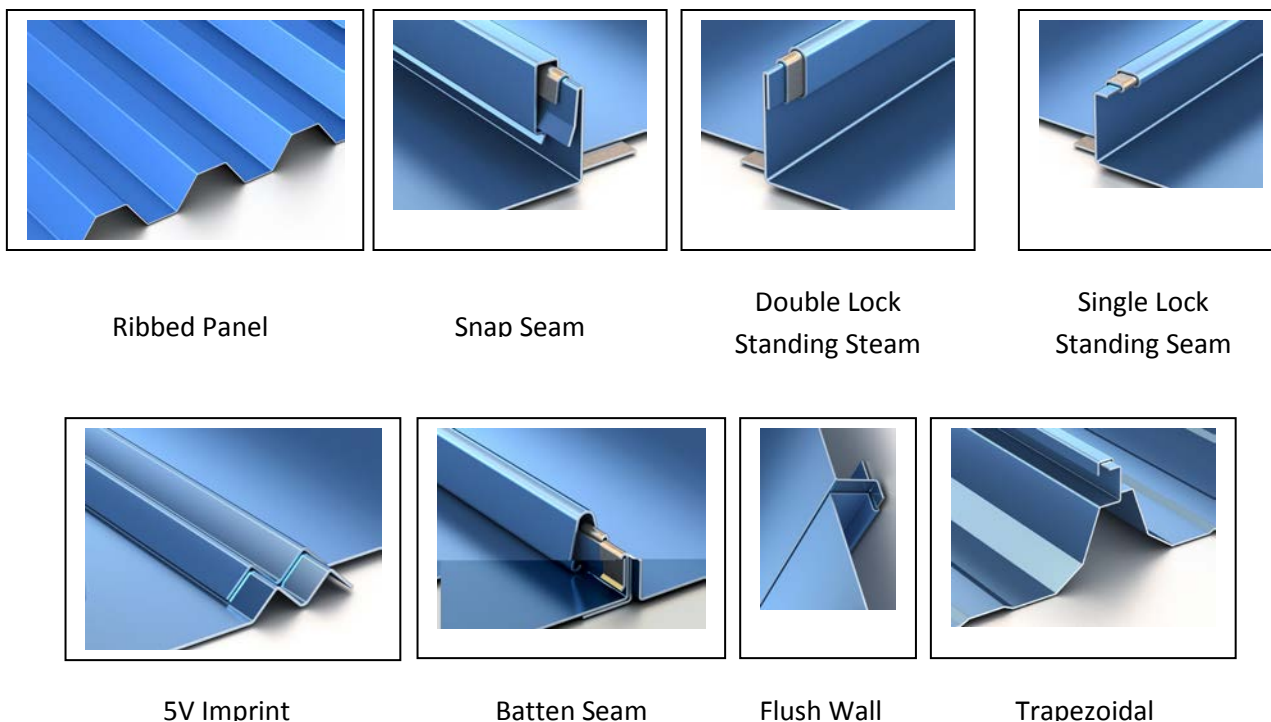


Figure 3: Images representing the range of formability

Materials

The LCA results in this document represent a steel panel, however, panels can be manufactured using aluminum or stainless and a variety of natural metals such as copper and zinc. Panel edges are roll formed to create interlocking side joints, which accommodate the concealed fastener and clip system and achieve the panel-to-panel seals. A variety of modules, profiles and side joints are available for metal roof systems. For example, side joints can be standing seam or overlapping. The width of the panel is referred to as the module and can typically range from 12 inches to 36 inches. The panel thickness range is 18, 20, 22, 24, 26, or 29 gauge. Profile depth range is 4 inches or less.

ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels
Industry-Wide EPD

According to ISO 14025

Raw materials/primary products

Component	Material	Availability	Origin	Mass (%)
Galvanized/ Galvalume coil	Steel coil, hot-dip coated	Fossil resource, limited	North America	100%

Table 1: Base material mass by percentage, MCA industry-average

Raw Material Extraction and Origin

Steel coil represents steel that has been hot-dip coated (e.g. zinc, aluminum-zinc coated) and rolled to 18, 20, 22, 24, 26 or 29 gauge thickness. The hot-dip coating provides corrosion protection and improved aesthetics before and after the roll forming process is applied. For aesthetic reasons, steel coil and aluminum substrates may be pre-painted using a continuous coil coating process whereby durable exterior primers and finish coats are applied to the metal surface. The mining location and transportation distances are not specified, as this EPD considered information from multiple organizations considered to be representative of the market. Weighted average of the upstream transportation of steel coil to the coil coating facilities is 128 miles. Following the coil coating process, the weighted average inbound transportation to rolled formed panel manufacturers is 110 miles.

In addition to steel coil, additional roll forming substrates may include aluminum, stainless steel, zinc or copper. Light striations, pencil-ribbing or stiffening beads may be applied to improve panel stiffness and/or reduce oil-canning. A smooth surface is typically standard and embossed surfaces may be available from some manufacturers.

Availability of Raw Materials

All raw materials are produced from fossil resources and thus of limited availability. Hot-dip coated steel coil production, however, consumes around 0.1 kg of scrap steel per kilogram of output.

Roll Forming Process

Roll forming is a continuous bending operation in which a strip of metal (typically coiled steel or aluminum) is passed through consecutive sets of rolls, or stands, each performing only an incremental part of the bend, until the desired cross-section profile is obtained. Roll forming is ideal for producing parts with long lengths or in large quantities with a minimum amount of handling as compared to other types of forming (i.e. press brake). A variety of cross-section profiles can be produced, but each profile requires a carefully crafted set of roll tools.

Producing the panels requires a five-stage process, as follows: The metal coils are introduced from an uncoiler (1). A flattener ensures an even, consistent surface for shaping (2). Any punching is done by presses prior to forming (3). The coil then enters a series of rolls designed to incrementally shape the steel sheet into the desired profile (4). Finally, the roll formed sheet is sheared to the required length, and stacked for inspection and final packaging (5).



ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels
Industry-Wide EPD

According to ISO 14025

Range of Applications

Steel panels are selected for use in a variety of roof and wall applications because of their long-term durability, low maintenance, and wide variety of color and finish options, and their ability to help improve energy efficiency, such as solar roof and wall systems, and rainscreen applications. Metal panels require less maintenance than other exterior systems and meet the most demanding performance requirements. Many designers and building owners also choose metal panels for their environmental value of having recycled content and being recyclable or reusable at the end of a building's useful life.

Banking	Hospitality
Commercial	Institutional
Healthcare	Light commercial and industrial
Municipal	Residential
Public venues, such as sports complexes, museums and convention centers	Retail
Religious	Schools and Universities
	Transportation

Table 2: Examples of the types of structures using steel panels for roofs and walls

Product Performance Data

- Performance Standards ROOFS and WALLS
- Latest Edition Governs Unless Noted

Substrate Performance

AISI S100 – North American Specification for the Design of Cold-Formed Steel Structural Members
Specifications for Aluminum Structures, the Aluminum Association

ASTM

- A463 - Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
- A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- A1063 - Standard Specification for Steel Sheet, Twin-Roll Cast, Zinc-Coated (Galvanized) by the Hot Dip Process
- A792 - Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
- A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip





Process

B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

Metal Roof Performance

ASTM

- B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus
- C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
- C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
- E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- E96 - Standard Test Methods for Water Vapor Transmission of Materials Specimen
- E2140 - Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head
- E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- E413 - Classification for Rating Sound Insulation
- E795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests
- E1514 - Specification for Structural Standing Seam Steel Roof Panel Systems
- E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
- E1637 - Specification for Structural Standing Seam Aluminum Roof Panel Systems
- E1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference
- E1680 - Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems

Metal Wall Performance

ASTM

- B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus
- C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
- C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation





- D1494- Standard Test Method for Diffuse Light Transmission Factor of Reinforced Plastics Panels
- E90 – Standard Test Method for Laboratory Measurement of Airborne Sound
- E96 – Standard Test Methods for Water Vapor Transmission of Materials
- E119 - Measurement Procedure for Noise Power Ratio
- E283- Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the
- E330- Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
- E413 - Classification for Rating Sound Insulation
- E795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests

Paint Finish Performance

ASTM

- D523 - Standard Test Method for Specular Gloss
- D968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
- D2244 -Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
- D2247 -Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
- D2794 -Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
- D4214 -Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

Fire Performance

ASTM

- E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- E119 - Standard Test Methods for Fire Tests of Building Construction and Materials
- E631 - Standard Terminology of Building Constructions

Model Codes or Standards

- International Building Code
- Local Building Code



ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels Industry-Wide EPD

According to ISO 14025

ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures
UL-Building Materials Directory
UL- Fire Resistance Directory
ASHRAE, TIMA –[Handbook of Fundamentals & Insulation Requirements]
SMACNA, [Architectural Sheet Metal Manual – Gutter design and flashing details]
(FS HH-I-521)(FS HH-I-558b)-[Fiberglass Insulation]
FS HH-I-1972)-([Insulation Board Thermal Faced, Polyurethane or Polyisocyanurate])
FMRC-Approval Guide
FMRC-Specification Tested Products Guide
ANSI B18.6.4 –[Steel Self-Tapping Screw Standard]
SAE J78 Self Drilling Tapping Screws
MCA Technical Bulletin, Fastener Selection Guidelines, 2008
AAMA 501-[Method of Test for Metal Curtain Walls]

Quality Control

Quality control is a major emphasis for all panel manufacturers. Some manufacturers have internal programs and others participate in third-party programs that validate the consistency of the processes involved in manufacturing these high quality products. All MCA member manufacturers work under the following guidelines:

Description	Tolerance
<u>Panel Length</u>	+/- 3/8 inches
<u>Panel End Squareness</u>	
Viewed from Panel Front (Measured across sheet)	0.5% of width and no more than 1/8 inch at one end
Viewed from Panel Side (Measured across sheet)	2% of panel depth and no more than 1/16 inch
<u>Camber</u> (Lateral bow of panel viewed from panel front)	3/16 inch per 10 feet length Accumulation allowed (e.g., 40 ft panel) Length maximum camber = 3/4 inch

Table 3: Allowable Fabrication Tolerances

References: MCA Specification Guideline: Preformed Metal Roof, 2004; MCA Specification Guideline: Preformed Metal Wall, 3rd edition, 2006; MCA Guide Specification for Residential Metal Roofing: 1995





Delivery Conditions and Properties

The delivery conditions can vary highly depending on the needs of the building structure and design. Panel width can range from approximately from 10 inches to 36 inches (0.25 meters to 1 meter, approximately). As characteristic of continuous production methods, panels can be sheared to the required length, but can range from 6 ft to 40 ft (2 meters to 12 meters, approximately).

Roll-formed metal panels can be produced with different skin metals, such as zinc, copper, and zinc. Steel, however, remains the predominant material.

Steel coil thickness can range from 29 gauge to 18 gauge. Thickness of the panels themselves can vary as well due to different corrugated profile designs.

Packaging



Figure 4: Metal roof and wall systems are generally transported by truck from the factory to a jobsite as shown in this picture. They can also be loaded into closed containers for transport by rail or ship.

Singular Effects

Key Product Standards

The following standards are provided as examples of standards which generally apply to all roll formed metal roof and wall panels. Individual manufacturers can provide specifics of which standards are applicable to their products.

Material Standards ROOFS

Latest Edition Governs Unless Noted

Substrate Performance

ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures

Specifications for Aluminum Structures, the Aluminum Association



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- A924- Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- B209- Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

Metal Roof Performance

ASTM

- B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus
- C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
- C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
- E90 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- E96 – Standard Test Methods for Water Vapor Transmission of Materials
- E330- Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- E413 - Classification for Rating Sound Insulation
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- E1646- Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference





E1680 - Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems

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Paint Finish Performance

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- D2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity





D2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

D4214 -Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

Fire Performance

ASTM

E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

E119 - Standard Test Methods for Fire Tests of Building Construction and Materials

E631 - Standard Terminology of Building Constructions

Model Codes or Standards

Local Building Code

ASCE Assignment of Authority and Responsibility for the Design of Steel Structures

UL-Building Materials Directory

UL- Fire Resistance Directory

ASHRAE, TIMA –[Handbook of Fundamentals & Insulation Requirements]

SMACNA, [Architectural Sheet Metal Manual – Gutter design and flashing details]

(FS HH-I-521)(FS HH-I-558b)-[Fiberglass Insulation]

FS HH-I-1972)-([Insulation Board Thermal Faced, Polyurethane or Polyisocyanurate])

FMRC-Approval Guide

FMRC-Specification Tested Products Guide

ANSI B18.6.4 –[Steel Self-Tapping Screw Standard]

SAE J78 Self Drilling Tapping Screws

MCA Technical Bulletin, Fastener Selection Guidelines, 2008

AAMA 501-[Method of Test for Metal Curtain Walls]

Thermal Effects

Thermal expansion or contraction of Roll Formed panels can occur in any direction on the panel and is always greatest





along the longest panel dimension. Roll Formed panels will thermally expand and contract according to their coefficient of thermal expansion. Metal roof and wall systems need to be designed to account for thermal movement of the panels.

Requirements for the Underlying Life Cycle Assessment

The LCA study and analysis were conducted according to the Product Category Rule (PCR) created by UL Environment for insulated metal panels, metal composite panels, and metal cladding, published on October 9, 2012 and valid through October 9, 2017.

Functional Unit/Reference Flow

The functional unit for this study is defined as “coverage of 93 square meters (1,000 square feet) 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.

To achieve the functional unit of 93 square meters (1,000 square feet) coverage, a reference flow of 577 kg is required for an industry-average roll formed metal cladding. Table 4 summarizes the key MCA primary products, substrates, and processes for which LCI data was collected from MCA member facilities.

Primary Product	Metal Substrate of Interest	MCA Primary Processes
Roll formed metal cladding	High performance coated 0.028" (24 gauge) steel coil	<ul style="list-style-type: none"> Continuous Coil Coating Roll forming

Table 4: Roll formed metal cladding, Key Metal Substrates and Processing

System Boundaries

The defined system boundary is a ‘cradle-to-gate’ LCA, which correlates to the Product Stage modules A1 – A3 as defined by EN 15804:

- A1 - Raw material supply
- A2 - Inbound transport of raw materials to manufacturing facility and transportation between steel coil coating and metal cladding manufacturing facilities
- A3 - Energy and water input at steel coating and metal cladding manufacturing facilities

A cradle-to-gate assessment excludes all impacts beyond the factory; thus, the reference service life (RSL) is not stated in the document. Figure 4 below illustrates the system boundary for the metal cladding product system.

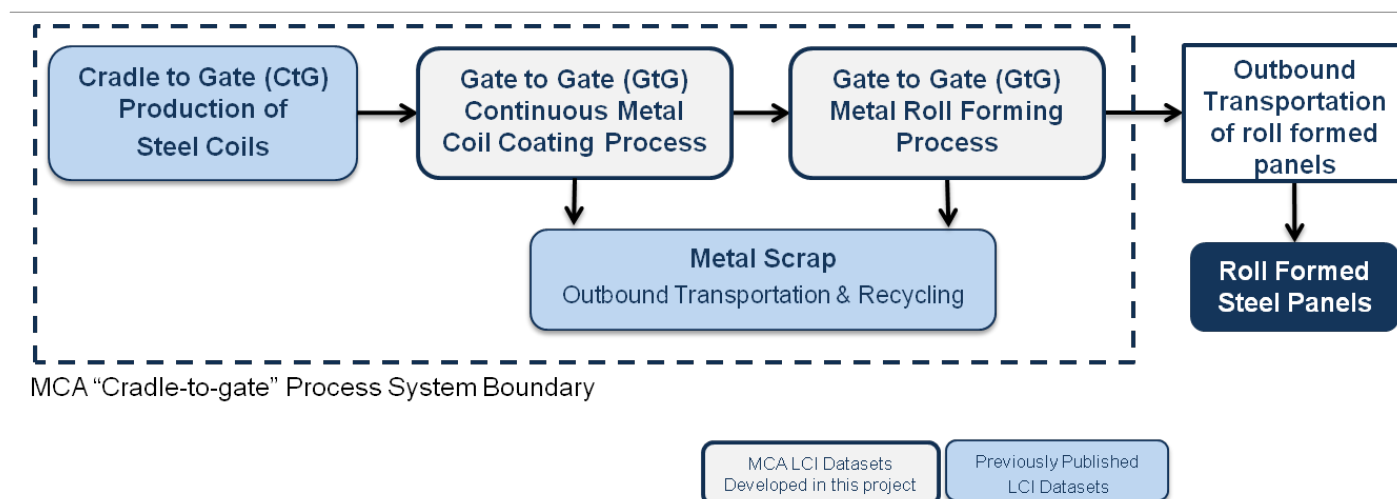


Figure 5: Cradle-to-Gate System Boundaries of roll formed metal cladding

Scope

The scoping stage considers all elements identified as contributing to the production of metal cladding products and then evaluated for their inclusion or exclusion from the LCA study. Table 5 summarizes the elements included and excluded from the cradle-to-gate system boundary for this study.

	Excluded
<ul style="list-style-type: none"> ✓ Extraction of input raw materials, transportation and production of the metal sheet used in the product ✓ Energy supply ✓ Overhead (heating, lighting) of manufacturing facilities ✓ In-bound transportation of all materials, intermediate products and fuels ✓ Operation of primary production equipment ✓ Operation of mobile support equipment ✓ Input water (for process and cooling) ✓ Waste and on-site waste water treatment ✓ Manufacture and transport of product packaging ✓ Process ancillary materials (e.g. fasteners) ✓ Waste & emissions ✓ Transportation & recycling of metal sheet scrap 	<ul style="list-style-type: none"> ✗ Maintenance and manufacture of fixed capital equipment ✗ Maintenance of mobile support equipment ✗ Outbound transportation of the main product/process output ✗ Hygiene related water use ✗ Employee commuting ✗ Human labor ✗ Installation and disposal of product

Table 5: System Boundaries Description for Cradle-to-Gate process

Temporal Scope

Primary data collected from MCA member companies for their operational activities are representative for the year 2010. Additional data necessary to model base material production and energy use, etc. was adopted from the GaBi 2011 databases.

Geographic Scope

The geographical coverage for this study is based on North American system boundaries for all processes and

ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels
Industry-Wide EPD

According to ISO 14025

products. Whenever North American background data was not readily available, European data was used as a proxy.

Background Data

The LCA model was created using the GaBi 4.4 Software system for life cycle engineering, developed by PE INTERNATIONAL AG. The GaBi 2011 LCI database provides the life cycle inventory data for several of the raw and process materials obtained from the background system. North American background data were used whenever possible; if such data were not available, European data were used as a proxy. The worldsteel North American average data were used for galvanized steel coil, with coil coating data obtained from the Metal Construction Association (MCA).

Life Cycle Assessment Results and Analysis

Cradle-to-gate life cycle impact assessment results are shown for both TRACI 2.0 and CML (November 2009) characterization factors. Due to the relative approach of LCA, which is based on a functional unit, these results are relative expressions only and do not predict impacts on category endpoints (such as Human Health or Ecosystem Quality), the exceeding of thresholds, safety margins, or risks.

With respect to global warming potential, no credit was given for the sequestration of biogenic carbon during the growth of biomass used in plant-derived packaging materials. Any carbon temporarily sequestered during the use of bio-based materials is assumed to be re-released to the atmosphere upon their decomposition. Since the life-time of plant-derived packaging materials is shorter than the 100 year time horizon of this impact category (GWP 100), biogenic carbon was excluded from the global warming potential calculations.

Total Environmental Impacts

TRACI 2.0 Impact Categories	Units	MCA Industry-average
Global warming potential (GWP100)	kg CO2-eq.	1,771
Ozone depletion potential (ODP)	kg CFC-11-eq.	4.70E-05
Acidification potential (AP)	kg H+ mol-eq.	383
Eutrophication potential (EP)	kg N-eq.	0.266
Smog formation potential (SFP)	kg O3-eq.	166
CML 2001 – November 2009		
Global warming potential (GWP100)	kg CO2-eq.	1,772
Ozone depletion potential (ODP)	kg CFC-11-eq.	9.29E-05
Acidification potential (AP)	kg SO2-eq.	6.93
Eutrophication potential (EP)	kg PO43--eq.	0.642
Photochemical oxidation potential (POCP)	kg C2H4-eq.	0.802
Abiotic depletion potential (ADP) – elements	kg Sb-eq.	0.0142
Abiotic depletion potential (ADP) – fossil fuels	MJ	19,900

Table 6: Total life cycle impacts of 93 square meters (1,000 sq ft) of roll formed cladding, TRACI 2.0 and CML 2001 (Nov 2009)

The chart below shows TRACI 2.0 impact categories by product stages A1 – A3. Two additional inventory metrics of primary energy demand, non-renewable (PED, non-ren.) and primary energy demand, renewable (PED, ren.) are included.



ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels Industry-Wide EPD

According to ISO 14025

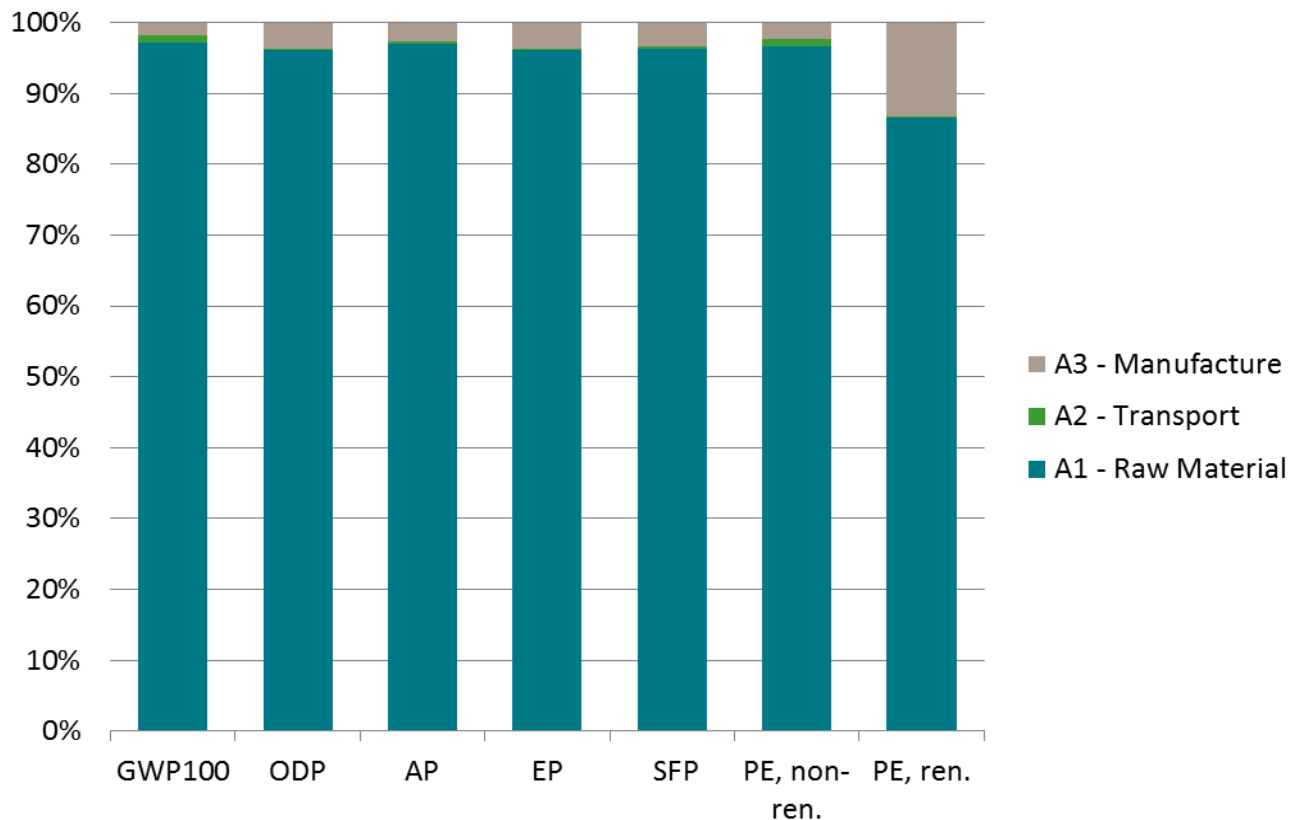


Figure 6: Total life cycle impacts of 93 square meters (1,000 sq ft) of metal cladding, TRACI 2.0 impacts and primary energy inventory

As described in the product description, steel coil can vary in thickness. Steel coil is assumed to be gauge 24 by default, however can range from 18 to 29 gauge. The effect of these thickness variations on the environmental indicators are shown below.

TRACI 2.0 Impact Categories	Unit	Steel gauge (24 Gauge default)					
		29 Gauge	26 Gauge	24 Gauge	22 Gauge	20 Gauge	18 Gauge
Global warming potential	kg CO ₂ -eq.	1,120	1,410	1,771	2,130	2,480	3,200
Ozone depletion potential	kg CFC11-eq.	4.32E-05	4.49E-05	4.70E-05	4.91E-05	5.11E-05	5.53E-05
Acidification potential	kg H ⁺ mol-eq.	241	305	383	461	539	694
Eutrophication potential	kg N-eq.	0.168	0.212	0.266	0.319	0.373	0.479
Smog formation potential	kg O ₃ -eq.	73.2	92.9	116	140	164	211
Total Resource Use and Waste Outputs							
Primary Energy, Renewable	MJ	510	588	684	781	879	1070



ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels
Industry-Wide EPD

According to ISO 14025

Primary Energy, Non-renewable	MJ	14,000	17,600	21,800	26,100	30,400	39,000
Secondary Materials	kg	158	204	260	316	371	483
Water Use	m ³	39.6	42.5	46	49.5	52.9	59.9
Hazardous Waste	kg	7.1	9.05	11.4	13.7	16.1	20.7
Non-hazardous Waste	kg	3.4	4.33	5.43	6.54	7.65	9.86
Stockpile Goods	kg	2,250	2,850	3,570	4,290	5,020	6,460
Radioactive Waste	kg	0.229	0.269	0.316	0.363	0.411	0.505
Materials for Recovery	kg	13	16.7	21.1	25.5	29.9	38.7

Table 7: TRACI 2.0 impacts, resource use, and waste outputs of 93 square meters (1,000 sq ft) of metal cladding for different steel coil gauges

Energy and Material Resources

Primary energy resources, secondary material, and water use are presented below, subdivided by stages. Since no secondary fuels are associated with roll formed panel, this category is not shown.

Product Stages	Primary Energy Demand, Renewable [MJ]	Primary Energy Demand, Non-renewable [MJ]	Secondary Material [kg]	Water use [m ³]
Total	684	21,800	260	46
A1 – Raw Material	597	21,100	260	21
A2 – Transport	0.37	255	0	0.704
A3 - Manufacture	90.6	480	0	29.7

Table 8: Energy and materials resource use of 93 square meters (1,000 sq ft) of metal cladding

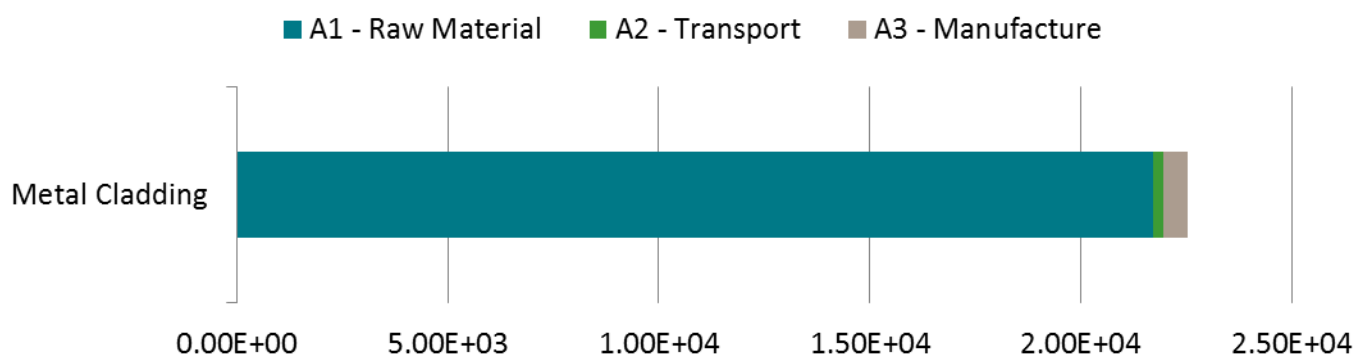


Figure 7: Total Primary Energy Demand by product stages A1 - A3

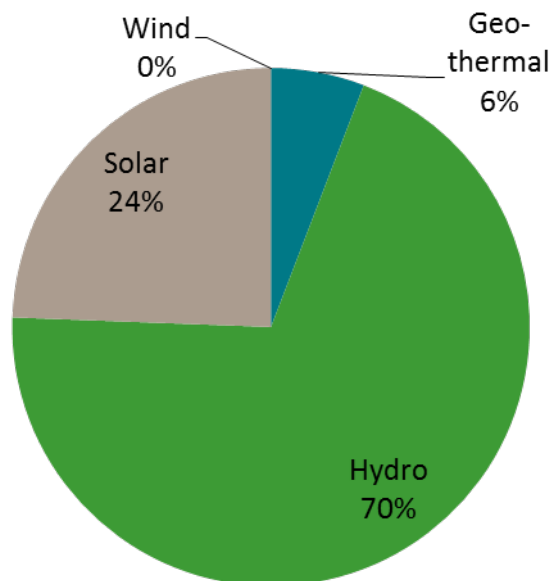


Figure 8: Renewable primary energy demand by fuel type

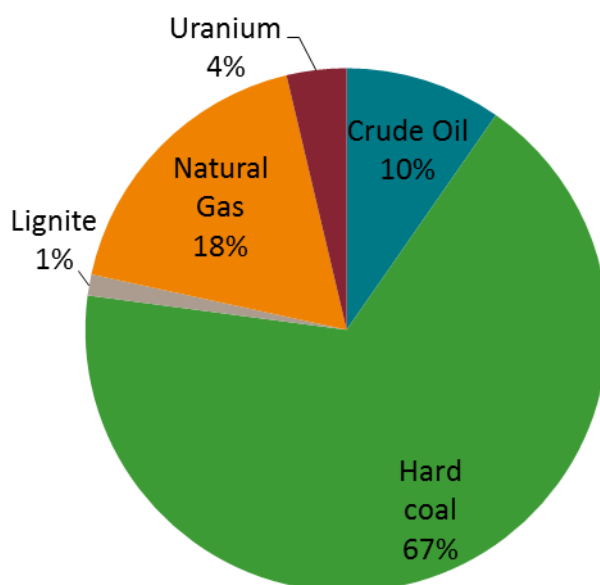


Figure 9: Non-renewable primary energy demand by fuel type

Renewable primary energy is also broken down into primary energy resources used as raw materials and primary energy resources excluding resources used as raw materials. Since consumption of renewable primary energy resources used as raw materials is exclusively due to packaging materials and takes place during raw materials supply, this category is not broken down by life cycle stage.

	Renewable primary energy used as raw materials [MJ]	Renewable primary energy, excluding those used as raw materials [MJ]	Renewable primary energy, total [MJ]
Roll formed cladding	131	553	684

Table 9: Total renewable energy used as raw material and as energy source

ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels
Industry-Wide EPD

According to ISO 14025

Waste and Output Flows

Additional environmental information, including hazardous, non-hazardous, and radioactive waste disposed; materials for recycling; and materials for energy recovery are shown below.

Since no reused components or exported energy are associated with a roll formed cladding's life cycle, these categories are excluded. Additionally, waste is assumed to be sent to landfill so no materials are available for energy recovery.

	MCA
Hazardous Waste [kg]	11.4
Non-Hazardous Waste [kg]	5.43
Stockpile goods [kg]	3,570
Radioactive Waste [kg]	0.316
Materials for Recovery [kg]	20.2

Table 10: Waste and output flows per functional unit

Interpretation

The above results represent a cradle-to-gate assessment of an industry-average profile of roll formed metal cladding produced by Metal Construction Association (MCA) member companies. The study was conducted for the declared unit of coverage of 93 square meters (1,000 square feet) with roll formed panels. Because of the cradle-to-gate system boundary (stages A1 – A3), impacts beyond manufacturing, such as delivery to construction site, installation, and disposal at the end of useful life, are not considered.

The global warming potential impact is dominated by stages A1 (materials) and A3 (manufacturing). In the raw material stage (A1), steel coil production is the major contributor at approximately 93% of the global warming impact of the cradle-to-gate system. Auxiliary material inputs, manufacturing process, and transportation comprise the additional 7%. The transportation stage (A2) included all known inbound transportation as well as delivery of coated steel coil to metal cladding manufacturing facilities. Delivery to the construction site is excluded in this EPD. The contribution to global warming from stage A2 is marginal (1%) and dominated by fuel combustion.

The manufacturing stage (A3) is a minor contributor to overall climate change impacts (2%). Electricity generation and natural gas combustion comprise the climate change impacts that originate at the manufacturing stage.

With respect to the other environmental indicators, raw materials dominate over 90%. Of the raw materials, North American steel comprise over 80% of the total impacts for all selected impacts other than ozone depletion. For ozone depletion, steel production is not the main contributor, but is significant nonetheless with 36% of the total impacts. Upstream emissions of halogenated compounds from raw materials comprise the majority of ozone depletion impacts (74%). Specifically, fluoropolymer, used in the coil coating process, is a significant contributor of the halogenated compound 1,1,1-Trichloroethane, which is a potent ozone-depleting substance



ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels
Industry-Wide EPD

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ENVIRONMENTAL PRODUCT DECLARATION



Roll Formed Steel Panels
Industry-Wide EPD

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