Environmental Product Declaration

According to ISO 14025

Fabricated Structural Steel Sections

Steel Dynamics, Inc.®
Long Products Group
Structural and Rail Division

Issue Date: June 30, 2022

Valid Until: June 30, 2027

Declaration Number: 341

Declaration Information

Declaration

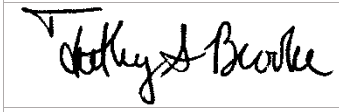
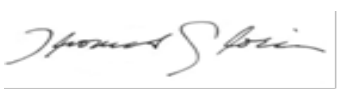
Program Operator: ASTM International	www.astm.org	https://lpg.steeldynamics.com/
Company: Steel Dynamics, Inc. (SDI)		

Product Information	Validity / Applicability
Product Name: Fabricated steel structural sections	**Period of Validity:** This declaration is valid for a period of 5 years from the date of publication
Product Definition: Structural sections are used in buildings, bridges, and industrial applications	
Declaration Type: Business to business	**Geographic Scope:** This declaration is valid for steel structural sections milled by SDI in Columbia City, IN sold and fabricated in North America
PCR Reference: UL: Part B: Steel Construction Product EPD Requirements UL 10010-34 v.2.0	

Product Application and / or Characteristics

This declaration covers fabricated structural sections for use in buildings, bridges, and industrial applications.

Technical Drawing or Product Visual	Content of the Declaration
	• Steel structural sections milled at single steel mill owned and operated by SDI and fabricated in North America • Steel made from greater than 90% recycled steel scrap via electric arc furnace (EAF) technology • Cradle-to-gate assessment results

Product Information	Validity / Applicability
This declaration and the rules on which this EPD is based have been examined by an independent verifier in accordance with ISO 14025.	
	
Name: Timothy S. Brooke **Date: June 30, 2022**	**Name: Thomas P. Gloria** **Date: June 30, 2022**

EPD Summary

This document is a Type III environmental product declaration by Steel Dynamics, Inc. (SDI) that is certified by ASTM International (ASTM) as conforming to the requirements of ISO 14025. ASTM has assessed that the Life Cycle Assessment (LCA) information fulfills the requirements of ISO 14040 and ISO 14044 in accordance with the instructions listed in the referenced product category rules. The intent of this document is to further the development of environmentally compatible and sustainable construction methods by providing comprehensive environmental information related to potential impacts in accordance with international standards.

This EPD was not written to support any comparative assertions. Even for similar products, differences in declared unit, use and end-of-life assumptions, and data quality may produce incomparable results. It is not recommended to compare EPDs with another organization as there may be differences in assumptions, methodology, allocation methods, and data quality such as variability in datasets and results of variability in assessment software tools.

This EPD presents inventory and impact assessment results which combine the manufacturing stage (A1) of SDI structural sections with industry-average transport to fabrication (A2) and fabrication (A3) as published by AISC in the EPD for “Fabricated Hot-rolled Structural Sections” (American Institute of Steel Construction, 2021). Results are also presented per metric ton of mill product at SDI before being scaled up to account for losses during fabrication.

Scope and Boundaries of the Life Cycle Assessment

The Life Cycle Assessment (LCA) was performed according to ISO 14040 (ISO, 2020a) and ISO 14044 (ISO, 2020b) following the requirements of the ASTM EPD Program Instructions and referenced PCR (UL, 2020).

System Boundary: Cradle-to-gate
Allocation Method: Substitution for co-products
Declared Unit: One metric ton (1,000 kg) of fabricated steel structural sections

EVALUATION VARIABLE	UNIT PER METRIC TON	TOTAL	UNIT PER SHORT TON	TOTAL
Primary Energy, non-renewable	MJ	16,400	BTU	1.41E+07
Primary Energy, renewable	MJ	1,200	BTU	1.03E+06
Global Warming Potential	metric ton CO_2 eq.	1.14	short ton CO_2 eq.	1.14
Ozone Depletion	metric ton R11 eq.	1.61E-12	short ton R11 eq.	1.61E-12
Acidification Potential	metric ton SO_2 eq.	6.04E-03	short ton SO_2 eq.	6.04E-03
Eutrophication Potential	metric ton N eq.	1.36E-04	short ton N eq.	1.36E-04
Photochemical Oxidant Formation	metric ton O_3 eq.	3.72E-02	short ton O_3 eq.	3.72E-02

Additional Information

Structural sections have recycled material content typically greater than 98%.

Fabricated Steel Structural Sections | EPD - 341

Product Description

Structural sections are used in buildings, bridges, and industrial applications. Our structural products include wide flange beams, American standard beams, manufactured housing beams, channels, and H-piling.

Delivered Product Configurations

Steel structural sections are offered in standard lengths but can also be cut to custom specifications.

Product Applicability and Technical Characteristics

Steel structural sections are defined by the following standards:

- ASTM A36/A36M-19 Standard Specification for Carbon Structural Steel
- ASTM A572/A572M-21 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- ASTM A529/A529M-19 Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
- ASTM A992/A992M-20 Standard Specification for Structural Steel Shapes
- ASTM A709/A709M-21 Standard Specification for Structural Steel for Bridges
- ASTM A588/A588M-19 Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
- ASTM A690/A690M-13a(2018) Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments
- CSA G40.20-13/G40.21-13 General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
- American Bureau of Shipping (2019) Ordinary and High-Strength Hull Structural Steel
- AASHTO M270-20 Standard Specification for Structural Steel for Bridges

Additional information can be found on SDI's website at https://lpg.steeldynamics.com/.

Life Cycle Stages

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

Figure 1: Life cycle modules included in analysis

Steel production (A1)

The study represents steel produced at SDI's steel mill in Columbia City, IN. Primary data include the amounts of steel scrap into the facility, alloys and process materials, electricity and fuel consumption, steel output, as well as emissions and wastes from their electric arc furnaces. A1 also includes inbound truck transportation for steel scrap and internal transport was included via reported fuel consumption, based on SDI data.

The declared product does 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 at levels exceeding safe health thresholds.

Transportation to fabrication (A2)

A2 is represented using results from the industry-average EPD for "Fabricated Hot-rolled Structural Sections" published by AISC (American Institute of Steel Construction, 2021).

Fabrication (A3)

A3 is represented using results from the industry-average EPD for "Fabricated Hot-rolled Structural Sections" published by AISC (American Institute of Steel Construction, 2021).

Underlying Life Cycle Assessment

Declared Unit

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

Declared Unit

Name	Required unit	Optional unit
Declared unit	1 metric ton	1 short ton
Density	7,800 kg / m^3	487 lbs. / ft^3

System Boundary

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

- A1: steel production;
- A2: transport to fabrication;*
- A3: steel fabrication.*

* As calculated and published by AISC in the industry-average EPD for “Fabricated Hot-rolled Structural Sections” (American Institute of Steel Construction, 2021).

MND = Module Not Declared

Product Stage			Construction Stage		Use Stage							End-of-Life Stage				Benefits & Loads
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
			EXCLUDED FROM THIS STUDY													
Steel production	Transport to fabrication	Fabrication	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction	Transport	Waste processing	Disposal	Reuse, recovery, recycling potential
x	x	x	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

This EPD represents average SDI structural steel production during the 2020 reference year.

Assumptions

This study describes an annual average structural sections product manufactured by SDI. Module A1 represents primary data from the steel mill, from scrap intake, through steel making and rolling to output of packaged

product. A1 results include structural steel mill product which becomes scrap in fabrication (adopting 7% scrap rate from AISC EPD study). Modules A2 and A3 represent results from the industry-average EPD for “Fabricated Hot-rolled Structural Sections” published by the (American Institute of Steel Construction, 2021)

Cut-off Criteria

All available energy and material flow data were included in the model for the processes identified within the system boundary of this study. The PCR’s cut-off criteria were applied only in the case of packaging. Based on a check of packaging data, packaging was shown to represent less than 1% of steel output mass and is, therefore, excluded under the cut-off criteria provided by the PCR. In cases where life cycle inventory data were not available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts.

Data Quality

A variety of tests and checks were performed throughout the project to ensure high quality of the completed LCA. Checks included an extensive review of the LCA model as well as the background data used.

Temporal Representativeness

Primary data represent twelve months of continuous operation in the 2017 calendar year. All secondary data came from the GaBi 2022 databases and are representative of the years 2016 to 2021. Structural sections A2 (transport to fabrication) and A3 (fabrication) results are adopted from AISC industry average EPD representing the 2019-2020 calendar years, with secondary data from the GaBi 2022 databases. As the study is intended to represent structural sections produced in 2020, temporal representativeness is considered to be high.

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, U.S., European, or global data were used as proxies. Geographical representativeness is considered to be good.

Technological Representativeness

The majority of primary data and all secondary data were modeled to be specific to the technologies or technology mixes under study. Structural sections production data represent manufacturing via electric arc furnace. Overall, technological representativeness is considered to be high.

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).

Completeness

Each unit process was checked for mass balance and completeness of the emission inventory. No foreground data were omitted in this study, except for packaging which was sufficiently small and not anticipated to significantly impact results. This approach is in line with the cut-off criteria in the PCR.

Consistency

To ensure consistency, all primary data were collected with the same level of detail (i.e., using consistent data collection templates), while background data were sourced from the GaBi 2022 databases. Allocation and other methodological choices were made consistently throughout the model.

Reproducibility

Reproducibility is supported as much as possible through the disclosure of input-output data, dataset choices, and modeling approaches. Based on information provided in the background LCA report, any third party should be able to approximate the results of this study using the same data and modeling approaches.

Sources of Data

Primary data for structural sections manufacturing were provided by SDI. Secondary data were obtained from GaBi 2022.1 databases.

Uncertainty

SDI provided complete facility data.

Allocation

Regarding co-products from structural sections production—system expansion is used to address these co-products from the steel mill. As such, zinc content in the baghouse dust (on average, 18% by weight) is credited with the production of primary zinc; slag is repurposed as embankment and credited with gravel production; and mill scale is credited with primary iron. Where manufacturing inputs, such as electricity use, were not sub-metered, they were allocated by mass.

Allocation of background data (energy and materials) taken from the GaBi 2022 databases is documented online at http://www.gabi-software.com/international/databases/gabi-databases/.

LCA: Results

Results

Life cycle assessment results are presented per metric ton (required reporting unit) and per short ton (optional reporting unit) of fabricated steel product. Results are also presented per metric ton of mill product at SDI before being scaled up to account for losses during fabrication.

The product stage (modules A1-A3) has been aggregated into a single number for each metric shown here, including module A2 and A3 results from the industry-average EPD for "Fabricated Hot-rolled Structural Sections" published by the (American Institute of Steel Construction, 2021).

Primary energy use represents lower heating value.

Table 1: Product stage energy results per 1 metric ton of fabricated structural sections

Primary energy	Units	A1	A2	A3	Total
Renewable primary energy excluding resources used as raw materials	MJ LHV	9.17E+02	6.24E+01	2.16E+02	**1.20E+03**
Renewable primary energy resources used as raw materials	MJ LHV	-	-	-	**-**
Non-renewable primary energy excluding resources used as raw materials	MJ LHV	1.42E+04	6.91E+02	1.47E+03	**1.64E+04**
Non-renewable primary energy resources used as raw materials	MJ LHV	-	-	1.26E+01	**1.26E+01**

Table 2 : Product stage material resource results per 1 metric ton of fabricated structural sections

Material resource use	Units	A1	A2	A3	Total
Use of secondary material	tonne	-	-	7.52E-04	**7.52E-04**
Use of secondary fuel (renewable)	MJ LHV	-1.98E-22	-	-	**-1.98E-22**
Use of secondary fuel (non-renewable)	MJ LHV	-2.33E-21	-	-	**-2.33E-21**
Recovered energy (RE)	MJ LHV	-	-	-	**-**
Use of net fresh water resources	m^3	3.70E+00	1.81E-01	6.82E-01	**4.56E+00**

Table 3 : Product stage waste and other environmental output results per 1 metric ton of fabricated structural sections

Waste or environmental output	Units	A1	A2	A3	Total
Hazardous waste disposed	tonne	1.98E-10	0.00E+00	3.32E-04	3.32E-04
Non-hazardous waste disposed	tonne	4.09E-02	0.00E+00	9.66E-03	5.06E-02
High radioactive waste	tonne	1.30E-09	3.16E-08	1.18E-07	1.45E-06
Low radioactive wastes	tonne	2.38E-08	2.64E-05	9.85E-05	1.49E-04
Components for re-use	tonne	-	-	-	-
Materials for recycling	tonne	-	-	0.07	0.07
Materials for energy recovery	tonne	-	-	-	-
Exported energy	MJ LCV	-	-	-	-

Table 4: Product stage life cycle impact assessment results per 1 metric ton of fabricated structural sections

Impact category		A1	A2	A3	Total
Impact Assessment Method: TRACI 2.1					
Global warming potential (GWP)	tonne CO_2 eq.	1.00	0.04	0.10	1.14
Ozone depletion potential (ODP)	tonne R11 eq.	-1.06E-14	8.67E-17	1.62E-12	1.61E-12
Acidification potential (AP)	tonne SO_2 eq.	5.71E-03	1.83E-04	1.52E-04	6.04E-03
Eutrophication potential (EP)	tonne N eq.	1.07E-04	1.64E-05	1.23E-05	1.36E-04
Smog formation (SFP)	tonne O_3 eq.	3.05E-02	4.44E-03	2.23E-03	3.72E-02
Impact Assessment Method: CML 2001 (version April 2013)					
Abiotic depletion potential, elements (ADPe)[1][2]	tonne Sb eq.	5.13E-06	-	-	-5.13E-06
Abiotic depletion potential, fossil (ADPf)	MJ LCV	11.42	0.07	0.10	11.60

[1] This indicator is based on assumptions regarding current reserves estimates. Users should use caution when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

[2] The AISC EPD did not publish ADPe results for categories A2 and A3 so these values are unknown and therefore zero

LCA: Interpretation

Visualization of Life Cycle Impact Assessment

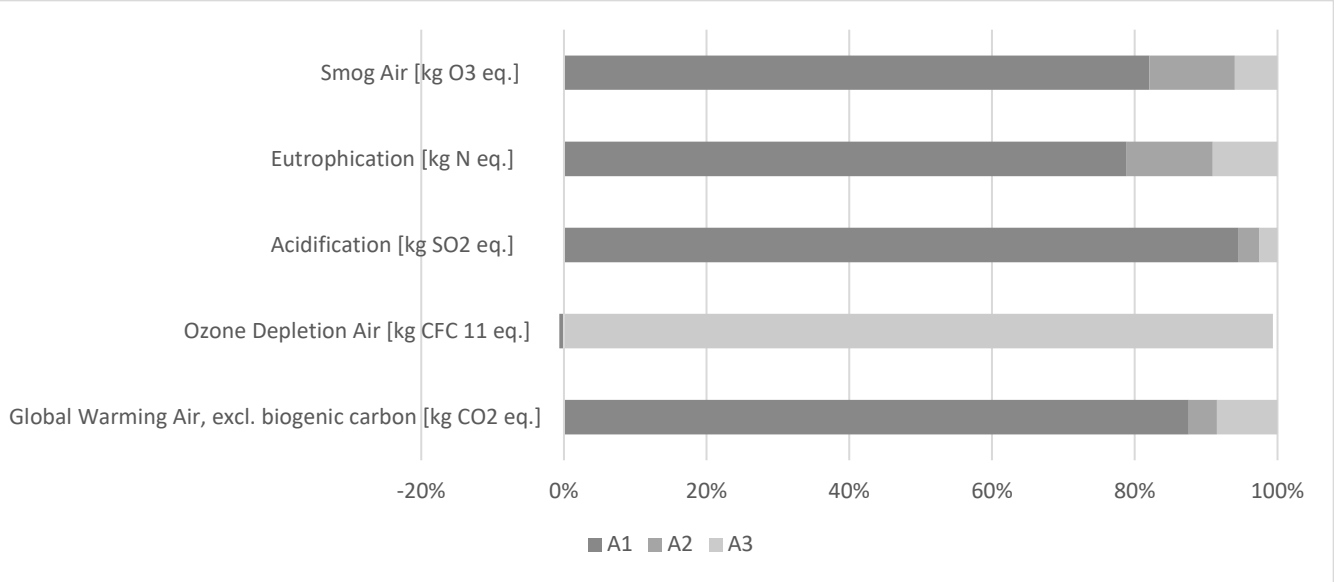


Figure 2: Relative contribution to life cycle modules to product stage impact assessment results

Note: ODP is dominated by the A3 stage, likely due to older data used to calculate results for AISC's EPD (American Institute of Steel Construction, 2021).

Disclaimer

This Environmental Product Declaration (EPD) conforms to ISO 14025, ISO 14040, ISO 14044, and ISO 21930 (ISO, 2017).

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.

Additional Environmental Information

Results

Life cycle assessment results above are presented per metric ton (required reporting unit) and per short ton (optional reporting unit) of fabricated structural sections. Here are results reported per metric ton of mill product leaving SDI. These results represent the unfabricated impacts of structural sections and they don't include a scaling factor which is applied above to account for 7% cutting waste which happens during fabrication.

In these tables, A1 represents the raw material inputs to steelmaking, A2 is the inbound transportation of those inputs, and A3 represents the energy and emissions associated with the steelmaking and rolling mill within SDI.

Table 5: Primary energy demand by usage for 1 metric ton of unfabricated structural section mill product [MJ LHV]

	A1	A2	A3	Total
Renewable primary energy excluding resources used as raw materials	1.33E+02	1.82E+01	7.06E+02	**8.57E+02**
Renewable primary energy resources used as raw materials	-	-	-	**-**
Non-renewable primary energy excluding resources used as raw materials	2.41E+03	4.72E+02	1.04E+04	**1.33E+04**
Non-renewable primary energy resources used as raw materials	-	-	-	**-**

Table 6: Other resources for 1 metric ton of unfabricated structural sections mill product

	Units	A1	A2	A3	Total
Use of secondary material	tonne	-	-	-	**-**
Use of secondary fuel (renewable)	MJ LHV	-	-	-1.85E-22	**-1.85E-22**
Use of secondary fuel (non-renewable)	MJ LHV	-	-	-2.18E-21	**-2.18E-21**
Recovered energy (RE)	MJ LHV	-	-	-	**-**
Use of net fresh water resources	m^3	4.99E-01	6.52E-02	2.89E+00	**3.45E+00**

Table 7: Wastes for 1 metric ton of unfabricated structural sections mill product

	Units	A1	A2	A3	Total
Hazardous waste	tonne	6.34E-11	1.96E-12	1.20E-10	1.85E-10
Non-hazardous waste	tonne	1.60E-02	4.03E-05	2.23E-02	3.83E-02
High radioactive waste	tonne	3.70E-08	1.55E-09	1.18E-06	1.22E-06
Low radioactive wastes	tonne	6.79E-07	2.83E-08	2.16E-05	2.23E-05

Table 8 TRACI 2.1 and ADP impact assessment results for 1 metric ton of unfabricated structural section mill product

	Units	A1	A2	A3	Total
Global warming potential (GWP)	tonne CO_2 eq.	0.18	0.03	0.72	0.93
Ozone depletion potential (ODP)	tonne R11 eq.	3.55E-15	6.33E-17	-1.35E-14	-9.89E-15
Acidification potential (AP)	tonne SO_2 eq.	9.24E-04	1.11E-04	4.30E-03	5.33E-03
Eutrophication potential (EP)	tonne N eq.	1.96E-05	1.09E-05	6.95E-05	1.00E-04
Smog formation (SFP)	tonne O_3 eq.	9.37E-03	2.57E-03	1.66E-02	2.85E-02
Abiotic depletion potential, elements (ADPe)[3]	tonne Sb eq.	1.20E-07	1.10E-08	-4.92E-06	-4.79E-06
Abiotic depletion potential, fossil (ADPf)	MJ LCV	2.32	0.47	7.88	10.67

Table 9: IPCC AR5 GWP100 results, per 1 metric ton of unfabricated structural sections mill product

	Units	A1	A2	A3	Total
Global warming potential (GWP)	tonne CO_2 eq.	0.19	0.03	0.74	**0.95**

[3] This indicator is based on assumptions regarding current reserves estimates. Users should use caution when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

References

American Institute of Steel Construction. (2021). *AISC.* Retrieved from aisc.org: https://www.aisc.org/globalassets/why-steel/epd-aisc-hr-sections-2021.pdf

ASTM. (2020). General Program Instructions, Version: 8.0. ASTM Program Operator for Product Category Rules (PCR) and Environmental Product Declarations (EPDs).

EPA. (2012). *Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI) - User's Manual.* Washington, D.C.: US EPA.

ISO. (2006). *ISO 14025: Environmental labels and declarations - Type III environmental declarations - Principles and procedures.* Geneva: International Organization for Standardization.

ISO. (2020a). *ISO 14040: Environmental management - Life cycle assessment - Requirements and guidelines. Geneva: International Organization for Standardization. Amd 1: 2020.*

ISO. (2020b). *ISO 14044: Environmental management - Life cycle assessment - Principles and framework. Geneva: International Organization for Standardization. Amd 1:2017 / Amd 2:2020.*

ISO. (2017). *ISO 21930: Sustainability in building construction - Environmental declaration of building products.* Geneva: International Organization for Standardization.

UL. (2020). PCR Part B: Designated Steel Construction Products.

UL Environment. (2018). PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Document: 10010 v.3.2.

UL Environment. (2020). PCR Guidance for Building-Related Products and Services Part B: Designated Steel Construction Product EPD Requirements. Document: 10010-34 v.2.0.

Contact Information

Study Commissioner

Steel Dynamics, Inc. (SDI)
2601 South County Road 700 East
Columbia City, Indiana 46725
+1 (260) 625-8100
https://lpg.steeldynamics.com/
https://stld.steeldynamics.com/

LCA Practitioner

Sphera Solutions, Inc.
130 E Randolph St, #2900
Chicago, IL 60601
https://sphera.com/contact-us/
www.sphera.com