ENVIRONMENTAL PRODUCT DECLARATION

FABRICATED HOLLOW STRUCTURAL SECTIONS

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
STEEL TUBE INSTITUTE

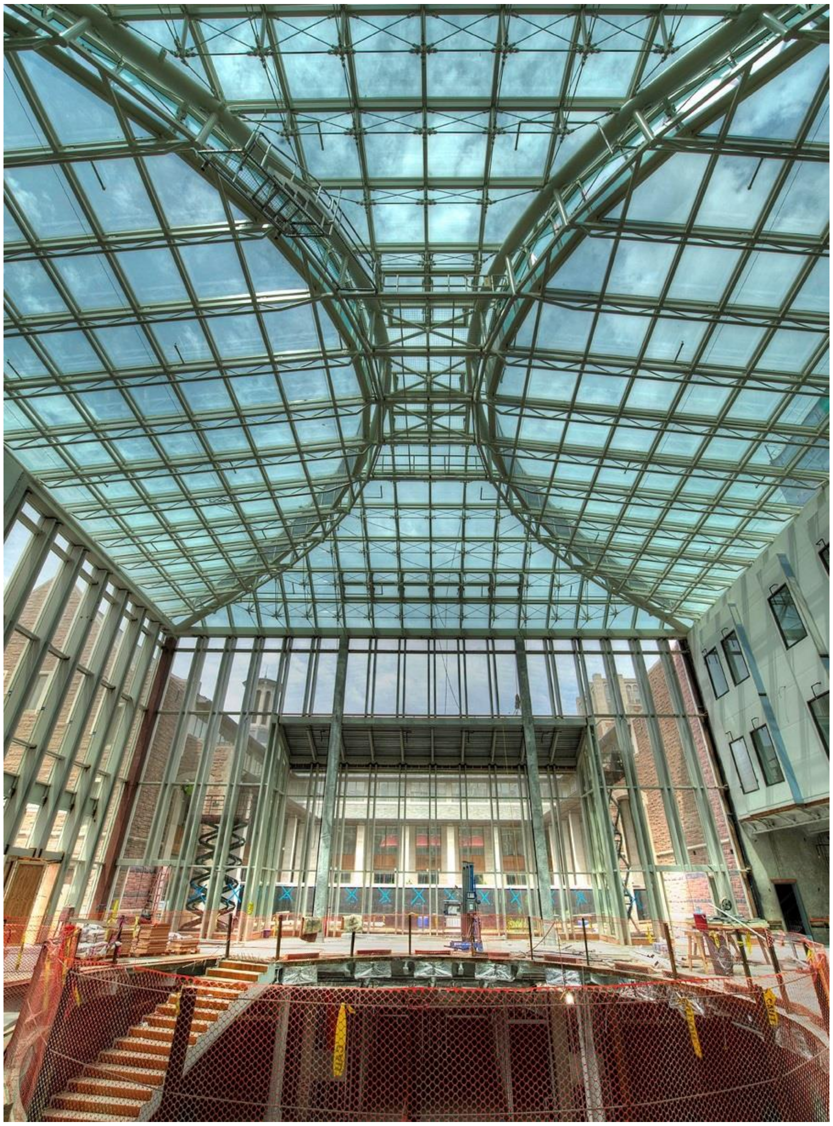


Photo courtesy of Atlas Tube

Hollow structural sections (HSS) complying with the definition of structural steel in AISC 303-16 produced in the United States, produced by a STI member, and fabricated by an AISC member fabricator.

Use of this EPD is limited to AISC members and STI members. AISC member names are available on-line at www.aisc.org/epd. STI members include Atlas Tube; EXLTUBE; Hannibal Industries, Inc.; Independence Tube Corporation; Maruichi American Corporation; Maruichi Leavitt Pipe & Tube, LLC; Maruichi Oregon Steel Tube (MOST); Searing Industries; Southland Tube, Inc.; and Vest, Inc.

The United States structural steel industry annually supplies, fabricates and erects structural steel framing for more than 10,000 buildings, bridges and industrial projects through a network of producers, service centers, steel fabricators and erectors.

The Steel Tube Institute (STI) was formed in 1930 when a group of manufacturers joined forces to promote and market steel tubing. Their goal was to mount a cooperative effort that would improve manufacturing techniques and inform customers about their products' utility and versatility. The organization is dedicated to the betterment of the steel industry and to the advancement of its member companies.

Long committed to the principles of sustainable manufacturing, the industry remains a world leader in the use of recycled materials and end-of-life recycling, with an end-of-life recovery rate of 98%.

The American Institute of Steel Construction (AISC) is a not-for-profit technical institute and trade association established in 1921 to serve the structural steel design community and construction industry. AISC currently represents over 920 structural steel fabricators in the US.

CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

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	American Institute of Steel Construction
DECLARATION NUMBER	4786979051.103.1
DECLARED PRODUCT	Fabricated hollow structural steel sections
REFERENCE PCR	North American PCR for Designated Steel Construction Products (SCS, 2015)
DATE OF ISSUE	December 15, 2016
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:	Review Panel Chair: Thomas Gloria Industrial Ecology Consultants
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

Product Definition

Association Description

The American Institute of Steel Construction (AISC), headquartered in Chicago, is a not-for-profit technical institute and trade association established in 1921 to serve the structural steel design community and construction industry in the United States. AISC's mission is to make structural steel the material of choice by being the leader in structural-steel-related technical and market-building activities, including: specification and code development, research, education, technical assistance, quality certification, standardization, and market development. AISC has a long tradition of service to the steel construction industry providing timely and reliable information.

The Steel Tube Institute (STI), is a not-for-profit trade association dedicated to advancing the growth and competitiveness of North America's steel tubular products. Established in 1930, the Institute's purpose was and still is to promote the benefits of steel tube in all aspects of current and future product utilization. STI's strength is bringing together resources to move the industry forward through active collaboration. STI's primary focus is in areas that include innovations in production and manufacturing methods, exchanging technical knowledge and expertise, impacting codes and specifications, and increasing marketplace knowledge.

STI also seeks to inform specifiers, consumers and end-users about the utility and versatility of steel tube and pipe by offering educational support through seminars, presentations, publications and more. STI is constantly evolving to best meet the needs of a sophisticated and competitive marketplace. The organization is dedicated to the betterment of our industry and our member companies.

Participating Members

This EPD represents fabricated hollow structural sections (HSS) produced by STI's and AISC's membership. All STI members who produce HSS contributed to this EPD, including

- Atlas Tube
- EXLTUBE
- Hannibal Industries, Inc.
- Independence Tube Corporation
- Maruichi American Corporation
- Maruichi Leavitt Pipe & Tube, LLC
- Maruichi Oregon Steel Tube (MOST)
- Searing Industries
- Southland Tube, Inc.
- Vest, Inc.

More than 250 AISC members contributed data for EPD development. Member names are available on-line at www.aisc.org/epd.

Product Description

Fabricated hollow structural sections are used in building, bridge, and industrial projects. These products are hollow square, rectangular and round shapes that are detailed, cut, drilled, bolted, welded, and otherwise processed at the fabricator in order to prepare them for installation.

Delivered Product Configurations

Structural steel consists of the elements of the structural frame that are shown and sized in the structural design documents, essential to support the design loads and described in the *Code of Standard Practice for Structural Steel Buildings and Bridges*, AISC 303-10.

Application and Codes of Practice

Hollow structural sections and structural steel are defined by the following standards:

- **ASTM A500:** Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- **ASTM A513:** Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
- **ASTM A847:** Standard Specification for Cold-Formed Welded and Seamless High-Strength, Low-Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance
- **ASTM A1085:** Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections
- **ANSI/AISC 360-16:** Specification for Structural Steel Buildings
- **ANSI/AISC 341-16:** Seismic Provisions for Structural Steel Buildings
- **AISC 303-16:** Code of Standard Practice for Structural Steel Buildings
- AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 7th Edition

Additional information can be found on AISC's website at www.aisc.org and STI's website at www.steeltubeinstitute.com/hss/ about-us/leed-epd.

Life Cycle Stages

The life cycle stages for fabricated HSS are summarized in the flow diagram shown in the figure below. Only the cradle-to-gate performance is considered in the analysis.

Raw Materials

Fabricated HSS are manufactured entirely from structural steel. They do not contain any materials or substances for which there exists a route to exposure that leads to humans or flora/fauna in the environment being exposed to said materials or substances at levels exceeding safe health thresholds. Steel production at the mill was represented by a background dataset for North American hot-rolled coil, which is used in STI's EPD on HSS prior to fabrication.

Inbound Transportation

Inbound transportation distances and modes for steel were collected from each fabrication facility. Fabricators also indicated an approximate range representing the inbound transportation for ancillary manufacturing materials (e.g., lubricants, gases, and welding electrodes).

Manufacturing

The major input to the fabrication process is the structural steel itself. However, small amounts of process materials are needed, such as lubricants for the machines and welding and cutting supplies (i.e., gases and electrodes). Energy is also needed to perform the manufacturing and move the materials. Metal scrap generated during manufacturing is recycled externally. Some facilities also conduct surface preparation, such as mechanical or compressed air blasting, in order to clean the surface and prepare it for coating. Galvanization typically takes place after fabrication at a different facility while paint style coatings may be applied in the fabrication shop. Environmental impacts associated with surface preparation and the application of coating materials are not included in this environmental product declaration.

Requirements for Underlying Life Cycle Assessment

A "cradle-to-gate" analysis using life cycle assessment (LCA) methodology was conducted for this EPD. The analysis was done according to the product category rule (PCR) for Designated Steel Construction Products and followed LCA principles, requirements and guidelines laid out in the ISO 14040/14044 standards. As such, EPDs of construction products may not be comparable if they do not comply with the same PCR. 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.).

Declared unit

The declared unit for this EPD is one metric ton of steel construction product. Note that comparison of EPD results on a mass basis, alone, is insufficient and should consider the technical performance of the product.

Name	Required Unit	Optional Unit
Declared Unit	metric ton	short ton
Density	7,800 kg / m^3	487 lbs. / $ft.^3$

System Boundaries

The "cradle-to-gate" life cycle stages represent the product stage (information modules A1-A3) and include:

- A1: all extraction and processing of raw materials, any reuse of products or materials from a previous product system, processing of secondary materials, and any energy recovery or other recovery processes from secondary fuels;
- A2: all transportation to the factory gate and all internal transport;
- A3: generation of fabrication electricity from primary energy resources, including upstream processes; production of all ancillary materials, pre-products, products, and co-products, including any packaging. Surface preparation using mechanical or compressed air blasting was excluded from the analysis.

Product Stage			Construction Stage		Use Stage					End-of-Life Stage				Benefits & Loads
A1	**A2**	**A3**	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
			EXCLUDED FROM THIS STUDY											
Raw materials supply	**Transport**	**Manufacturing**	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	De-construction	Transport	Waste processing	Disposal	Reuse, recovery, recycling potential

This EPD represents 2014 fabricated HSS production in the United States as produced by STI and AISC member companies.

Assumptions

The fabrication data do not differentiate between fabrication of structural sections, steel plate, hollow structural sections, or non-structural steel. Data were allocated to structural steel based on shop hours. Additionally, per-metric ton fabrication electricity consumption was calculated based on a subset of manufacturers—specifically those who reported conducting neither mechanical nor compressed air blasting on their products.

All of the raw materials and energy inputs have been modeled using processes and flows that closely follow actual production data on raw materials and processes. All of the reported material and energy flows have been accounted for.

Allocation

Allocation between fabricated structural steel and fabricated non-structural steel was based on shop hours. Allocation of background data (energy and materials) taken from the GaBi 2016 databases is documented online at http://www.gabi-software.com/international/support/gabi/.

Cut-off Criteria

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

- Mass: If a flow is less than 1% of the cumulative mass of the model it may be excluded, providing its environmental relevance is not a concern.
- Energy: If a flow is less than 1% of the cumulative energy of the model it may be excluded, providing its environmental relevance is not a concern.
- Environmental relevance: If a flow meets the above criteria for exclusion, yet is thought to potentially have a significant environmental impact, it was included.

Only packaging materials were excluded. Additionally, capital goods for the production processes (machines, buildings, etc.) were not taken into consideration.

Life Cycle Assessment Results and Analysis

Life cycle assessment results are presented per metric ton of steel product, the required reporting unit, and per short ton of steel product, the optional reporting unit. Primary energy use represents net calorific value (NCV).

Note: worldsteel life cycle inventories for steel products do not include potential environmental impacts for certain alloying elements—in particular, silico-manganese. These elements were excluded from the analysis due to lack of available data at the time the worldsteel LCIs was conducted and, in order to achieve consistency, were accordingly excluded from AISC's LCI for structural sections. Thus EPDs based on worldsteel and AISC steel data cannot be compared with EPDs whose steel LCIs include the alloying elements due to differences in scope.

Use of Energy and Material Resources

Primary Energy	Results per metric ton		Results per short ton	
Use of renewable primary energy resources excluding those used as raw materials	731	MJ	6.29E+05	BTU
Use of renewable primary energy resources as raw materials	0	MJ	0	BTU
Total use of renewable primary energy resources	**731**	**MJ**	**6.29E+05**	**BTU**
Use of non-renewable primary energy resources excluding those used as raw materials	27,500	MJ	2.36E+07	BTU
Use of non-renewable primary energy resources as raw materials	0	MJ	0	BTU
Total use of non-renewable primary energy resources	**27,500**	**MJ**	**2.36E+07**	**BTU**

Material Resource Use	Results per metric ton		Results per short ton	
Use of secondary material	0.0683	metric ton	0.0683	short ton
Use of renewable secondary fuels	0	MJ	0	BTU
Use of non-renewable secondary fuels	0	MJ	0	BTU
Net use of fresh water*	*(n/a)*	m^3	*(n/a)*	gallons

* Net use of fresh water is not reported in this EPD due to lack of consistent water data in worldsteel's steel hot rolled coil dataset. worldsteel is currently working to update its data; once these data are published, net use of fresh water results can be calculated and reported.

Life Cycle Impact Assessment

Parameter	Results per metric ton		Results per short ton	
Impact Assessment Method: TRACI 2.1				
Global warming potential (GWP100)	2.39E-00	metric ton CO_2 eq	2.39E-00	short ton CO_2 eq
Depletion potential of the stratospheric ozone layer (ODP)	2.23E-08	metric ton CFC-11 eq	2.23E-08	short ton CFC-11 eq
Acidification potential of soil and water (AP)	8.73E-03	metric ton SO_2 eq	8.73E-03	short ton SO_2 eq
Eutrophication potential (EP)	4.38E-04	metric ton N eq	4.38E-04	short ton N eq
Formation potential of tropospheric ozone (POCP)	1.17E-01	metric ton O_3 eq	1.17E-01	short ton O_3 eq
Impact Assessment Method: CML2001 (version April 2013)				
Abiotic depletion potential (ADP-elements)*	1.11E-07	metric ton Sb eq	1.11E-07	short ton Sb eq
Abiotic depletion potential (ADP-fossil)	2.64E+04	MJ	2.27E+07	BTU

* This indicator is based on assumptions regarding current reserves estimates; therefore, caution is necessary when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

Other Environmental Information

Parameter	Results per metric ton		Results per short ton	
Hazardous waste disposed*	*(n/a)*	metric ton	*(n/a)*	short ton
Non-hazardous waste disposed*	*(n/a)*	metric ton	*(n/a)*	short ton
Radioactive waste disposed	4.30E-04	metric ton	4.30E-04	short ton
Components for re-use	0	metric ton	0	short ton
Materials for recycling	0	metric ton	0	short ton
Materials for energy recovery	0	metric ton	0	short ton
Exported energy	0	MJ per energy carrier	0	BTU per energy carrier

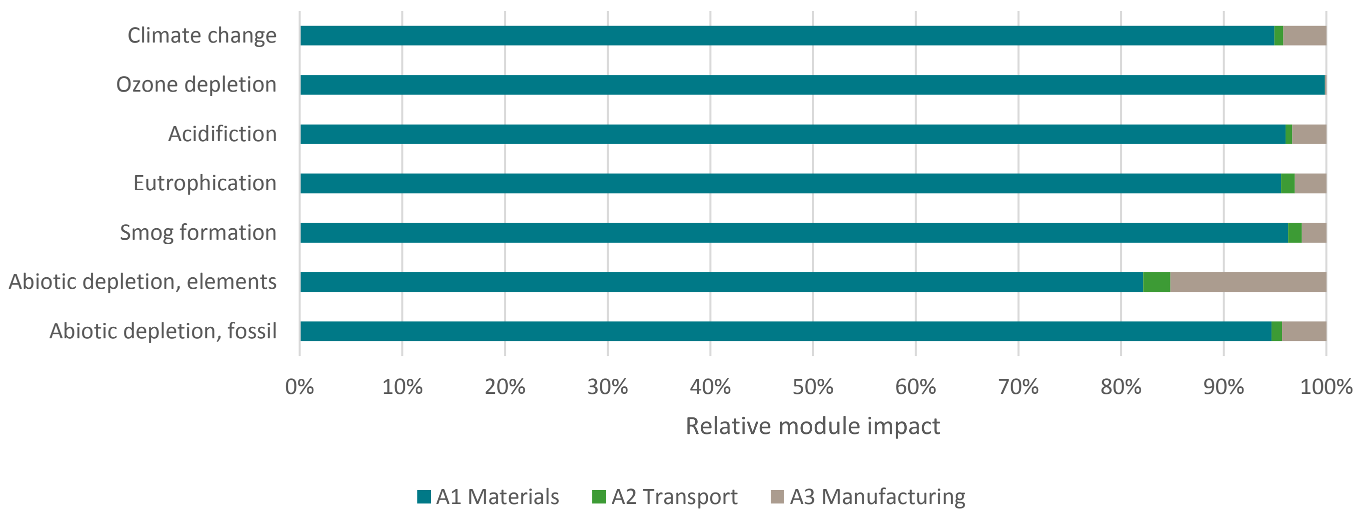
* Hazardous and non-hazardous waste disposed are not reported in this EPD due to lack of waste inventory data in worldsteel's hot rolled coil dataset.

Visualization of Life Cycle Impact Assessment

The diagrams in this section illustrate the degree to which the modules drive the major impact categories.

Primary Energy Demand from Non-Renewable Resources

Impact Assessment Categories



Data Quality Assessment

Temporal representativeness: Primary fabrication data were collected for 12-consecutive months during the 2013 and 2014 calendar years. The majority of secondary data come from the GaBi 2016 databases and are representative of the years 2010-2015. Hot-rolled coil data, on which hollow structural sections production is based, are published by worldsteel and representative of the years 2007-2010. Therefore, temporal representativeness is fair. **Geographical representativeness:** All primary and secondary data were collected specific to the countries or regions under study. Whenever country-specific background data were not readily available, US, European, or global data were used as proxies. Geographical representativeness is considered to be high. **Technological representativeness:** Primary data were collected for the production of fabricated structural steel by AISC members and represent the manufacturing technologies in use. Hot-rolled coil data that form the basis of the hollow structural sections production represent a mixture of electric arc furnace and basic oxygen furnace technologies, although the ratio reflects who particpated in worldsteel's analysis and may not reflect production today. All other data are either representative of North America or of the country-specific technology mix (electricity grid and other inputs). Where technology-specific secondary data were unavilable, proxy data were used. Technological representativeness is considered to be fair. **Precision:** As the majority of the relevant foreground data are measured data or calculated based on primary information sources of the owner of the technology, precision is considered to be high. All background data are sourced from GaBi databases with the documented precision (www.gabi-software.com).

Disclaimer: This Environmental Product Declaration (EPD) conforms to ISO 14025, ISO 14040, ISO 14044, and ISO 21930.

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Scope of Results Reported: The PCR requires the reporting of a limited set of LCA metrics; therefore, there may be relevant environmental impacts beyond those disclosed by this EPD. The EPD does not indicate that any environmental or social performance benchmarks are met nor thresholds exceeded.

Accuracy of Results: This EPD has been developed in accordance with the PCR applicable for the identified product following the principles, requirements and guidelines of the ISO 14040, ISO 14044, ISO 14025 and ISO 21930 standards. The results in this EPD are estimations of potential impacts. The accuracy of results in different EPDs may vary as a result of value choices, background data assumptions and quality of data collected.

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. Such comparisons can be inaccurate, and could lead to the erroneous selection of materials or products which are higher-impact, at least in some impact categories. Any comparison of EPDs shall be subject to the requirements of ISO 21930. For comparison of EPDs which report different module scopes, such that one EPD includes Module D and the other does not, the comparison shall only be made on the basis of Modules A1, A2 and A3. Additionally, when Module D is included in the EPDs being compared, all EPDs must use the same methodology for calculation of Module D values.

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LCA Practitioner

The EPD and underlying LCA model were developed by thinkstep, Inc. on behalf of AISC and STI.

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