

ENVIRONMENTAL PRODUCT DECLARATION

FABRICATED HOLLOW STRUCTURAL SECTIONS

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
STEEL TUBE INSTITUTE

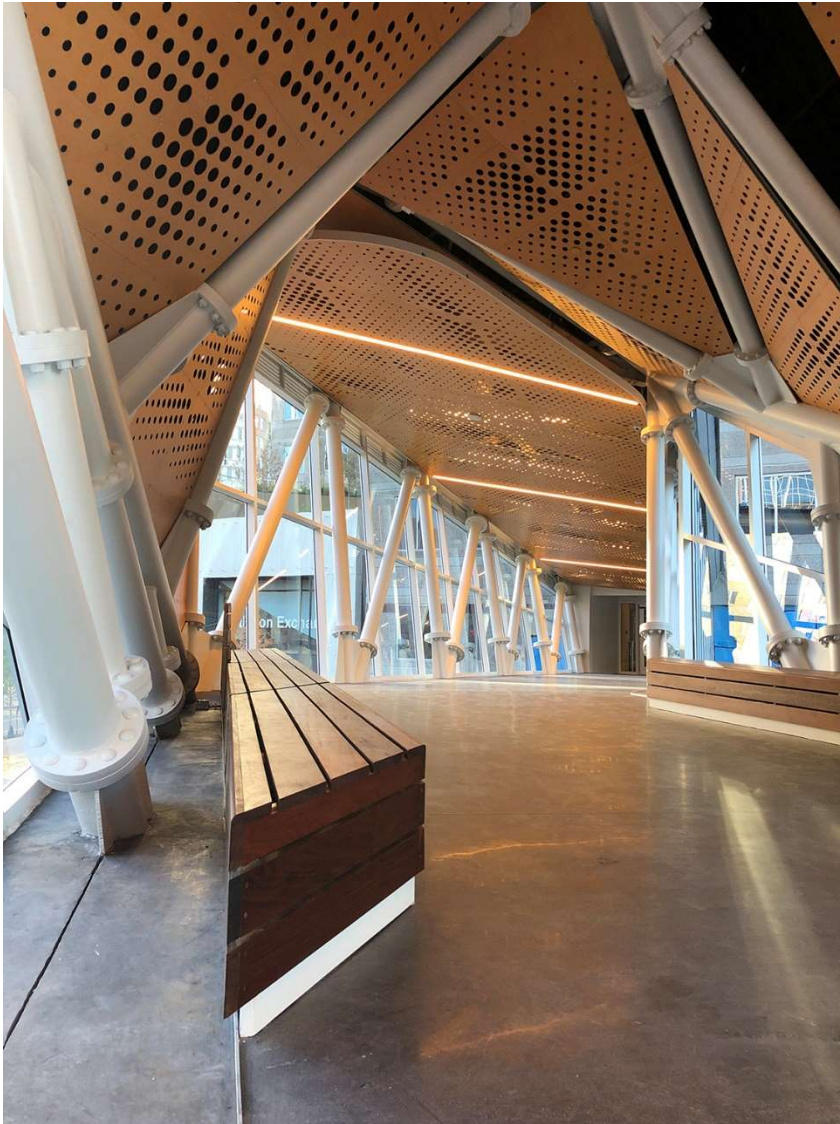


Image credit: Studio Techne Architects

Shown above are hollow structural sections (HSS) complying with the definition of structural steel in AISC 303-16, produced in North America by an STI member, and fabricated by an AISC member fabricator.

Use of this EPD is limited to AISC and STI members. AISC member names are available online at www.aisc.org/epd. STI members include Atlas Tube, Maruichi American Corporation, Maruichi Leavitt Pipe & Tube, Maruichi Oregon Steel Tube (MOST), Nucor Tubular Products, Searing Industries, Vest, Inc., and Wheatland Tube.



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.

Long committed to the principles of sustainable manufacturing, the industry remains the world leader in the use of recycled materials and end-of-life recycling with an end-of-life recovery rate exceeding 97%.

The American Institute of Steel Construction and its National Steel Bridge Alliance division is a not-for-profit technical institute and trade association established in 1921 to serve the structural steel design community and construction industry for buildings and bridges. AISC currently represents producers of structural sections, plate, and nearly 1,000 structural steel fabricators in the US.

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 diversity. The organization is dedicated to the betterment of the steel industry and to the advancement of its member companies.



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

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EN 15804, and ISO21930:2017

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.2.5 March 2020	
ASSOCIATION NAME AND ADDRESS	American Institute of Steel Construction 130 E Randolph Street, Suite 2000 Chicago, IL 60601	
DECLARATION NUMBER	4789556099.103.1	
DECLARED PRODUCT & DECLARED UNIT	Fabricated hollow structural steel, 1 metric ton	
REFERENCE PCR AND VERSION NUMBER	Part A: Calculation Rules for the LCA and Requirements Project Report (IBU/UL Environment, V3.2, 12.12.2018) and Part B: Designated Steel Construction Product EPD Requirements (UL Environment, V2.0, 08.26.2020)	
DESCRIPTION OF PRODUCT APPLICATION/USE	Fabricated hollow structural steel sections	
MARKETS OF APPLICABILITY	North America	
DATE OF ISSUE	February 3, 2022	
PERIOD OF VALIDITY	5 years	
EPD TYPE	Industry average	
EPD SCOPE	Cradle to gate	
YEAR(S) OF REPORTED PRIMARY DATA	2019-2020	
LCA SOFTWARE & VERSION NUMBER	GaBi v10	
LCI DATABASE(S) & VERSION NUMBER	GaBi 2020 (CUP 2020.2)	
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR5 + TRACI 2.1	

The sub-category PCR review was conducted by:	UL Environment
	PCR Review Panel
	epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025: 2006. <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL	Cooper McCollum, UL Environment <i>Cooper McC</i>
	Sphera Solutions Inc
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	James Mellentine, Thrive ESG <i>James H. Mellentine</i>

LIMITATIONS
Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts or raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools 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 estimation 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 for upstream or downstream of the life cycle stages declared.



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS



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General Information

Description of Organization

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 the EPD, including:

- Atlas Tube
- Maruichi American Corporation
- Maruichi Leavitt Pipe & Tube
- Maruichi Oregon Steel Tube (MOST)
- Nucor Tubular Products
- Searing Industries
- Vest, Inc.
- Wheatland Tube

More than 75 AISC members contributed data for EPD development. Member names are available online 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.

Product Specification

Fabricated hollow structural sections are comprised of a family of steel products of varying strength, performance, physical, metallurgical, and chemical characteristics as 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



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

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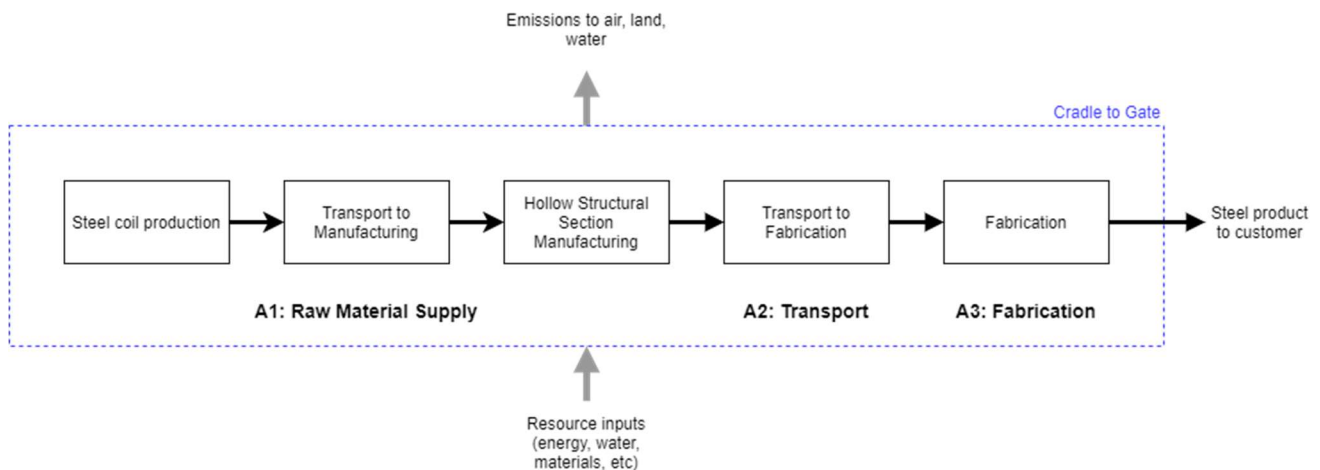
Tubing

- **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

Structural Steel, as defined in *The Code of Standard Practice for Buildings and Bridges* (ANSI/AISC 303-16), is then fabricated according to the applicable standards.

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

Flow Diagram



Product Average

The 2019 and 2020 production data used to develop this EPD consider all fabrication activities at participating AISC member companies. The fabricators are located throughout the United States. Results are weighted according to production totals at participating fabricators.

Application

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.

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



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

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EN 15804, and ISO21930:2017

- **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
- **ANSI/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.org.

Material Composition

Fabricated hollow structural sections are fabricated entirely from structural steel. Note: Steel products used inside the building envelope (e.g. used in load-bearing applications present inside wall structures) do not include materials or substances which may have any potential route of exposure to humans or flora/fauna in the environment.

Life Cycle Stages – Background Information

Declared unit

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

Table 1. Declared unit

NAME	VALUE	UNIT
Declared unit	1	metric ton
Density (typical)	7,800	kg/m ³

System Boundaries

This EPD is “cradle-to-gate” in scope. The life cycle stages included in the assessment represent the product stage (modules A1-A3) and include:

ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

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EN 15804, and ISO21930:2017

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
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
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	MND	MND

* X = module included, MND = module not declared

Allocation

Allocation based on shop hours was used to separate the manufacturing of fabricated structural steel from that of fabricated non-structural steel.

Allocation of background data (energy and materials) taken from the GaBi 2021 databases is documented online at <http://www.gabi-software.com/america/support/gabi/>.

Since the EPD does not cover the end-of-life of the products, end-of-life allocation is outside the scope of the study. Metal scrap from fabrication (module A3) was balanced with the scrap demand of the raw materials module (A1) in order to calculate the net scrap input to module A1.

Under a cradle-to-gate system boundary, scrap inputs to the system are not associated with any upstream burden, and scrap produced during manufacturing is assumed to be at least the same quality as scrap inputs into steelmaking. Remelting of scrap to produce structural steel and other raw materials is accounted for within upstream datasets.

Cut-off Rules

No formal cut-off criteria were defined for this study. The system boundary was defined based on relevance to the goal of the study. For the processes within the system boundary, all available energy and material flow data have been included in the model.

Data Sources

The LCA model was created using the GaBi software system for life cycle engineering, version 10, developed by Sphera (Sphera, 2021). Background life cycle inventory data for raw materials and processes were obtained from the GaBi 2021 database (CUP 2021.2). Primary fabrication data were provided by AISC member companies.

Data Quality

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



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

According to ISO 14025,
EN 15804, and ISO21930:2017

Period Under Review

Primary data were collected for fabrication during the years 2019 and 2020. Background data for HSS production was taken from the STI industry average EPD (Steel Tube Institute, 2021) and represent the years 2019 and 2020. This analysis is intended to represent fabrication in 2019.

Estimates and Assumptions

In cases where no matching life cycle inventories are available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts. The choice of proxy data is documented in the background report.

The fabrication data do not differentiate between fabrication of structural sections, steel plate, hollow structural sections, or non-structural steel. Therefore it was assumed that the fabrication process does not differ between these various products.

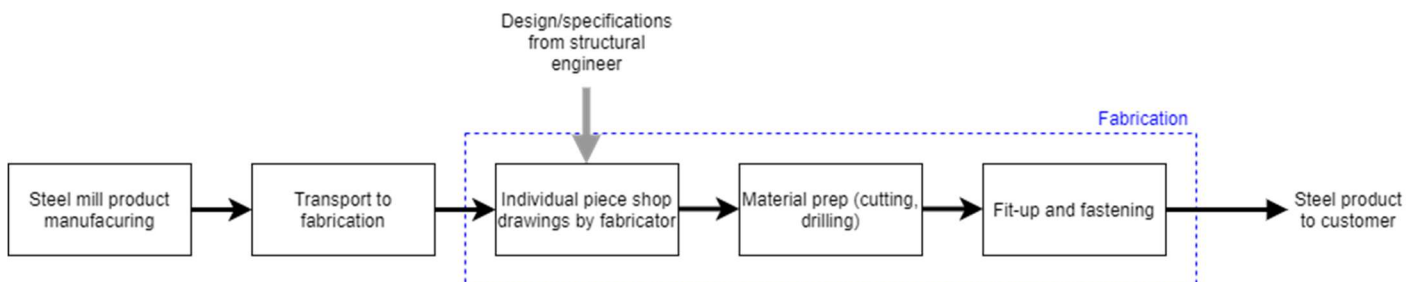
Emissions of welding gases were calculated rather than measured, in the absence of reported emissions data by the participating fabricators.

Inbound transportation distances of ancillary materials to the fabricator were assumed to be 45 miles by truck. Inbound transportation of steel is based on actual distances and modes reported by participants.

Technical Information and Scenarios

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. The manufacturing process is illustrated in the diagram below.



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

According to ISO 14025,
EN 15804, and ISO21930:2017

Inbound Transportation

Inbound transportation distances and modes for steel were collected from each participating fabrication facility.

Disposal

End-of-life is outside of the scope of this EPD.

Environmental Indicators Derived from LCA

North American life cycle impact assessment (LCIA) results are declared using TRACI 2.1 (Bare, 2012; EPA, 2012) methodology, with the exception of GWP which is reported using the IPCC AR5 (IPCC, 2013) methodology, excluding biogenic carbon dioxide. Primary energy use represents the lower heating value (LHV) a.k.a. net calorific value (NCV).

LCIA results are relative expressions and do not predict actual impacts, the exceeding of thresholds, safety margins or risks.

Table 2. LCIA results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
GWP 100	kg CO ₂ eq.	1.99E+03	1.85E+03	4.46E+01	9.67E+01
ODP	kg CFC 11 eq.	1.62E-09	-2.35E-12	8.67E-14	1.62E-09
AP	kg SO ₂ eq.	4.35E+00	4.01E+00	1.83E-01	1.52E-01
EP	kg N eq.	2.35E-01	2.06E-01	1.64E-02	1.23E-02
SFP	kg O ₃ eq.	7.56E+01	6.89E+01	4.44E+00	2.23E+00
ADP _{fossil}	MJ surplus	1.78E+03	1.60E+03	7.16E+01	1.04E+02

Comparability: Comparisons cannot be made between product-specific or industry average EPDs at the design stage of a project before a building has been specified. Comparisons may be made between product-specific or industry average EPDs at the time of product purchase when product performance and specifications have been established and serve as a functional unit for comparison. Environmental impact results shall be converted to a functional unit basis before any comparison is attempted.

Any comparison of EPDs shall be subject to the requirements of ISO 21930. EPDs are not comparative assertions and are either not comparable or have limited comparability when they have different system boundaries, are based on different product category rules or are missing relevant environmental impacts. Such comparison can be inaccurate, and could lead to erroneous selection of materials or products which are higher-impact, at least in some impact categories.



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

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EN 15804, and ISO21930:2017

Table 3. Resource use results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
RPR _E	MJ LHV	1.26E+03	9.82E+02	6.24E+01	2.16E+02
RPR _M	MJ LHV	1.96E-01	1.96E-01	-	-
NRPR _E	MJ LHV	2.58E+04	2.36E+04	6.91E+02	1.47E+03
NRPR _M	MJ LHV	1.28E+01	1.96E-01	-	1.26E+01
SM	kg	9.84E+02	9.83E+02	-	7.52E-01
RSF	MJ LHV	-	-	-	-
NRSF	MJ LHV	-	-	-	-
RE	MJ LHV	-	-	-	-
FW	m ³	1.11E+01	1.02E+01	1.81E-01	6.82E-01

Table 4. Output flows and waste categories results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
HWD	kg	4.98E-01	1.66E-01	-	3.32E-01
NHWD	kg	1.60E+01	6.34E+00	-	9.66E+00
HLRW	kg	1.01E-03	8.57E-04	3.16E-05	1.18E-04
ILLRW	kg	8.41E-01	7.16E-01	2.64E-02	9.85E-02
CRU	kg	-	-	-	-
MR	kg	1.53E+02	7.62E+01	-	7.71E+01
MER	kg	-	-	-	-
EE	MJ LHV	-	-	-	-

Per the PCR, “industry average EPDs shall report information on the statistical distribution of results for all TRACI indicators”. The min and max results presented in Table 5 represent the facilities with the lowest (best) and highest (worst) impacts, respectively. Min and max facilities are calculated for each impact category. The mean and median do not take production volumes across facilities into account (i.e. it is a calculation based on each individual facility as a data point), while the weighted average presented in Table 2 is calculated via production volume weightings reported by each fabricator.



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

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Table 5. Statistical distribution of LCIA results, per 1 metric ton

PARAMETER	UNIT	MIN (A1-A3)	MAX (A1-A3)	MAX/MIN RATIO (A1-A3)	MEAN (A1-A3)	MEDIAN (A1-A3)
GWP 100	kg CO ₂ eq.	1.72E+03	2.32E+03	1.35E+00	1.99E+03	1.97E+03
ODP	kg CFC 11 eq.	-2.55E-12	4.41E-08	-1.73E+04	2.56E-09	-1.92E-12
AP	kg SO ₂ eq.	3.72E+00	5.23E+00	1.41E+00	4.30E+00	4.26E+00
EP	kg N eq.	1.91E-01	3.19E-01	1.67E+00	2.31E-01	2.28E-01
SFP	kg O ₃ eq.	6.39E+01	9.56E+01	1.49E+00	7.45E+01	7.38E+01
ADP _{fossil}	MJ surplus	1.49E+03	2.21E+03	1.49E+00	1.77E+03	1.76E+03

* ODP has limited relevance due to the absence of ozone-depleting emissions in the LCI, particularly in the foreground system. Use of region-specific electricity grid mix datasets for each fabricator therefore contributes to order of magnitude differences between ODP results for participating facilities.

Visualization of Life Cycle Impact Assessment

The relative contribution of each life cycle stage to the overall cradle-to-gate impact are presented in Figure 1, while the contribution of fabrication process components to A3 impacts are presented in Figure 2.

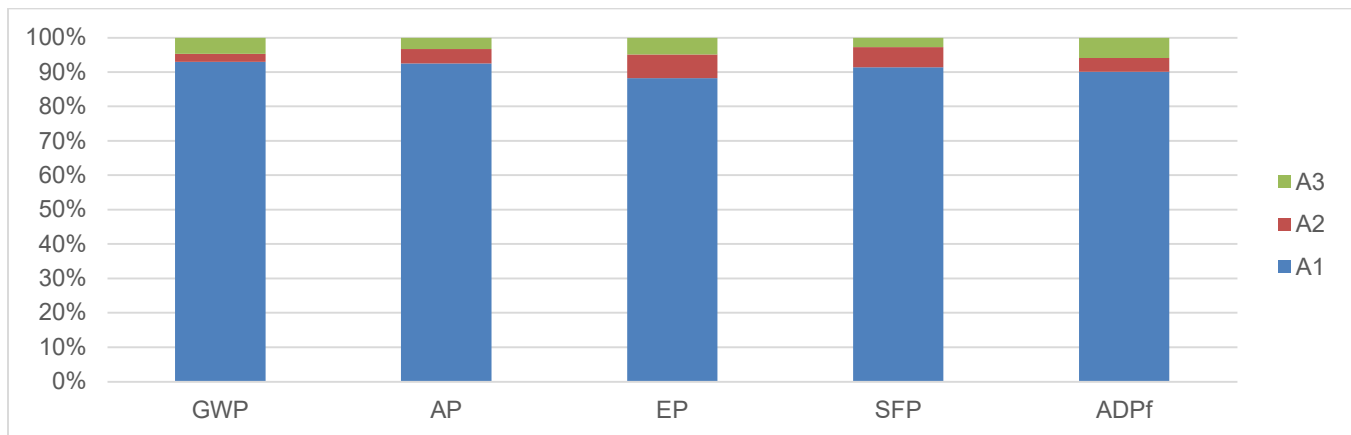


Figure 1: Relative contribution by life cycle stage for 1 metric ton of fabricated HSS



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS

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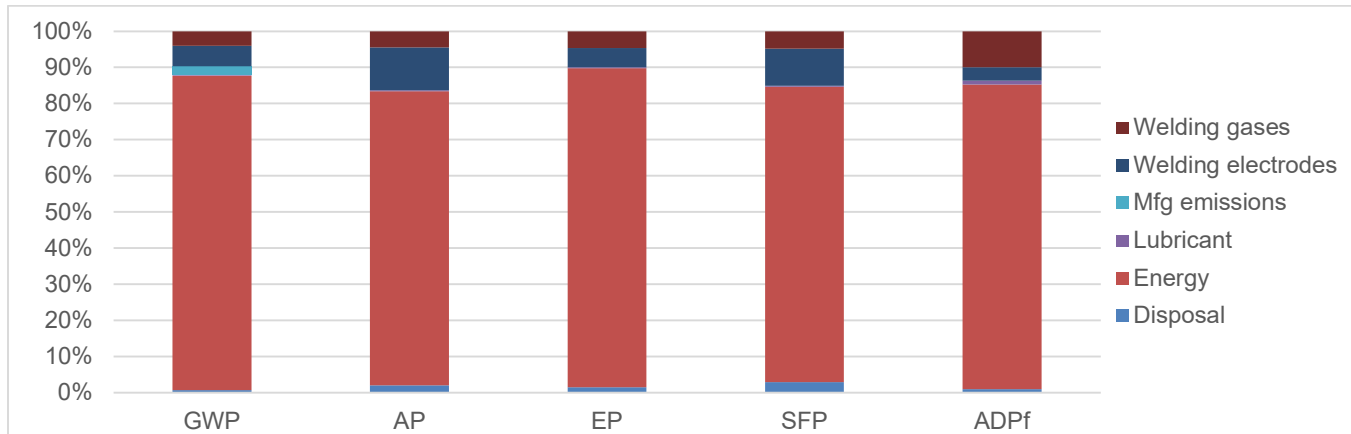


Figure 2: Relative contribution of fabrication components for 1 metric ton of fabricated HSS

Interpretation

Upstream steel manufacturing (A1) is the primary contributor across all indicators except for ODP, which is driven by electricity use in fabrication. Inbound transportation of steel to the fabricator (A2) and fabrication (A3) also contribute to potential environmental impacts, but on a smaller order of magnitude.

Within the fabrication process (A3), energy use, in particular electricity use, is the dominant contributor across indicators. Welding electrodes and gases are also relevant contributors. In addition, combustion of welding gases and fuels for onsite transportation contribute to GWP.



ENVIRONMENTAL PRODUCT DECLARATION



AMERICAN INSTITUTE OF STEEL CONSTRUCTION & STEEL TUBE INSTITUTE
FABRICATED HOLLOW STRUCTURAL SECTIONS



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EN 15804, and ISO21930:2017

Additional Environmental Information

Environment and Health During Manufacturing

Environmental, occupational health and safety practices are in accordance with OSHA and individual state requirements.

Environment and Health During Installation

During installation and use, fabricated hollow structural steel sections do not adversely impact human health or release emissions to indoor air. In addition, no environmental impacts to water, air or soil are expected during the product lifetime. The product does not contain any hazardous substances according to the Resource Conservation and Recovery Act (RCRA), Subtitle 3.

Further Information

Additional information regarding the sustainable attributes of fabricated hollow structural sections can be found at www.aisc.org/sustainability. Information regarding this EPD is available at www.aisc.org/epd.

References

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