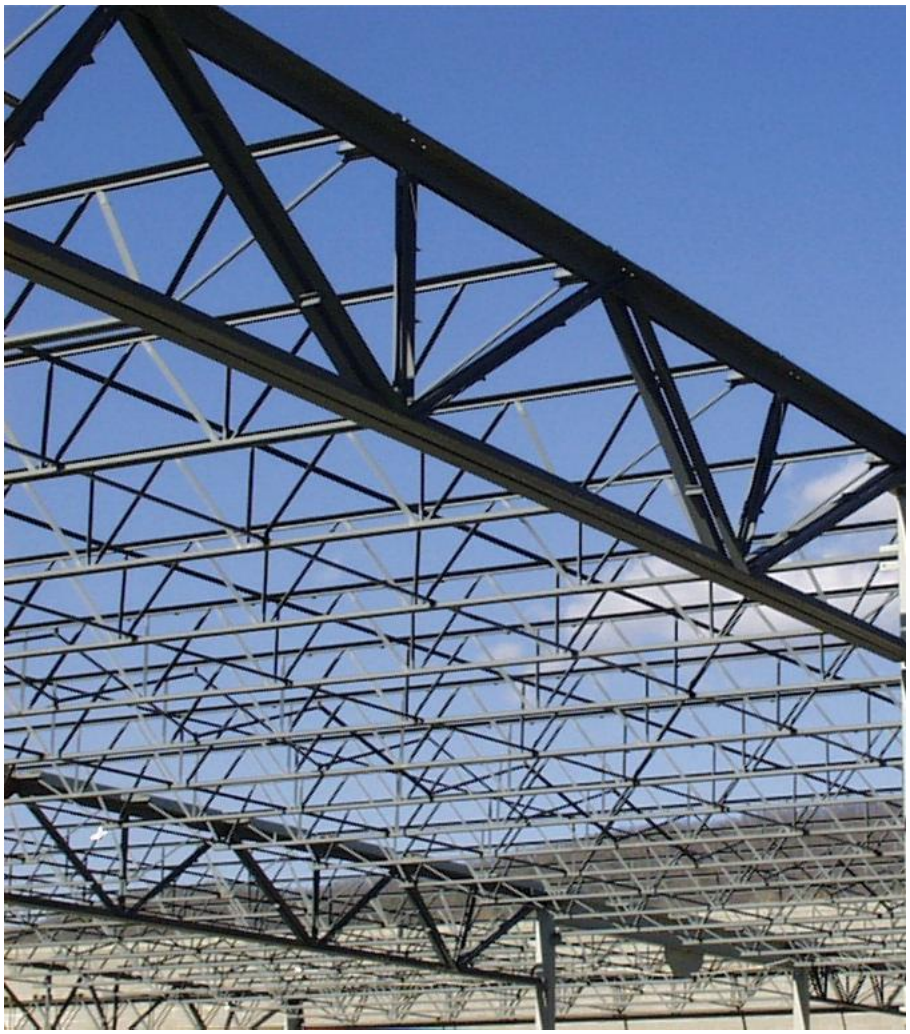
ENVIRONMENTAL PRODUCT DECLARATION

OPEN WEB STEEL JOISTS AND JOIST GIRDERS

STEEL JOIST INSTITUTE



Steel is one of the world's most recycled products, lending itself to positive environmental contributions as well as sustainable construction

This publication represents Steel Joist Institute's membership: Atecno; Canam Group, Inc.; Canam Steel Corp.; ESJ; Gooder-Henrichsen; Joist Structural Systems; New Millennium Building Systems; Seyco Joist Company; Valley Joist; and Vulcraft (Nucor Corporation).

The Steel Joist Institute and its members have undertaken the development of this Environmental Product Declaration to show the construction industry the merits of steel joist construction from an environmental sustainability point of view.

Green building professionals have known for decades that the steel used in the manufacture of our products is highly recycled. More than 85% of the steel used in production of steel joist product in North America comes through recycling. And when the service life of the building is over, steel joists can be recycled and the material used to build another building, create an automobile or become a home appliance.

This publication, based on rigorous LCA modeling and broad sampling of our industry, provides scientific backup for what we already knew: Steel has always been the leading material for safe, sustainable construction and will continue to be a leader in green buildings.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

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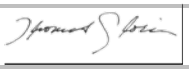
EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Environment 333 Pfingsten Road Northbrook, IL 60611	https://www.ul.com/ https://spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v.2.5 March 2020	
ASSOCIATION NAME AND ADDRESS	Steel Joist Institute | 140 W. Evans Street Suite 203, Florence, SC 29501	
DECLARATION NUMBER	4789985166.101.1	
DECLARED PRODUCT & DECLARED UNIT	Open web steel joists and joist girders, 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	Steel joist used in construction	
MARKETS OF APPLICABILITY	North America	
DATE OF ISSUE	January 21, 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 2021 (CUP 2021.1)	
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR5 + TRACI 2.1	

The sub-category PCR review was conducted by:	UL Environment PCR Review Panel epd@ul.com
This declaration was independently verified in accordance with ISO 14025: 2006. The UL Environment "Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report,", v3.2 (December 2018), in conformance with ISO 21930:2017, serves as the core PCR, with additional considerations from the USGBC/UL Environment Part A Enhancement (2017) ☐ INTERNAL ☒EXTERNAL	 Cooper McCollum, UL Environment
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Sphera Solutions Inc.
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	 Thomas P. Gloria, Industrial Ecology Consultants

LIMITATIONS

The environmental impact results of steel products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the steel product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted. Please refer to the results section for additional EPD comparability guidelines.

Environmental declarations from different programs (ISO 14025) may not be comparable.

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and ISO 21930:2017

General Information

Description of Organization

The Steel Joist Institute (SJI), a nonprofit organization of active joist manufacturers and other organizations and companies connected to the industry, was founded in 1928 to address the need for uniform joist standards within the industry.

Today, the Institute continues to maintain the standards for steel joist construction. In addition, the SJI provides educational opportunities for construction professionals utilizing a library of printed publications and both live and recorded webinars. We also offer assistance in identifying existing joists in buildings undergoing retrofit.

Participating Members

This EPD represents steel joists produced by all SJI member companies who contributed to the development of the EPD. The members that participated in data collection for this EPD are listed below and account for more than 90% of North American membership production.

- Canam Steel Corporation
- New Millenium Building Systems
- Vulcraft (Nucor Corporation)

Product Description

Steel joists are welded steel products that are used to frame a building and support the deck (which, in turn, supports a building's roof and floors). They are custom engineered to suit the design of each building. Joists in this EPD represent product manufactured in North America from steel product produced in North America.

Open Web Steel Joists, which are secondary framing members, range from 254 mm to 3048 mm (10" to 120") deep, and up to 73152 mm (240') long.

Joist Girders, which are primary framing members, range from 508 mm to 3048 mm (20" to 120") deep and 6096 mm to 36576 mm (20' to 120') long.

Composite Joists are open web product that are used in the construction of concrete roofs and floors allowing composite action between the joist and the concrete, range from 254 mm to 2438 mm (10" to 96") deep, and up to 36576 mm (120') long.

Product Specification

Steel joist products are defined by the following standards.

- ANSI/SJI-100 (for open web steel joist and joist girders)
- ANSI/SJI-200 (for composite steel joists)

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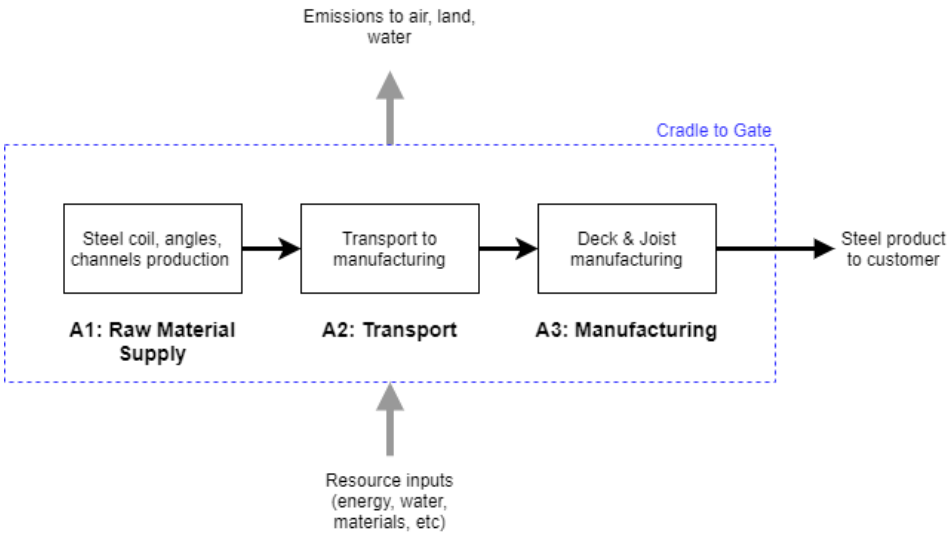
Flow Diagram



Product Average

The data collected represents steel joist production in 2019 and 2020 by participating SJI members located throughout North America. Results are weighted according to production totals at participating facilities.

Application

Steel joist products are used as structural supports for building applications.

Material Composition

Steel joist is manufactured almost entirely from welded structural steel, with a small amount of paint included. The products do not contain any hazardous substances according to the Resource Conservation and Recovery Act (RCRA), Subtitle 3. The products do not release dangerous substances to the environment, including indoor air emissions, gamma or ionizing radiation, or chemicals released to air or leached to water and soil.

Methodological Framework

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.

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System Boundary

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:

PRODUCT STAGE			CONSTRUCT-ION 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

No multi-output allocation was required in the foreground system of the study.

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/. Background data for steelmaking from AISI and worldsteel use the system expansion allocation method for co-products from the steelmaking process.

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 manufacturing (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 module A1 using upstream datasets.

Cut-off Rules

In lieu of arbitrary cut-off criteria, all available energy and material flow data were included in the model for processes within the system boundary.

In cases where no matching life cycle inventories were available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts.

Data Sources

The LCA model was created using the GaBi 10 software system for life cycle engineering, developed by Sphera (Sphera, 2021). Background life cycle inventory data for raw materials and processes were obtained from the GaBi 2021 database (CUP 2021.1). Primary manufacturing data were provided by participating SJI member companies.

Data Quality

A variery of tests and checks were performed by the LCA practitioner throughout the project to ensure high quality of the completed LCA. Checks in cluded 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.

Period Under Review

Primary data were collected for steel joist production during the years 2019 and 2020. Background data for steel product manufacturing was taken from the AISI and worldsteel and represents steel production during 2017 and 2019 respectively. This analysis is intended to represent steel joist manufacturing in 2019.

Estimates and Assumptions

The steel joist inventory data was collected by participating SJI member companies to represent steel joist manufacturing in North America. Where inbound transportation data was incomplete, a distance of 500 miles by truck was used.

Proxy data were applied to some materials where no matching life cycle inventories were available as documented in the background report.

Technical Information and Scenarios

Manufacturing

Steel joists are made of five main components: top chord, bottom chord, end web and interior web members and bearing seats. These components are cut, bent and assembled to create the steel joist. The major input to the manufacturing process is steel; however small amounts of process materials are needed, such as lubricants for the machines and electrodes and gases for welding. Energy is also needed to perform the manufacturing and move the materials.

Inbound Transportation

Inbound transportation distances and modes for steel and process materials were collected from each participating steel joist manufacturer.

Transportation

Transportation to the customer or construction site is outside the scope of this EPD.

Product Installation

Installation is outside the scope of this EPD.

Use

Product use is outside the scope of this EPD.

Reuse, Recycling, and Energy Recovery

Product reuse, recycling, and incineration for energy recovery is outside the scope of this EPD.

Disposal

Product disposal is outside 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. 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 1. LCIA results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
GWP 100	kg CO_2 eq.	**1.43E+03**	1.19E+03	4.41E+01	2.03E+02
ODP*	kg CFC 11 eq.	**2.79E-08**	2.63E-08	8.75E-15	1.68E-09
AP	kg SO_2 eq.	**3.26E+00**	2.82E+00	2.62E-01	1.76E-01
EP	kg N eq.	**1.80E-01**	1.38E-01	2.31E-02	1.89E-02
SFP	kg O_3 eq.	**5.56E+01**	4.33E+01	7.45E+00	4.85E+00
ADP_{fossil}	MJ surplus	**1.63E+03**	1.16E+03	8.21E+01	3.88E+02

* ODP has limited relevance due to the absence of ozone-depleting emissions in the LCI, particularly in the foreground system.

Comparability: comparison of the environmental performance of construction works and construction products using EPD information shall be based on the product's use and impacts at the construction works level. In general, EPDs may not be used for comparability purposes when not considered in a construction works context. Given this PCR ensures products meet the same functional requirements, comparability is permissible provided the information given for such comparison is transparent and the limitations of comparability explained."

When comparing EPDs created using this PCR, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to different results for upstream or downstream of the life cycle stages declared.

Table 2. Resource use results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
RPR_E	MJ LHV	**9.70E+02**	8.03E+02	2.55E+01	1.42E+02
RPR_M	MJ LHV	**2.91E+01**	-	-	2.91E+01
$NRPR_E$	MJ LHV	**1.93E+04**	1.55E+04	6.20E+02	3.21E+03
$NRPR_M$	MJ LHV	**6.97E-02**	-	-	6.97E-02
SM	kg	**8.28E+02**	8.28E+02	-	4.68E-01
RSF	MJ LHV	**-**	-	-	-
NRSF	MJ LHV	**-**	-	-	-
RE	MJ LHV	**-**	-	-	-
FW	m^3	**6.13E+00**	5.46E+00	1.09E-01	5.67E-01

Table 3. Output flows and waste categories results, per 1 metric ton

PARAMETER	UNIT	TOTAL	A1	A2	A3
HWD	kg	**2.08E-02**	-	-	2.08E-02
NHWD	kg	**-**	-	-	-
HLRW	kg	**8.15E-04**	7.25E-04	2.09E-06	8.78E-05
ILLRW	kg	**6.82E-01**	6.07E-01	1.76E-03	7.34E-02
CRU	kg	**-**	-	-	-
MR	kg	**2.60E+01**	-	-	2.60E+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 4 represent the facilities with the lowest (best) and highest (worst) impacts, respectively. Min and max facilities are determined for each impact category separately. 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 1 through Table 3 is calculated via production volume weightings reported by each participating facility.

Table 4. 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.	1.09E+03	1.81E+03	1.66E+00	1.45E+03	1.45E+03
ODP	kg CFC 11 eq.	7.91E-12	1.88E-07	2.38E+04	1.93E-08	7.07E-09
AP	kg SO_2 eq.	2.59E+00	4.11E+00	1.59E+00	3.33E+00	3.33E+00
EP	kg N eq.	1.27E-01	2.46E-01	1.94E+00	1.84E-01	1.80E-01
SFP	kg O_3 eq.	3.95E+01	8.33E+01	2.11E+00	5.73E+01	5.79E+01
ADP_{fossil}	MJ surplus	1.26E+03	2.92E+03	2.32E+00	1.71E+03	1.46E+03

Visualization of Life Cycle Impact Assessment

The relative contribution of each life cycle stage to the overall cradle-to-gate impacts are presented in Figure-1.

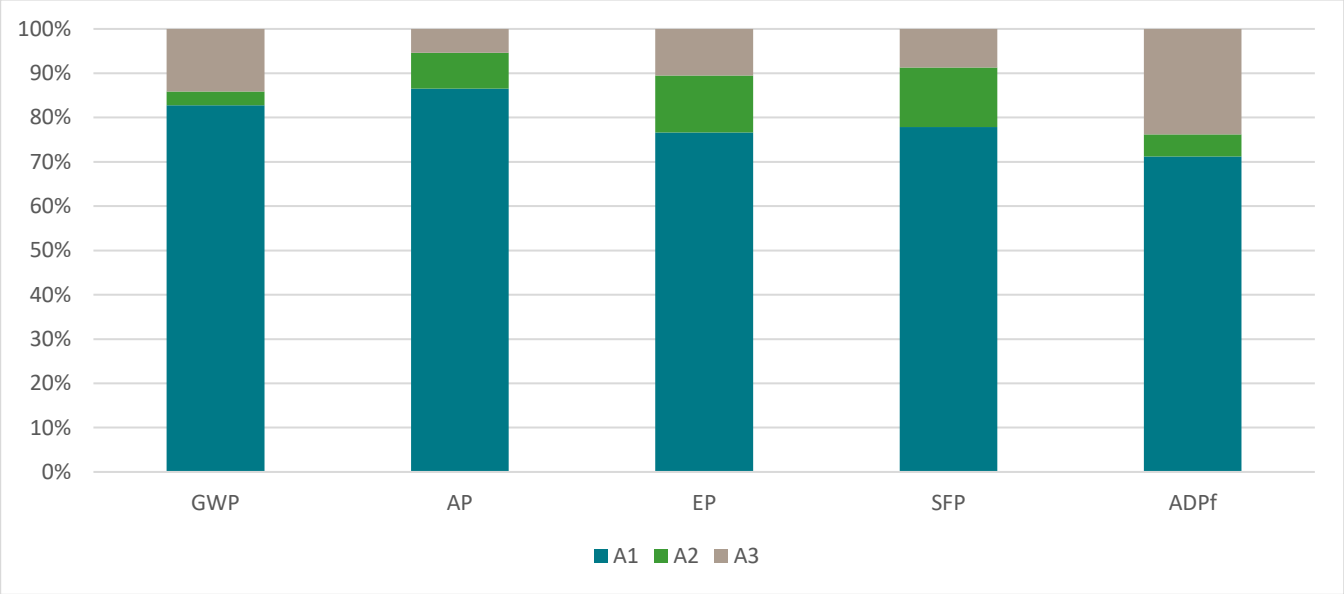

Figure 1: Relative contribution by life cycle stage for 1 metric ton of steel joist

Interpretation

The cradle-to-gate potential environmental impacts of steel joist products are driven by upstream steel production (A1). Inbound transport to manufacturing (A2) and joist manufacturing (A3) contribute to potential environmental impacts on a smaller order of magnitude.

Additional Environmental Information

Further Information

Further information can be found on the Steel Joist Institute's website: www.steeljoist.org.

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