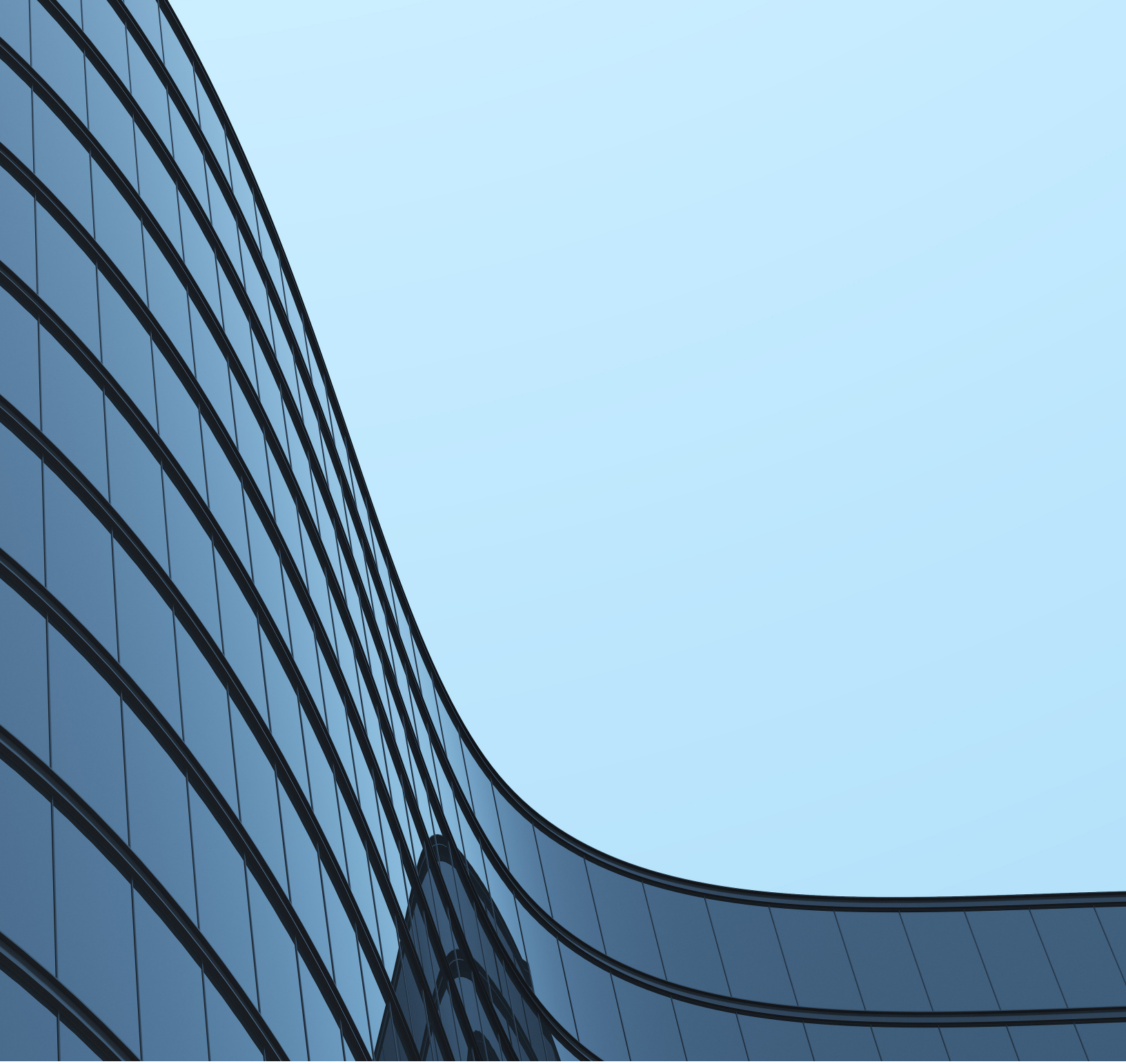


SUSTAINABLE STEEL

SPECIFICATION WRITING GUIDE

NUCOR®

NOTE TO SPECIFIER

This document is meant to serve as a guide to aid designers in specifying embodied carbon limits on steel materials through the addition of language to structural steel specifications (CSI Masterformat Division 05) to meet a project's sustainability goals. The sample language provided in this guide is intended to be inserted into project specifications, where applicable, to meet a project's needs. All language and benchmark values included in this guide are to be reviewed and assessed on a project-by-project basis by a qualified professional to determine feasibility.

Nucor recommends meeting with ownership, the construction team, and the design team to establish overall sustainability goals in the initial stages of a project. As always, Nucor's Construction Solutions team is available to answer any questions or for additional project assistance.

ABOUT US

Nucor is the largest steel products manufacturer in North America, and we recognize our role in protecting the environment. We value the environment of the communities in which we operate, and recognize its importance to our teammates, their families, and our continued welfare. Protecting the environment is critical to our operations and the company's long-term success. To this end, we endorse the following principles:

PERFORMANCE

To continuously improve the effectiveness of our ISO 14001:2004 or ISO 14001:2015 Environmental Management System (EMS). Nucor will:

- Pursue pollution prevention and waste minimization opportunities;
- Investigate and develop technologies and operations that improve environmental performance;
- Regularly evaluate the EMS and make appropriate improvements.

STEWARDSHIP

Nucor recognizes our potential for environmental impact on the communities in which we operate. We will continuously strive to minimize these effects by evaluating our operations and researching new technologies and opportunities.

RESPONSIBILITY

Environmental protection is the individual obligation of each Nucor teammate and a primary responsibility of management. Nucor requires our contractors, vendors, and suppliers to comply with applicable environmental laws.

STANDARD

Nucor and its divisions will comply with the laws and regulations governing our operations. Environmental compliance is a priority for Nucor management equal with all other business functions.

OUTREACH

Nucor will strive to foster open dialogue so that we may effectively communicate with our teammates, our neighbors, and other concerned parties.

BACKGROUND

Annually, nearly 40 percent of all global greenhouse gas (GHG) emissions can be attributed to the building and construction sectors. The carbon emissions directly associated with the manufacturing of building materials and building construction, commonly referred to as embodied carbon, are responsible for approximately 11 percent of the annual GHG emissions generated globally[1]. According to Architecture 2030, the estimated global building floor area is expected to double by 2060. That's the equivalent of adding an entire New York City to the globe, every month, for the next 38 years. Therefore, it is imperative for the architecture, engineering, and construction (AEC) community to strive to reduce embodied carbon in their designs.

In 2021, the World Steel Association estimated that the average global production of one metric ton of steel created approximately 1.91 tons of CO2 emissions[2].

THERE ARE TWO MODERN STEELMAKING METHODS:

Extractive Steel: Basic Oxygen Furnaces (BOF)
Steel as created using raw materials (iron ore, coal, and limestone) as primary inputs and predominantly using coal power and natural gas as a fuel source. BOF steel can contain up to 30 percent recycled content, but the global average is much lower. This energy intensive process requires an average of 24 GJ[3] to produce a metric ton of steel. The global average CO_2 intensity for BOF steel production was **2.32 tons** of CO_2 per ton of steel in 2021.

Circular Steel: Electric Arc Furnaces (EAF)
Steel as created using recycled scrap steel and electricity as a primary heat source. EAF steel can contain over 90 percent recycled content and requires only around 10 GJ[3] of energy to produce a metric ton of steel. The global average CO_2 intensity for EAF steel production was **0.67 tons** of CO_2 per ton of steel in 2021.

Making steel with EAF produces less than 1/3 of the emissions of steel made with BOF.

To learn more, click here or scan the QR code.

Through recycling, EAF steelmaking utilizes the scrap steel available to bypass the polluting step of processing raw materials in the BOF process. With less than half the energy demands and one-third of the CO_2 emissions, EAF made steel is much more energy efficient and environmentally friendly than steel produced by its BOF counterparts.

Globally, approximately 74 percent of steel is produced in BOFs, while the remaining 26 percent is produced in EAFs. However, these values are nearly reversed for steel produced in the United States, with approximately 70 percent of North American steel production coming from an EAF facility. The prevalent use of EAF mills domestically makes sourcing steel manufactured in the United States an ideal way to reduce a building's embodied carbon while reducing project risks associated with importing materials.

Structural steel specifications can be updated to inform material procurement practices, creating a path to source steel with fewer carbon emissions.

Public policies, building codes and certifications have primarily focused on reducing operational energy and carbon. However, the ratio between operation carbon and embodied carbon, which is associated with the manufacturing of the building materials, can potentially be one-to-one. Therefore, the effort to decarbonize the building sector has expanded to include embodied carbon alongside operational carbon.

Policies at municipal, state, and federal levels have been implemented to influence procurement practices on building projects. For example, the Buy Clean California Act, which went into effect in July 2022, established limits on embodied carbon for different construction materials, including structural steel. Whether required by legislation or motivated by project sustainability goals, architects and engineers need to be knowledgeable on how to incorporate sustainability into their design procedures and add procurement parameters into their construction documents. Upfront communication with all parties involved, especially the general contractor and steel fabricator, will ensure proper procurement of required materials.

ENVIRONMENTAL PRODUCT DECLARATIONS

INTRODUCTION INFO

A key tool for measuring a building material's environmental impacts is an environmental product declaration (EPD). An EPD is an independently verified and registered document that communicates transparent and comparable information about the environmental impact of a product over its life cycle. In some ways an EPD is like a nutrition label, stating what a product is made of and estimating how the production of it impacts the environment. When designers, contractors, and owners have a better understanding of the impact each material will have on their building with data reporting like EPDs, they can make the best choices to achieve project-specific sustainability goals.

The creation of an EPD must be regulated to ensure the document is a verified, accurate, apples-to-apples comparison of products. When EPDs are created, they must follow the guidelines and requirements of a product category rule (PCR). The current PCR regulating structural steel is the "North American Product Category Rule for Designated Steel Construction Products." Additionally, all EPDs must follow the requirements and guidelines of an International Organization for Standardization (ISO) standard; the structural steel industry-wide EPD is governed by ISO 14025.

Either an industry-wide or company-by-company approach can be utilized for structural materials like steel. The key is that there are several steps in the structural steel supply chain, each with their own processes and environmental impacts, which must be properly accounted for and modeled to create an accurate EPD.

EPDs of different materials are not directly comparable. Full conformance with a PCR allows EPD comparability only when the PCR-mandated stages of a life cycle have been considered. For example, one ton of wood does not equal one ton of steel; therefore, it is important that a whole building life cycle analysis (WBLCA) and design be performed to accurately determine a structure's environmental impacts and material quantities.

On January 1, 2021, Nucor had only one EPD for one product, covering one Nucor facility. As of 2023, Nucor has 12 EPDs for seven different products, encompassing over 40 Nucor facilities, and we are looking to further develop additional EPDs each day. Requiring the submission of EPDs will encourage manufacturers to produce more EPDs for their products, thus improving documentation, transparency, and further benchmarking within the industry.

COMMENTARY

PART 1.A.1

The specifier must explicitly state which products will require the submission of EPDs for their project. For example, the Buy Clean California Act (BCCA) mandates the submission of EPDs for structural steel (hot-rolled sections, hollow structural sections, and plate). These products fall under Section 051200. In addition to structural steel products, Nucor recommends requiring EPDs for steel floor and roof decking [Section 053000].

While rebar is a steel product covered by BCCA, sample concrete reinforcing steel (rebar) specifications are not in the scope of this guide. The language in this part may be added to other specification sections, such as steel joists, rebar, and other products, to meet project goals or as the specifier deems appropriate.

PART 1.A.2

Global Warming Potential (GWP) is the primary metric, or impact category, indicated on EPDs that is required for their direct work as noted in Part 1.A.2.a, but the balance of impact categories (Part 1.A.2.b to Part 1.A.2.f) shall also be reported. These impact categories are required to produce a comprehensive building life cycle assessment and are required for meeting targeted LCA LEED v4 points. Adding language to this section will allow EPD requirements to remain in one part of the overall project specification and avoid the duplication of information. If LEED credits are not being pursued, or the designer prefers for LEED language to be located solely in another specification section, then it is acceptable to omit the language for non-GWP impact categories (Part 1.A.2.b to Part 1.A.2.f).

PART 1.A.3

As previously noted, there are two different types of EPDs: industry-wide (IW-EPDs) and manufacturer-specific EPDs. For the purposes of early-phase project studies or embodied carbon calculations, it is recommended that specifiers use IW-EPDs for each building product, as the manufacturer of the product may not be known in the early phases of a project. The parties responsible for procurement should be selecting products based on GWP criteria from manufacturer-specific EPDs. Once the project reaches a phase when sourcing of a product is confirmed by the project's construction team, the manufacturer-specific GWP values from the appropriate facility may be used to further refine LCA studies or calculations.

Industry-wide EPDs are not acceptable for material procurement and may not be submitted for review. It is critical that each product covered under Part 1.A.1 be traceable back to a manufacturer. Thus, the GWP values indicated on an EPD must be associated with the specific plant location(s) matching the procured product.

EPD SAMPLE LANGUAGE – STEEL FRAMING

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL
1.0X SUBMITTALS

A. Environmental Product Declarations (EPD): Submit manufacturer's EPD per the following:

1. EPDs to be submitted for each of the following structural steel types:
    a. Hot-rolled structural sections (W, S, M).
    b. Hollow structural sections (HSS).
    c. Structural plate.

2. All EPDs are to be third-party verified in accordance with the current version of ISO 14025 (validated by a date that has not expired) and indicate the following Impact Categories:
    a. Global Warming Potential (GWP): All GWP information submitted shall be in the form of $kgCO_2eq/kg$.
    b. Ozone Depletion Potential (ODP): All ODP information shall be in the form of kgCFC-11/kg.
    c. Acidification Potential (AP): All AP information shall be submitted in the form of kgSO2/kg.
    d. Eutrophication Potential (EP): All EP information submitted shall be in the form of kgN/kg.
    e. Smog Formation Potential (SFP): All SFP information shall be submitted in the form of kgO3/kg.
    f. Energy Consumption: All energy consumption information shall be submitted in the form of MJ.

3. Manufacturer-specific GWP information will be one of the decision criteria when awarding this scope. The manufacturer EPD must indicate GWP information from the specific mill or plant facility from which the material is to be procured. EPDs including GWP information for more than one facility are acceptable as long as each facility's GWP information is reported separately. EPDs reporting GWP values as averages from multiple facilities only or industry-wide EPDs are not acceptable.

4. EPDs must clearly indicate the Product Flow Diagram disclosing if product fabrication is included within the "cradle-to-gate" life cycle scope (product stages A1-A3) of the EPD.

PART 1.A.4

EPDs for most building products will cover a "cradle-to-gate" product life cycle, with additional stages or modules provided in some cases. Cradle-to-gate refers to modules A1-A3, or the "Product Stage" of the steel product life cycle. It is important to note whether the EPD provided considers the product to be fabricated or unfabricated.

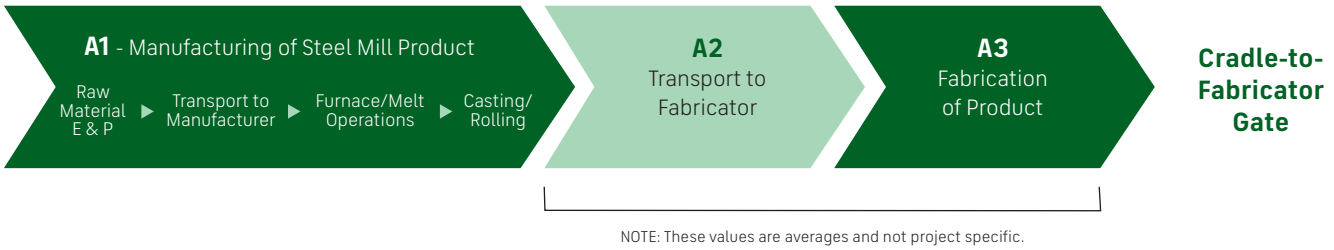
- An unfabricated steel product is the product supplied directly by a steel mill or plant. For example, a wide-flange column that has not been drilled, welded to, or modified is referred to as unfabricated. The life cycle for this type of product is referred to as "Cradle-to-Mill Gate."

- A fabricated steel product is one that has been manufactured by a steel producer, transported to a fabricator or secondary processor, and then altered into its final form prior to installation. Following the previous example, once the wide-flange column is drilled for field bolting, cut as required or has connection material welded to it, the product is now considered to be fabricated. The life cycle for this type of product is referred to as "Cradle-to-Fabricator Gate."

The Product Stage modules A1-A3 differ between the two types of products as depicted in the graphic below.

UNFABRICATED STEEL PRODUCT LIFE CYCLE STAGES

FABRICATED STEEL PRODUCT LIFE CYCLE STAGES



NOTE: These values are averages and not project specific.

It is recommended to use the unfabricated steel mill product GWP as the standard measure of GWP. Additionally, unfabricated product GWP can be derived from a fabricated product EPD. The inverse is not true. However, it is ultimately up to the specifier to choose whether fabricated or unfabricated EPDs shall be submitted based on project preference.

- For an unfabricated steel product, the controlling GWP is the sum of values from modules A1, A2 & A3 indicated within the EPD.

- For a fabricated steel product, the controlling GWP is only the value from module A1, which represents the mill product and "Cradle-to-Mill Gate" life cycle. Refer to the Appendix for an example showing how to calculate the GWP of an unfabricated product when a fabricated product EPD is provided.

Some manufacturer EPDs will provide GWP information for the "End of Life Stage" (Module C) or additional benefits beyond the system boundaries (Module D) to account for material reuse or recycling. It is important to note which product stages are included in an EPD – in addition to various other information including manufacturer, facility locations, product specific inputs, and system boundaries.

EPD SAMPLE LANGUAGE – STEEL DECKING

SECTION 05 30 00
STEEL DECKING

PART 1 - GENERAL
1.0X SUBMITTALS

A. Environmental Product Declarations (EPD): Submit steel floor or roof deck manufacturer's EPD per the following:

1. All EPDs are to be third-party verified in accordance with the current version of ISO 14025 (validated by a date that has not yet expired) and indicate the following Impact Categories:
    a. Global Warming Potential (GWP): All GWP information submitted shall be in the form of $kgCO_2eq/kg$.
    b. Ozone Depletion Potential (ODP): All ODP information shall be in the form of kgCFC-11/kg.
    c. Acidification Potential (AP): All AP information shall be submitted in the form of $kgSO_2/kg$.
    d. Eutrophication Potential (EP): All EP information submitted shall be in the form of kgN/kg.
    e. Smog Formation Potential (SFP): All SFP information shall be submitted in the form of kgO_3/kg.
    f. Energy Consumption: All energy consumption information shall be submitted in the form of MJ.

2. Manufacturer-specific GWP information will be one of the decision criteria when awarding this scope. The manufacturer EPD must indicate GWP information from the specific mill or plant facility from which the material is procured. EPDs including GWP information for more than one facility are acceptable as long as each facility's GWP information is reported separately. EPDs reporting GWP values as averages from multiple facilities only or industry-wide EPDs are not acceptable.

3. EPDs must clearly indicate the Product Flow Diagram disclosing if product fabrication is included within the "cradle-to-gate" life cycle scope (product stages A1-A3) of the EPD.

GLOBAL WARMING POTENTIAL

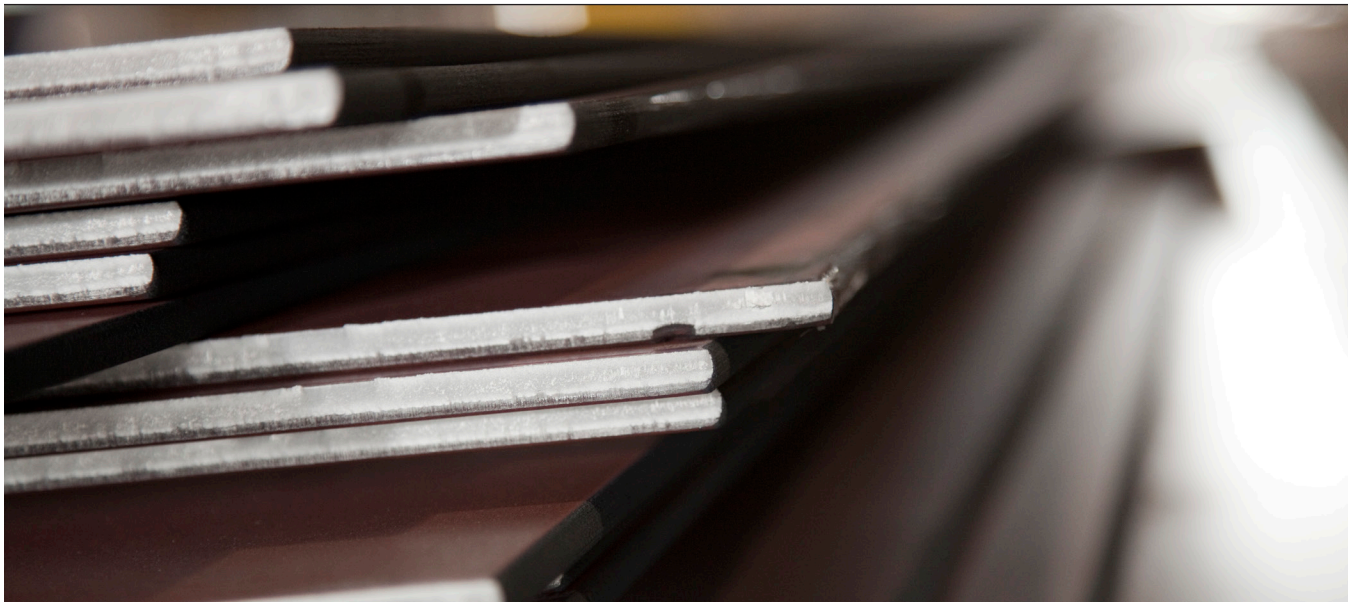
INTRODUCTION

A building's embodied carbon is the greenhouse gas emissions released during the following life-cycle stages: raw material extraction, transportation, manufacturing, construction, maintenance/renovation, and end-of-life of the structure. It is reported as global warming potential (GWP), using the impact of one molecule of carbon dioxide as the frame of reference. Therefore, GWP is reported as kg CO_2e. Targeting more sustainable material procurement results in lower embodied carbon from the materials used in construction.

EMBODIED CARBON kg CO_2eq = **PRODUCT QUANTITY** metric ton (from material takeoff) × **PRODUCT GWP** kg CO_2eq/metric ton (from EPD)

With nearly 40 percent of the annual, global GHG emissions attributed directly to the building and construction sectors, it is critical that the AEC community requests open and transparent documentation of building products' embodied carbon to continue to provide more sustainable structures for the future. Specifications can be used to limit the GWP of materials procured for projects. This builds upon the increasing availability of EPDs, making it possible to discern the embodied carbon impacts of different products.

Nucor has committed to a 35 percent reduction in our combined Scope 1 and 2 greenhouse gas emissions by 2030. This will lower Nucor's greenhouse gas emissions intensity of steel mills to 77 percent less than today's global steelmaking average. Implementing GWP limits encourages producers to improve their manufacturing practices and lower their carbon intensities.



COMMENTARY

PART 2.A

Per the prior section, it is recommended to use GWP of unfabricated products as the determining criteria for material selection. This places the focus on the GWP impact of the steelmaking process, which is significantly greater than the GWP contributions of transportation to the fabricator (Fabricated A2) and fabrication (Fabricated A3) stages. Fabricated A2 and A3 GWP impacts are assumed values based on average distance from mills to customers and average fabrication for the specified product and are not specific to a project. Additionally, even if a fabricated product EPD is provided, the unfabricated GWP value can be derived.

In an ideal scenario, all material procured will meet the GWP limitations imposed by this section of the specification. Since that may not always be possible, it is recommended to leave an allowance for material (by overall tonnage percent) that does not meet the GWP limitations. This value should be discussed and agreed upon by the project team.

It is also recommended to include GWP limits in the construction documents as a part of the general notes section on structural steel, as shown in the Appendix. This gives prominence to the information in the drawings and encourages review of the values on each project.

PART 2.A.2

It is acceptable to receive fabricated product EPDs when reviewing them against unfabricated limits. Some fabricated EPDs will even provide an unfabricated (i.e., "cradle-to-gate, mill product," "cradle-to-gate, unfabricated," or "cradle-to-mill gate") GWP value. In that case, no further conversion needs to be performed.

The documentation of modules A1-A3 can vary amongst manufacturers. If only a total value (sum of A1, A2 & A3) is provided, it is acceptable to conservatively treat the fabricated product as unfabricated. Furthermore, if each module (A1, A2, A3) is individually documented, it is acceptable to conservatively treat module A1 as the unfabricated product GWP. However, in a fabricated product EPD, the A1 value will include additional impacts beyond the mill-level production of one metric ton (the declared unit of a fabricated steel EPD) of unfabricated steel. This is because the fabrication process generates an amount of unused steel, such as from coping or drilling the material. The ratio of unfabricated material required to produce one unit of fabricated material is called the scrap rate. For example, one metric ton of hot-rolled structural product requires an average of 1.07 metric tons of unfabricated hot-rolled structural steel, so 1.07 is the scrap rate for hot-rolled structural steel. If this value is explicitly documented on the fabricated product EPD, it is acceptable to divide the A1 values by the scrap rate to calculate the unfabricated product values. Refer to the Appendix for a fabricated to unfabricated product GWP sample calculation.

Some construction products like joists are inherently fabricated products. Thus, unfabricated limits cannot be imposed upon them. In the cases of these products, the engineer must clearly state which products fall under the fabricated or unfabricated limits specified. Sample specification language for fabricated structural steel framing and metal deck can be found in the Appendix. The specifier may also opt to allow the submission of either fabricated or unfabricated GWP product, but then must publish "Max. Allowable GWP" values for both fabricated and unfabricated products.

GWP SAMPLE LANGUAGE – STEEL FRAMING

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 2 - PRODUCTS
2.0X MATERIALS

A. Structural Steel Global Warming Potential (GWP): The GWP of unfabricated structural products over its "cradle-to-mill gate" life cycle must not exceed the limits indicated in the table below. The intent is that 85 percent* of the product tonnage for the shapes indicated meet the requirements indicated. The controlling GWP value is to be taken as follows:

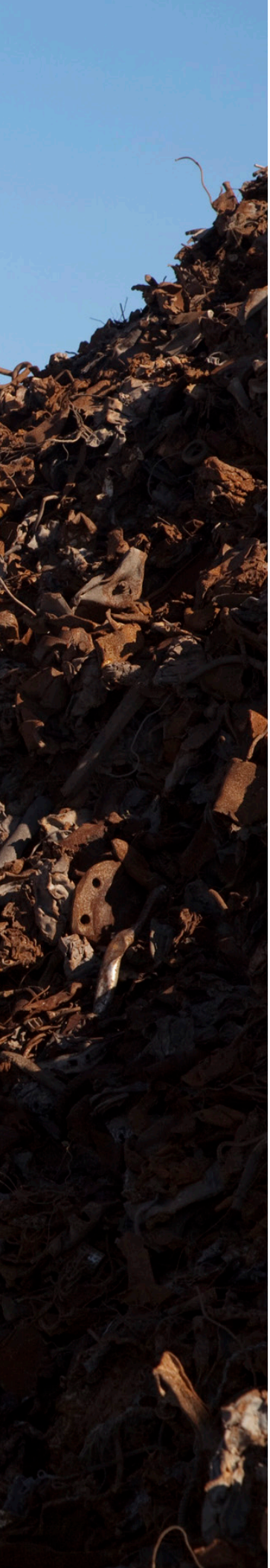
1. If an unfabricated Steel Product EPD is provided, the sum of GWP from product stages A1, A2 and A3 is to be taken as the controlling GWP value.

2. If an EPD for a fabricated steel product is provided, the GWP value listed for "cradle-to-gate, mill product" shall be used.
    a. If the EPD does not explicitly state "cradle-to-gate, mill product," "cradle-to-gate, unfabricated," or "cradle-to-mill gate," the GWP at product stage A1 may be taken as the controlling GWP value.
    b. If the EPD does not explicitly list and separate GWP for product stages A1, A2 and A3 and declares an aggregated GWP for stages A1-3, A1-3 may conservatively be considered as A1.
    c. If the EPD explicitly states that the GWP calculation for the A1 stage includes an allowance for scrap generated during the fabrication process (ex: "scrap rate" = 1.07), it is acceptable to use the stage A1 GWP divided by the "scrap rate" as the controlling GWP value.

PRODUCT	MAX. ACCEPTABLE GWP (MT CO_2EQ/MT STEEL)
Hot-Rolled Structural Sections	**
Plate	**
Hollow Structural Section (HSS)	**

*Percentage of material required to comply with GWP limits is to be established by specifier.
**Maximum acceptable GWP limits are to be established by specifier based on project goals.


RECYCLED
CONTENT



INTRODUCTION

Steel is a very sustainable material because it can be infinitely recycled with no loss to its material properties or strength. In North America, approximately 80 million tons of steel are recycled each year. Since scrap steel is the main ingredient in EAF steelmaking, less mining for raw materials is required to make new steel products. For every ton of recycled steel, approximately 2,500 pounds of iron ore, 1,400 pounds of coal, and 120 pounds of limestone are saved, which means a much lower environmental impact for steel made from recycled scrap. Recycling steel also saves energy – EAF steel production uses nearly 60 percent less energy than BOF steel production.

Globally, only 26 percent of the more than 2 billion net tons of steel produced in 2020 was made by recycling scrap in EAF production. Scrap inputs for the total crude steel production globally have remained at around 35 percent since 2012. To effectively address the goals set by the Paris Climate Agreement, the International Energy Agency recommends that the global market share of EAF production must reach over 40 percent by 2030. Therefore, recycled content is another metric by which the sustainable impact of steel can be measured.

Nucor proudly implements circular steelmaking to recycle scrap into high-quality steel with low emissions, using one of the cleanest and most energy efficient steel-making processes available – EAF steel production. Steel can be infinitely recycled and reused without any quality loss. Nationwide, Nucor steel products are made with an average of 77.3 percent recycled content, with some products containing nearly 100 percent recycled content.

COMMENTARY

PART 1.A.1

Similar to the process of imposing GWP limits on products, adding recycled content as product procurement criteria will require the submission of additional documentation by the construction team for review. The procurement team shall submit recycled content letters or official documentation from the manufacturer of each building product covered under the specification language.

To align with LEED v4 language and "green building" application requirements, it is recommended to set minimum average recycled content values as the total of post-consumer recycled content percentage plus one-half of the pre-consumer recycled content percentage.

In an ideal scenario, all material procured will meet the minimum recycled content limitations imposed by this section of the specification. However, that may not always be possible, so leaving an allowance for material (by overall tonnage percent) that does not meet the limits is recommended. This value should be discussed amongst the project team and negotiated.

RECYCLED CONTENT SAMPLE LANGUAGE, PART 1 - STEEL FRAMING

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL
1.0X SUBMITTALS

A. Recycled Content of Steel Products: Provide documentation in accordance with the current version of ISO 14021 from the manufacturer of each steel product listed below. For each product, both the post-consumer and pre-consumer recycled content percentage by weight must be indicated.

1. W and WT Shapes.
2. Channels, Angles, M and S Shapes.
3. Plates.
4. Hollow Structural Sections (HSS).

RECYCLED CONTENT SAMPLE LANGUAGE, PART 1 - STEEL DECKING

SECTION 05 30 00
STEEL DECKING

PART 1 - GENERAL
1.0X SUBMITTALS

A. Recycled Content of Steel Products: Provide documentation in accordance with the current version of ISO 14021 from the manufacturer of steel floor and roof decking products. For each product, both the post-consumer and pre-consumer recycled content percentage by weight must be indicated.

RECYCLED CONTENT SAMPLE LANGUAGE, PART 2 - STEEL FRAMING

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 2 - PRODUCTS
2.0X MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content such that the post-consumer recycled content plus one-half of the pre-consumer recycled content is not less than the values indicated below. The intent is that 85 percent* of the product tonnage for these shapes meets the requirements listed.

1. W and WT Shapes: **- percent****
2. Channels, Angles, M and S Shapes: **- percent****
3. Plates: **- percent****
4. Hollow Structural Sections: **- percent****

*Percentage of material required to comply with recycled content limits is to be established by specifier.
**Recycled content limits are to be established by specifier.

RECYCLED CONTENT SAMPLE LANGUAGE, PART 2 - STEEL DECKING

SECTION 05 30 00
STEEL DECKING

PART 2 - PRODUCTS
2.0X MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content such that the post-consumer recycled content plus one-half of the pre-consumer recycled content is not less than - percent*. The intent is that 90 percent** of the product tonnage meets this requirement.

*Percentage of material required to comply with recycled content limits is to be established by specifier.
**Recycled content limits are to be established by specifier.

APPENDIX

GWP SAMPLE LANGUAGE - STEEL FRAMING (FABRICATED PRODUCT CRITERIA)

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 2 - PRODUCTS
2.0X MATERIALS

A. Structural Steel Global Warming Potential (GWP): The GWP of fabricated structural products over their "cradle-to-fabricator-gate" life cycle must not exceed the limits indicated in the table below. The intent is that 85 percent* of the product tonnage for the shapes indicated meet the requirements indicated. The controlling GWP value is to be taken as follows:

1. If a fabricated product EPD is provided, the sum of GWP from product stages A1, A2 and A3 is to be taken as the controlling GWP value.
    a. Unfabricated product EPDs will not be accepted.

PRODUCT	MAX. ACCEPTABLE GWP ($MT\ CO_2EQ/MT\ STEEL$)
Hot-Rolled Structural Sections	**
Plate	**
Hollow Structural Section (HSS)	**

*Percentage of material required to comply with recycled content limits is to be established by specifier.
**Recycled content limits are to be established by specifier.

GWP SAMPLE LANGUAGE - STEEL DECKING

SECTION 05 30 00
STEEL DECKING

PART 2 - PRODUCTS
2.0X MATERIALS

A. Structural Steel Global Warming Potential (GWP): The GWP of fabricated steel floor or roof deck products over their "cradle-to-fabricator-gate" life cycle must not exceed the limits indicated in the table below. The intent is that 90 percent* of the product tonnage for the decking meet the requirements indicated. The controlling GWP value is to be taken as follows:

1. A fabricated EPD for each product is to be provided. The sum of GWP from product stages A1, A2 and A3 is to be taken as the controlling GWP value.

PRODUCT	MAX. ACCEPTABLE GWP ($MT\ CO_2EQ/MT\ STEEL$)
Floor or Roof Decking	**

*Percentage of material required to comply with recycled content limits is to be established by specifier.
**Recycled content limits are to be established by specifier.

GENERAL NOTES SHEET
SS STRUCTURAL SHEET

ELEMENT	MIN. STRENGTH (KSI)		ASTM	EPD REQ'D	MAX. GWP ($kgCO_2e/ton$)		MIN. RECYCLED CONTENT %	COMMENTS
	Fy	Fu			UNFAB.	FAB.		
W and WT Shapes	50	65	A992	x				
W14x 90plf & Heavier	65	80	A913	x				
M & S Shapes	50	65	A992	x				
C & MC Shapes	50	65	A572	x				
Angle (L) Shapes	50	65	A572	x				
Square/Rect. & Round HSS	50	62	A500 Gr. C	x				
Plates	50	65	A572	x				

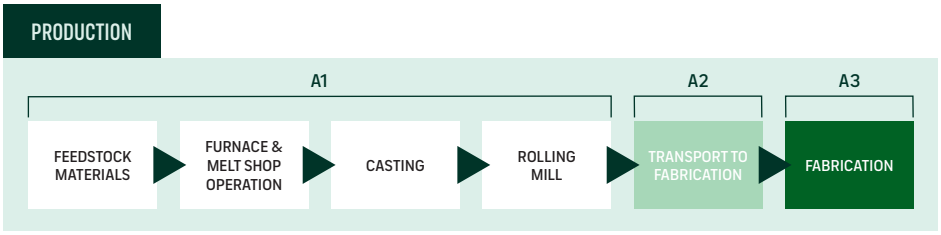
SAMPLE CALCULATION

FIND THE GWP OF AN UNFABRICATED PRODUCT WHEN FABRICATED PRODUCT EPD IS PROVIDED.

STEP 1

Read the introduction of the EPD.

Understand if the EPD is for a fabricated or unfabricated product. Find the EPD product flow chart and system boundary diagram to understand the product's life cycle. It can be determined that this is a fabricated product EPD.



STEP 2

Find the "Scrap-Rate."

The scrap-rate can typically be found in the "LCA Results" section, but documentation can vary between suppliers, so read carefully! The line below is extracted from Nucor's Fabricated Hot-Rolled Structural Steel Sections EPD.

"Fabrication requires 1.07 metric ton of structural sections per 1 metric ton of fabricated product. A1 includes production of all 1.07 metric ton of structural sections."

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS & LOADS BEYOND THE SYSTEM BOUNDARY
RAW MATERIAL SUPPLY	TRANSPORT	MANUFACTURING	TRANSPORT FROM THE 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	D1
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

STEP 3

Locate the facility-specific GWP information, per 1 metric ton.

GWP [KG CO_2 EQ.]	A1	A2	A3	TOTAL	CRADLE-TO-GATE, MILL PRODUCT
Nucor-Yamato Steel	8.75E+02	1.07E+01	1.10E+02	**9.96E+02**	**8.16E+02**

STEP 4

Calculate the unfabricated product GWP

A1 = unfabricated product GWP per 1.07 metric tons of steel (considering scrap rate)
= 8.75E+02 kg CO_2e / 1.07 metric tons of steel
= 8.16E+02 kg CO_2e / 1 metric ton of steel

Note: Some producers explicitly state the unfabricated or mill product GWP values, so you don't have to!

BONUS STEP

Calculate embodied Carbon for 5,000 tons of steel beam

V = 5,000 tons
GWP = 8.16E+02 kg
CO_2e / MT (unfabricated)
EMBODIED CARBON = V x GWP = 4,080 kg CO_2e


RESOURCES

NUCOR RESOURCES

Environmental Product Declarations

Recycled Content Letters

Sustainability Page

Construction Solutions Page

Two Ways to Make Steel Article

Spec Language

REFERENCES

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2. "Sustainability Indicators - worldsteel.org." worldsteel.org, 4 May 2023, worldsteel.org/steel-topics/sustainability/sustainability-indicators.
3. "CO2 Data Report 2021." Worldsteel. September 20, 2021.

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