ENVIRONMENTAL PRODUCT DECLARATION

HOT-ROLLED ALUMINUM

INDUSTRY-AVERAGE HOT-ROLLED ALUMINUM
MANUFACTURED IN NORTH AMERICA

The Aluminum Association

The Aluminum Association and the aluminum industry are committed to responsible environmental stewardship. Aluminum is one of the most sustainable materials in use today:

- Strong and lightweight: Aluminum's favorable strength-to-weight ratio means it can be substituted for heavier materials, driving energy efficiency.
- Infinitely recyclable: Aluminum can be recycled over and over again without losing any of its fundamental properties.
- Efficiency Improvements: Through voluntary industry efforts, the North American aluminum industry has reduced the carbon footprint of primary aluminum production by 37 percent since 1995.
- Corrosion-resistant: Durable aluminum lasts longer than many competing materials, limiting the need for replacement.
- Highly recycled: Aluminum is one of the most recycled materials on the market today. And producing recycled aluminum takes just 8 percent of the energy needed to make primary aluminum.

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
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ENVIRONMENTAL PRODUCT DECLARATION

The Aluminum Association

Hot-Rolled Aluminum Semi-Fabrication
Products of Aluminum and Aluminum Alloys

According to ISO 14025 and EN 15804

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	The Aluminum Association
DECLARATION NUMBER	4786092064.103.1
DECLARED PRODUCT	Hot-Rolled Aluminum sheet or plate
REFERENCE PCR	Products of Aluminum and Aluminum Alloys (IBU, July 2012)
DATE OF ISSUE	October 16, 2014
PERIOD OF VALIDITY	5 years
EXTENSION PERIOD	2.5 Years-April 16, 2022
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:	The Independent Expert Committee
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	Wade Stout, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas Gloria, Industrial Ecology Consultants

This EPD conforms with EN 15804

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Hot-Rolled Aluminum
Products of Aluminum and Aluminum Alloys

According to ISO 14025

Product

Product Description

This EPD covers the production of hot-rolled aluminum plates and sheets, excluding aluminum foil. The results represent an average across all hot-rolled aluminum sheets and plates. The results represent an average across all hot-rolled aluminum sheets and plates manufactured in North America (United States and Canada). Averages are obtained through aggregating production-weighted data from the participating companies.

Applications

Hot-rolled aluminum is used in a variety of market sectors, including the following:

- Transportation: automobile components, truck and trailer components, train components, aircraft components, etc.
- Building, construction and infrastructure: building roofs, sidings, wall plates, furniture and decorations, bridge and stadium components, road and traffic signs, etc.
- Packaging: beverage containers
- Consumer durables: components of consumer durable goods, such as computers, home appliances, and recreation devices and utilities; .

Technical Data

Name	Value	Unit
Density	2.66-2.84	$(kg/m^3) \times 10^3$
Melting point (Typical)	475-655	°C
Electrical conductivity (Typical) at 20°C/at 68˚F	Equal Volume:16-36	MS/m (0.58*%IACS)
Thermal conductivity (Typical) at 25˚c/at 77˚F	113-234	W/(m.K)
Average Coefficient of thermal expansion (Typical) 20˚ to 100˚c /68° to 212°F	22.3-23.9	per ˚C
Modulus of elasticity (Typical)	69-73	$MPa \times 10^3$
Hardness (Typical)	19-150	HB
Yield strength (min)	15-485	MPa
Ultimate tensile strength (min)	55-550	Mpa
Breaking elongation (min) (50mm&4D)	>1	%
Chemical composition	Varying alloy by alloy, Al 87.17-99.6	% by mass

Application Rules

ASTM B209/B209M-10 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B928/B928M-13 Standard Specification for High Magnesium Aluminum-Alloy Sheet and Plate for Marine Service and Similar Environments

ASTM B632/B632M-08 Standard Specification for Aluminum-Alloy Rolled Tread Plate

ASTM B746/B746M-02(2012) Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches

Delivery Status

The output of hot rolling is hot-rolled coil (re-roll coil), sheet and plate, or intermediate rolling products (continuous casting products) transported to an end-use customer or to a cold rolling and finishing facility. The dimensions of the sheet and plate vary based on the product type and application.

Base and Ancillary Materials

Hot-rolled aluminum products made in North America contain a considerable proportion of metal recycled from aluminum scrap. The metal composition of products, based on metal feedstock information collected at the melting furnaces for rolling ingot production or subsequent rolling on-site, is shown below. Product shipped to different market sectors may vary significantly on its metal compositions. Recovered aluminum from internal process (run-around) scrap is considered as a repeated closed-loop manufacturing process and therefore is excluded from metal composition declaration. Definitions of Internal Process (Run-Around) Scrap, Post-Industrial Scrap and Post-Consumer Scrap are consistent with ISO 14021/25 (2006) on environmental labels and declarations, and the related interpretations by UL Environment.

Hot-rolled aluminum products may include various types of coatings, including anodized, painted, and laquered finishes. All coating materials are included in inventory, based on averages across the industry.

Category of Metal Source	Percentage (by mass)
Primary Aluminum (including alloy agents)	34
Recovered Aluminum from Other Post-Industrial Scrap	26
Recovered Metal from Post-Consumer Scrap	40

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According to ISO 14025

Manufacture

Typically aluminum is delivered to a hot-rolling facility as pre-cast aluminum ingots, scrap, or molten aluminum. The metal is then melted and cast, as necessary, into ingots to be rolled, or molten metal may be formed into sheets through a process called continous casting. Continous casting takes molten metal and solidifies it into a continous strip. Currently about 20% of the North American sheet and plate production is produced by continuous casting. It is worthwhile to note that continuous casting products can be either directly used for end-use purposes, or further rolled to produce thinner gauge products.

Direct chill cast aluminum ingots/slabs or continuous cast strips, while still hot, can be further treated and hot rolled. Or in other cases, completely chilled ingots or strips can be used for hot rolling but preheating must be done to heat the intermediates to a required temperature.

Hot rolling is the method of rolling metal at a temperature high enough to avoid strain-hardening (work-hardening) as the metal is deformed. The ingots are preheated to about 1000˚F and fed through a hot reversing mill. In the reversing mill, the coil passes back and forth between rolls and the thickness is reduced to 4 to 5 inches with a corresponding increase in length. This part of the hot rolling process is also called a Breakdown rolling process.

Following the reversing mills, the slabs are fed to a continuous hot mill where the thickness is further reduced. The metal, called re-roll or hot band, is edge trimmed and rolled into a coil and is ready to be transferred to the cold mill.

Environment and Health during Manufacturing

Air: Hazardous air emission releases comply with regulatory thresholds.

Water/soil: Pollutants in wastewater discharge comply with regulatory thresholds.

Noise: Due to adequate acoustical absorption and mitigation devices, measurements of sound levels have shown that all values inside and outside the production plant comply with regulatory thresholds.

Product Processing and Installation

Further processing and installation of hot-rolled aluminum depends on the final application of the product and is outside the scope of this EPD.

Packaging

Product delivery packaging includes wood, steel, paper board, and sometimes plastic wraps. Packaging is included in the scope of this EPD.

Condition of Use

No special conditions of use are relevant for this product under the scope of this EPD.

Environment and Health During Use

The environmental and health effects during use are dependent on the ultimate use of the hot-rolled aluminum and are outside the scope of this EPD. The following general statements are relevant for all aluminum products:

- Aluminum products are often made from both primary and recycled ingots
- There is no relevant chemical composition difference between primary and secondary ingots if both are governed by the same alloy designation and chemical composition limit standards
- The service life of the final product depends on its application, but is typically long due to aluminum's excellent corrosion resistance
- For that same reason, maintenance needs during use are usually low.

Reference Service Life

Service lifes for hot-rolled aluminum vary based on the application. This EPD does not cover the product use phase and therefore makes no specific claim as to a typical reference service life.

Extraordinary Effects

Fire: Aluminum products comply with all local and federal laws with respect to fire hazards and control.

Water: There is no evidence to suggest water runoff or exposure under normal and intended operation will violate general water quality standards.

Mechanical destruction: Not relevant for aluminum sheet and plate.

Recycling Phase

Aluminum is a highly recyclable material. During manufacturing, most process and new scrap are fed back into the production process. At the end of life, aluminum scrap is collected and sold to both secondary smelting and semi-fabrication companies. The recycling rate for aluminum scrap is assumed to be 95%. Recycling over 95% is typical for aluminum products in high volume automotive and construction market sectors (IAI 2013).

Post-industrial scrap is highly utilized within the aluminum industry. Most process and new scrap materials that occur in the manufacture and processing of hot-rolled are fed back into the production process.

Disposal

It is assumed that 5% of the cold-rolled aluminum products are sent to the landfill for disposal at the end of life. The European Waste Code for aluminum is 17 04 02.

Further Information

For further information on aluminum and aluminum products, please visit the Aluminum Association website: www.aluminum.org.

The life cycle assessment was conducted by PE INTERNATIONAL using GaBi data.

PE INTERNATIONAL
SUSTAINABILITY PERFORMANCE

Life Cycle Assessment

Declared Unit

The declared unit is the production and end-of-life treatment for one metric ton of hot-rolled aluminum. The results can be converted to one kilogram by dividing by 1000.

System Boundary

This is a “cradle-to-gate – with options” EPD. The following processes are considered in the product stages A1–A3 of the hot-rolled aluminum production:

- The provision of resources, additives and energy
- Transport of resources and additives to the production site
- Production process of hot-rolled aluminum on site, including energy, production of additives, disposal of production residues, consideration of related emissions, and recycling of production scrap (“closed loop”).

Product stages C4 and D are also included, with 95% of the hot-rolled product assumed to be recycled at the end-of-life, and 5% disposed of by landfilling. End-of-life recycling is accounted for using the avoided burden recycling methodology.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)																
PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport	Construction-installation process	Use	Maintenance	Repair	Replacement[1]	Refurbishment[1]	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X

Estimates and Assumptions

The LCA required only limited use of estimates and assumptions. The most relevant estimation/assumption is the end-of-life recycling rate of 95%, which is discussed in the *Recycling Phase* section. Averages and best-estimates were used to fill in minor data gaps, such as the source of ingots for some facilitites. Other estimates and assumptions are discussed in detail in the LCA background report.

Cut-off Criteria

Input: All material flows that enter the system and are over 1% of the product mass or contribute more than 1% to the primary energy consumption are included.

Output: All material flows that exit the system and whose environmental impact makes up more than 1% of the total impact in an impact category considered are included.

Background Data

In order to model the life cycle for the production of the hot-rolled aluminum, the GaBi 6 software system developed by PE INTERNATIONAL was used. All relevant background data necessary for the production of hot-rolled aluminum were taken from the GaBi 2012 databases or were made available by the Aluminum Association through industry survey results. Companies participating in the project, either with AA or AIA, are provided in the *Participating Companies* section.

Data Quality

The data is considered of high quality. Inventory data quality is judged by its precision (measured, calculated or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied on a study serving as a data source) and representativeness (geographical, temporal, and technological). To cover these requirements and to ensure reliable results, first-hand industry data in combination with consistent background life cycle inventories from the GaBi 2012 database were used.

The LCI data sets from the GaBi database are widely distributed and used with the GaBi 6 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.

Period under Review

Primary data collected from the participating companies and from their operational activities is representative for the year of 2010. Additional data necessary to model raw material production, energy generation, etc. were adopted from the GaBi 6.0 software system database.

During the survey, however, a small group of semi-fabrication facilities reported operational data for 2008, 2009, or 2011, depending on the time when they started to respond to the survey and the convenience of their data availability. This deviation from the defined reference year has been taken into account as it is being assumed that there are no radical changes in the technology and operational practice for semi-fabrications from the year 2008 to 2011.

Allocation

Allocation is used to address recycled content, post-production scrap, and waste at end-of-life. The avoided burden allocation approach was applied. Under this approach, end-of-life scrap is first balanced out with any open scrap inputs into production. Only the remaining *net scrap* is then modeled as being sent to material recycling in order to avoid double-counting the benefits of using recycled content. If more scrap is recovered at product end-of-life than is required in the manufacturing stage, the product system receives a credit equal to the burden of primary material production minus the burden of recycling scrap into secondary material based on the mass of secondary material produced. This credit represents the avoided burden of primary material production.

Comparability

A comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to EN 15804 and the building context, respectively the product-specific characteristics of performance are taken into account.

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Life Cycle Assessment: Results

Results given per one metric ton of hot-rolled aluminum.

ENVIRONMENTAL IMPACTS

CML 2001 (Nov 2010)

		Manufacturing	End-of-Life	Credits
Parameter	**Unit**	**A1-A3**	**C4**	**D**
GWP	kg CO_2 eq	3.93E+03	2.17E+00	-1.80E+03
ODP	kg CFC-11 eq	2.52E-07	2.50E-10	-7.58E-08
AP	kg SO_2 eq	2.34E+01	8.86E-03	-1.29E+01
EP	kg PO_4^3 eq	1.09E+00	8.03E-04	-5.33E-01
POCP	kg C_2H_4 eq	1.32E+00	1.00E-03	-6.45E-01
ADPE	kg Sb eq	2.26E-03	8.03E-07	-9.60E-04
ADPF	MJ	4.36E+04	3.43E+01	-1.69E+04

TRACI 2.1

		Manufacturing	End-of-Life	Credits
Parameter	**Unit**	**A1-A3**	**C4**	**D**
GWP	kg CO_2 eq	3.93E+03	2.17E+00	-1.80E+03
ODP	kg CFC-11 eq	2.68E-07	2.66E-10	-8.06E-08
AP Air	kg SO_2 eq	2.19E+01	8.99E-03	-1.19E+01
AP Water	kg SO_2 eq	2.07E-03	9.08E-06	-9.70E-04
EP Air	kg N eq	3.64E-01	1.30E-03	-1.69E-01
EP Water	kg N eq	6.17E-02	7.69E-05	-2.71E-02
SP	kg O_3 eq	1.87E+02	1.40E-01	-9.16E+01
FF	MJ	3.74E+03	4.30E+00	-1.08E+03

RESOURCE USE

		Manufacturing	End-of-Life	Credits
Parameter	**Unit**	**A1-A3**	**C4**	**D**
PERE	[MJ]	1.81E+04	1.59E+00	-1.07E+04
PERM	[MJ]	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	1.81E+04	1.59E+00	-1.07E+04
PENRE	[MJ]	4.36E+04	3.43E+01	-1.69E+04
PENRM	[MJ]	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	4.36E+04	3.43E+01	-1.69E+04
SM	[kg]	7.22E+02	0.00E+00	0.00E+00
RSF	[MJ]	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00
FW	[m^3]	1.37E+05	-8.20E+01	-4.66E+04

OUTPUT FLOWS AND WASTE CATEGORIES

		Manufacturing	End-of-Life	Credits
Parameter	**Unit**	**A1-A3**	**C4**	**D**
HWD	[kg]	9.84E+02	0.00E+00	-6.85E+02
NHWD	[kg]	9.20E+01	5.00E+01	-2.72E+01
RWD	[kg]	2.61E+00	4.42E-04	-1.03E+00
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00
MFR	[kg]	1.15E+01	9.50E+02	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	0.00E+00

Glossary

Environmental Impacts

GWP	Global warming potential
ODP	Depletion potential of the stratospheric ozone layer
AP	Acidification potential
EP	Eutrophication potential
POCP	Photochemical oxidant creation potential
SFP	Smog formation potential
ADPE	Abiotic depletion potential for non-fossil resources
ADPF	Abiotic depletion potential for fossil resources
FF	Fossil fuel consumption

Resource Use

PERE	Renewable primary energy as energy carrier
PERM	Renewable primary energy resources as material utilization
PERT	Total use of renewable primary energy resources
PENRE	Non-renewable primary energy as energy carrier
PENRM	Non-renewable primary energy as material utilization
PENRT	Total use of non-renewable primary energy resources
SM	Use of secondary material
RSF	Use of renewable secondary fuels
NRSF	Use of non-renewable secondary fuels
FW	Use of net fresh water

Output Flows and Waste Categories

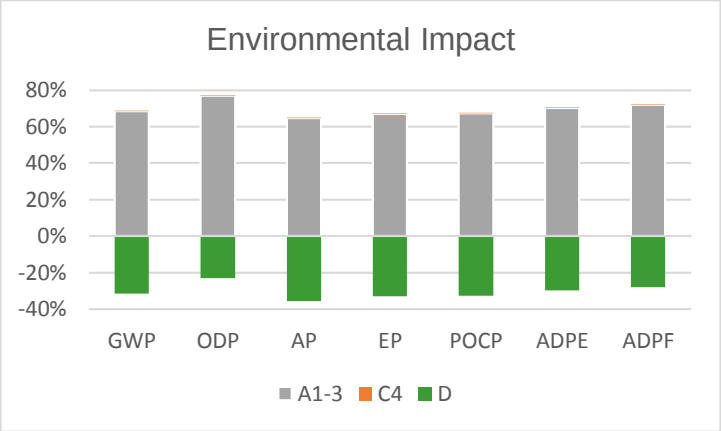
HWD	Hazardous waste disposed
NHWD	Non-hazardous waste disposed
RWD	Radioactive waste disposed
CRU	Components for re-use
MFR	Materials for recycling
MER	Materials for energy recovery
EEE	Exported electrical energy
EET	Exported thermal energy

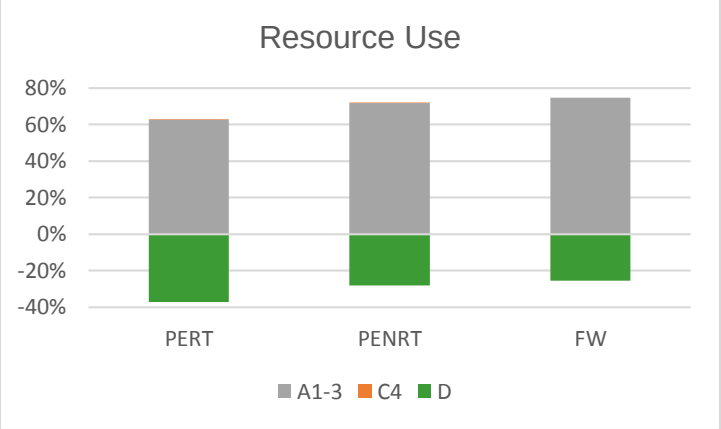
Life Cycle Assessment: Interpretation

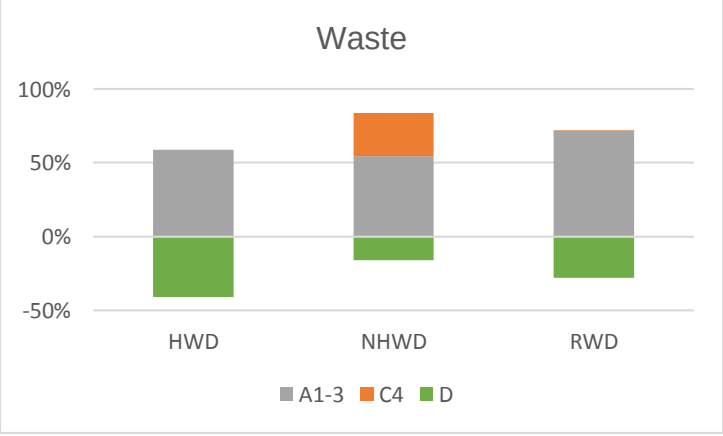
The results represent the cradle-to-gate and end-of-life environmental performance of a metric ton of hot-rolled aluminum. The majority of the environmental impacts are from the production of the aluminum, however the credits from recycling the aluminum at end-of-life help to offset the initial burden.

As with any metal, the recycling rate has a significant impact on the life cycle environmental performance of hot-rolled aluminum. A 95% recycling rate is assumed. Aluminum is an ideal material for recycling because the metal can be recycled over and over again without any loss in quality (AIA 2013).

Finally, it is interesting to note that the landfilling of hot-rolled aluminum in C4 has a negative use of net fresh water (FW). This is due to the landfill collecting rain water and introducing it into the watershed as landfill leachate.







Participating Companies

Company	Data Category	Note
Alcoa Inc.	Bauxite, Alumina, Primary Aluminum, Recycled Aluminum, Hot and Cold Rolling, Extrusion	Includes Kawneer and Traco
Aleris International Inc.	Recycled Aluminum, Hot and Cold Rolling	
Alexandria Extrusion Company	Extrusion	
Century Aluminum Company	Primary Aluminum	
Constellium	Hot and Cold Rolling	At the time of data survey, it was owned by Rio Tinto Alcan
Grupo Cuprum	Recycled Aluminum, Extrusion	
Hydro Aluminum North America	Bauxite, Alumina, Recycled Aluminum, Extrusion	
Jupiter Aluminum Corporation	Recycled Aluminum, Hot and Cold Rolling	
Kaiser Aluminum	Recycled Aluminum, Hot and Cold Rolling, Extrusion	
KB Alloy	Recycled Aluminum	
Logan Aluminum	Recycled Aluminum, Hot and Cold Rolling	
Metal Exchange Corporation	Recycled Aluminum, Extrusion	
Minalex Corporation	Extrusion	
Nichols Aluminum	Recycled Aluminum, Hot and Cold Rolling	
Noranda Aluminum Inc.	Alumina, Primary Aluminum	
Novelis Inc.	Recycled Aluminum, Hot and Cold Rolling	
Ormet Corporation	Alumina, Primary Aluminum	
Peerless of America	Extrusion	
Penn Aluminum International LLC	Extrusion	
Rio Tinto Alcan	Bauxite, Alumina, Primary Aluminum	
Sapa Extrusions Inc.	Recycled Aluminum, Extrusion	
Scepter Inc.	Recycled Aluminum	
Sherwin Alumina	Alumina	
Smelter Service Corporation	Recycled Aluminum	
Tri-Arrows Aluminum Inc.	Recycled Aluminum, Hot and Cold Rolling	

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