NSF 1102-23

Product Category Rule for Environmental Product Declarations

PCR for Fenestration Assemblies

Program Operator
NSF International
National Center for Sustainability Standards
Valid through December 31, 2028
ncss@nsf.org

PCR REVISION HISTORY

Version	Date issued
Version 1 (published by Earthsure)	September 2015
Extension	September 2021
Extension	September 2022
Version 2	December 2023

Published by
NSF International
P.O. Box 130140, Ann Arbor, Michigan 48113-0140, U.S.A.

PRODUCT CATEGORY RULES REVIEW PANEL

Program Operator

NSF International

Recommended for adoption by

The PCR Committee for Fenestration Assemblies

Expert Review Panel

Dr. Thomas P. Gloria, Ph.D
Industrial Ecology Consultants
35 Bracebridge Road
Newton, MA 02459 U.S.A.
t.gloria@industrial-ecology.com

Jack Geibig
EcoForm
2624 Abelia Way, Suite 611
Knoxville, TN 37931 U.S.A.
jgeibig@ecoform.com

Bill Stough
Bill Stough, LLC
822 Cherry SE, Suite 203
Grand Rapids, MI 49506 U.S.A.
bill@billstough.net

PCR review panel comments may be obtained by contacting NSF International's National Center for Sustainability Standards at ncss@nsf.org.

NSF International shall ensure that reasonable balance among the members of a PCR committee is achieved and potential conflicts of interest were resolved prior to commencing this PCR development. No participation fees will be charged by NSF International to interested parties for participation on PCR Development Committees, for attendance at PCR Development Committee meetings, or for commenting on a draft PCR document.

ABOUT NSF'S NATIONAL CENTER FOR SUSTAINABILITY STANDARDS (NCSS)

Through the National Center for Sustainability Standards, NSF develops life cycle based, multi-attribute sustainability standards, protocols, and PCRs for various industries including building products and materials, furniture, carpet and flooring, fabrics, wallcoverings, roofing membranes, green chemicals, and water and wastewater.

The National Center for Sustainability Standards will continue to add to its growing portfolio while providing education, outreach, and innovative support to private industry, trade associations, government and academia to foster a consensus-based approach toward conformity assessment in the sustainability field. Visit <www.nsfsustainability.org> or contact ncss@nsf.org.

To initiate your LCA, receive your EPD verification, or have questions on where to start, contact NSF Sustainability at sustainability@nsf.org or 734-476-2543.

CONTENTS

PCR DEVELOPMENT AND STAKEHOLDER CONSULTATION

This PCR documents the goal and scope of life cycle assessments (LCAs) for this product category in order to produce environmental product declarations according to ISO 14025:2006 and ISO 21930:2017. This PCR includes the life cycle phases in order to obtain the raw materials and manufacture fenestration assemblies. The definition of fenestration assemblies is specifically outlined in Section 1 of this document. The scope excludes screens which may be used in some fenestration systems, but are not a requirement of functionality.

The development of this PCR was supported by the Window and Fenestration Assembly Industry (Window & Door Manufacturers Association <www.wdma.com>; Fenestration and Glazing Industry Alliance <www.fgiaonline.org>; and National Glass Association <www.glass.org>) and its members.

1 SCOPE

As stipulated in ISO 21930:2017[1] Clause 1, with the following additions.

This rule covers exterior-grade, finished, assembled fenestration assemblies that selectively permit the passing of air, daylight, or people. Fenestration assemblies provided by a single source, or where products are made at multiple manufacturing locations or travel to different distribution or retail center supplier using industry wide components or fenestration assemblies based on North American data for use in buildings, including skylights, windows, curtain walls, storefronts, and doors. Per ISO 21930:2017, Clause 5.3, and Section 5.3 of this document, products shall be functionally equivalent, and the environmental indicators of the average composition shall not differ by more than ± 10% of the individual. However, the mention of industry-wide components does not necessitate that industry-wide LCA data be used in the LCA models.

All non-optional components that compose fenestration assemblies shall be included in EPDs, using this as a reference PCR, and cannot be excluded under cut-off criteria. In addition, any products that are in-scope under any of the following PCRs are excluded from the scope of this document:

1. *PCR for Interior Architectural Wood Door Leaves*, NSF[2]
2. *Product Category Rule (PCR) Guidance for Building-Related Products and Services*, Part B: "Commercial Steel Doors and Steel Frames EPD Requirements," UL Solutions[3]
3. *Product Category Rule (PCR) Guidance for Building-Related Products and Services*, Part B: "Processed Glass EPD Requirements," UL Solutions[3]

   NOTE — "Section 5 LCA: Results Per Part A, Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts (TRACI) v2.1 impacts in **Error! Reference source not found.** [sic] shall be reported to insure [sic] a North American context." User shall refer to Part A: Life Cycle Assessment Calculation Rules and Report Requirements V4, Table 9.

4. *NGA PCR for Flat Glass: UN CPC 3771*, NSF[2]

[1] International Organization for Standardization. Chemin de Blandonnet 8, Case Postale 401, 1214 Vernier, Geneva, Switzerland. <www.iso.org>

[2] NSF. 789 N Dixboro Road, Ann Arbor, MI 48105. <www.nsf.org/nsf-standards/product-category-rules>

[3] UL Solutions. 33 Pfingsten Road, Northbrook, IL 60062. <www.ul.com/resources/product-category-rules-pcrs>

Any fenestration assembly product type not shown in Table 1 are outside of the scope of this PCR.

This PCR is valid through December 31, 2028.

Table 1
Modification of Table 4-3 from ANSI/NFRC 100-2020 to accommodate fenestration assembly types covered by this PCR

Product type	Opening (X) Non-operating (O)	Model size (width × height) SI (IP)
casement – single	X	600 mm × 1,500 mm (24 in × 59 in)
dual action	X	1,200 mm × 1,500 mm (47 in × 59 in)
fixed	O	1,200 mm × 1,500 mm (47 in × 59 in)
hinged escape	X	1,500 mm × 1,200 mm (59 in × 47 in)
horizontal slider	XO or XX	1,500 mm × 1,200 mm (59 in × 47 in)
JAL/jai awning	X	1,200 mm × 1,500 mm (47 in × 59 in)
pivoted	X	1,200 mm × 1,500 mm (47 in × 59 in)
projecting (awning – dual)	XX	1,500 mm × 1,200 mm (59 in × 47 in)
projecting (awning – single)	X	1,500 mm × 600 mm (59 in × 24 in)
door – sidelite	X or O	600 mm × 2,090 mm (24 in × 82 3/8 in)
skylight/roof window	X	1,200 mm × 1,200 mm (47 in × 47 in)
sliding patio door with frame	XO or XX	2,000 mm × 2,000 mm (79 in × 79 in)

Table 1
Modification of Table 4-3 from ANSI/NFRC 100-2020 to accommodate fenestration assembly types covered by this PCR

Product type	Opening (X) Non-operating (O)	Model size (width × height) SI (IP)
curtain wall/window wall/ storefront/sloped glazing/ ribbon window	OO	2,000 mm × 2,000 mm (79 in × 79 in)
side-hinged exterior door	XO, or XX	1,920 mm × 2,090 mm (75 1/2 in × 82 3/8 in)
tropical awning	X	1,500 mm × 1,200 mm (59 in × 47 in)
tubular daylight device	O	330 mm diameter (14 in diameter)
vertical slider	XO or XX	1,200 mm × 1,500 mm (47 in × 59 in)
NOTE — When two symbols are shown together, it should be understood as follows: XO = a portion of the product is opening, a portion of the product is non-operational XX = all portions of the product are non-operational		

2 NORMATIVE REFERENCES

The following documents are referred to in the text. For undated references, the latest edition of the referenced document (including any amendments) applies.

AAMA/WDMA/CSA 101/I.S.2/A440-11 NAFS, *North American Fenestration Standard/Specification For Windows, Doors, And Skylights*[4]

ANSI/NFRC 100-2020, *Procedure for Determining Fenestration Product U-Factors*[5]

FTC Green Guides[6]

[4] Fenestration and Glazing Industry Alliance. 1900 E Golf Road, Suite 1250, Schaumburg, IL 60173. <www.fgiaonline.org>

[5] National Fenestration Rating Council. 6305 Ivy Lane #410, Greenbelt, MD 20770. <nfrccommunity.org>

[6] Federal Trade Commission. 600 Pennsylvania Avenue, NW, Washington, DC 20580. <www.ftc.gov>

Greenhouse Gas Protocol – Product Life Cycle Accounting and Reporting Standard[7]

ISO 14025:2006, *Environmental labels and declarations – Type III environmental declarations – Principles and procedures*[1]

ISO 14040:2006/AMD 1:2020, *Environmental management – Life cycle assessment – Principles and framework*[1]

ISO 14044:2006/AMD 1:2017/AMD 2:2022, *Environmental management – Life cycle assessment – Requirements and guidelines*[1]

ISO 21930:2017, *Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services*[1]

Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI 2.1)[8]

U.S. Life Cycle Inventory Database, Project Development Guidelines[9]

3 TERMS AND DEFINITIONS

While this PCR will be used primarily in North America, it may be used in other regions where program operators deem it appropriate. Per ISO 21930:2017[1] Clause 3, with the following additions:

background data: Data from processes not under operational control of the EPD owner.

CAS number: Numeric identifier of chemicals provided by the Chemical Abstracts Service.

consumptive water: Water removed from available supplies without return to a water resource system (e.g., water used in manufacturing, agriculture, and food preparation that is not returned to a stream, river, or water treatment plant).

[7] World Resources Institute. 100 G Street NE, Suite 800, Washington, DC 20002. <www.wri.org>

[8] U.S. Environmental Protection Agency. 1200 Pennsylvania Avenue NW, Washington, DC 20004. <www.epa.gov>

[9] National Renewable Energy Laboratory. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. <www.nrel.gov>

curtain wall: Per AAMA/WDMA/CSA 101/I.S.2/A440-05,[4] "an external non-bearing wall, intended to separate the exterior and interior environments."

cutoff criteria: Specification of the amount of material or energy flow or the level of environmental significance associated with unit processes of a product system to be excluded from a LCA study (adapted from ISO 14044[1]).

first tier suppliers: Company selling product to the company seeking the EPD.

foreground data: Data from processes under operational control of the EPD owner.

glazed door: An exterior door having a glazed area of 25% or more of the area of the door.

glazing: *(n)* An infill material such as glass or plastics; *(v)* The process of installing an infill material into a prepared opening in fenestration assemblie, and other products.

intermediate processing: Conversion of raw materials to intermediates (e.g., bauxite ore into aluminum, etc.).

primary data: Raw data is data by company individuals that are directly related to that company, e.g., electricity invoices, monthly monitoring data, supplier sources, etc.

raw material (primary): Made from materials initially extracted from nature. Examples include bauxite ore, petroleum, etc. that are used to create basic materials used in the production of windowfenestration assemblies (e.g., aluminum, vinyl).

raw material (secondary): Recovered, reclaimed, or recycled content that is used to create basic materials for the production of window assemblies (e.g., timber).

skylight: A specific type of fenestration assembly installed at a slope of 60° from horizontal or less.

windows fenestration assembly: An operable or non-operable product that is part of a building enclosure that admits sunlight and sometimes provides ventilation, and is usually framed and glazed.

4 ACRONYMS AND ABBREVIATED TERMS

Per ISO 21930:2017[1] Clause 4, with the following additions:

AAMA American Architectural Manufacturers Association
ANSI American National Standards Institute
AP acidification potential
B2B business to business
B2C business to consumer
BOM bill of materials
CAS Chemical Abstracts Service
CSA CSA Group
EN European Standards
EP eutrophication potential
EPD environmental product declaration
EU European Union
FGIA Fenestration and Glazing Industry Alliance
FSC Forest Stewardship Council
FTC Federal Trade Commision
GHG greenhouse gas
GWP global warming potential
ILCD International Reference Life Cycle Data System
IPCC Intergovernmental Panel on Climate Change
IRC International Residential Code
ISO International Organization for Standardization
LCA life cycle assessment
LCACP Life Cycle Assessment Certified Professional, through the American Center for Life Cycle Assessment, the Australian LCA Society or the LCA Society of New Zealand
LCI life cycle inventory
LCIA life cycle impact assessment
NAFS North American Fenestration Standard
NERC North American Electric Reliability Corporation
NFRC National Fenestration Rating Council

NGA	National Glass Association
NREL	National Renewable Energy Laboratory
NSF	NSF International
ODP	ozone depletion potential
PCR	product category rule
PEFC	Programme for the Endorsement of Forest Certification
PM	particulate matter
POCP	photochemical oxidant creation potential
RSL	reference service life
SFI	Sustainable Forestry initiative
TRACI	Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts
TRI	Toxics Release Inventory
USLCI	U.S. Life Cycle Inventory
WARM	Waste Reduction Model
WDMA	Window & Door Manufacturers Association
WRI	World Resources Institute

5 GENERAL ASPECTS

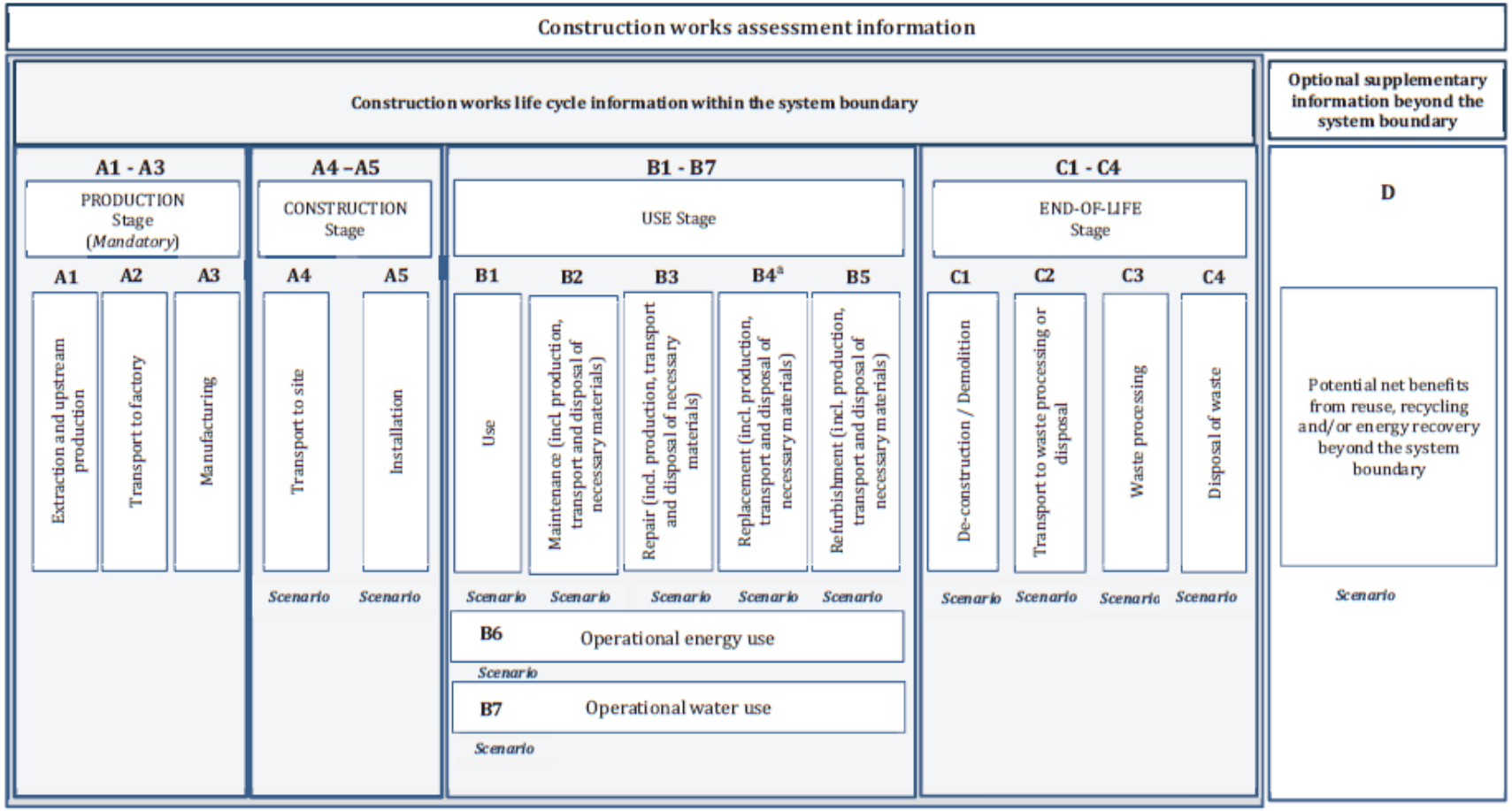
5.1 Objectives of this PCR

This PCR has been developed to conform with ISO 21930:2017[1] and to establish requirements specific to fenestration assemblies. Its overall goals are identical to those stated in ISO 21930:2017 Clause 5.1.

5.2 Life cycle stages

This PCR and any subsequent EPDs shall only use the mandatory modules and the life cycle stages described in ISO 21930:2017 Clause 5.2 and reproduced in Figure 1 below (A1-A3).

Figure 1
Relevant system boundaries, information modules and life cycle stages of building products –
Figure 2, pg. 26 ISO 21930:2017



[a] Replacement information module (B4) not applicable at the product level.

The system boundary of EPDs shall at a minimum be consistent with ISO 21930:2017[1] Clause 5.2. EPDs shall only include the life cycle phases from cradle-to-gate (A1-A3) , inclusion of A4-A5 are optional. This is because of the lack of a single baseline regarding the uses of fenestration assemblies, due to the wide variation in possible use scenarios between various fenestration assemblies. All relevant inputs shall be included in LCA models with the exception of:

- personnel impacts;
- research and development activities;
- business travel; and
- any secondary packaging (pallets, for example).

The rationale for excluding these areas is that they have been determined by LCAs conducted by member companies to represent a negligible environmental impact in the overall life cycle performance of a fenestration assembly. These studies are not publicly available as they are company-specific and contain confidential data, but the general findings and assumptions were discussed and accepted by the PCR Committee.

It should also be noted that certain aggregated LCI data sets used to generate the EPD may not include all relevant flows. These differences should be noted in the data quality assessment discussed in Section 7.2.

Based on the discussions by the PCR development committee, it is believed that no significant data gaps are present in the PCR.

As stipulated by ISO 21930:2017, the system boundary shall follow both the modularity and polluter pays principle. These are discussed in greater detail in Clause 7.1.1 and Table 1 of ISO 21930:2017.

5.3 Average EPDs for groups of similar product

Per ISO 21930:2017[1] Clause 5.3 with the following clarifications and additions:

Given the specifications of fenestration assemblies, average EPDs may be necessary.

For example, if Site A manufactures 80% of the product system covered by the EPD and each kilogram of product manufactured requires 5 MJ of energy, whereas as Site B makes 20% of the product and each kilogram of product manufactured requires 10 MJ of energy, the average energy used per kilogram would be 6 MJ [(80%*5)+(20%*10)].

The same logic would apply for transportation distances.

The same logic applies if multiple products are made at one site. For example, if a site manufacturers five different products and the specific product being assessed only represents 10% of the site's output. Then 10% of the impacts occurring at that manufacturing site shall be applied to that product's LCA impacts and accounting.

If information is unavailable and default values are not already provided by this PCR, justification for any used values shall be documented and disclosed in both the project report and subsequent EPD.

5.4 Use of EPDs for construction products

Per the language in ISO 21930:2017[1] Clause 5.4, the goal of EPDs derived using this sub-category PCR shall be used primarily in a B2B capacity. Any use in a B2C capacity shall follow the rules outlined in ISO 14025:2006 Clause 9.

5.5 Comparability of EPDs for construction products

All comparability requirements stated in ISO 21930:2017[1] 5.5 shall be followed. Comparative assertions (i.e., superiority claims versus a competing product) regarding the specific product system shall not be made in the EPD, and any comparison must also consider both the limitations of LCA as only potential impacts are being reported by the EPD (damage is not being assessed). Additionally, the following statement shall be included in all EPDs using this sub-category PCR:

> *"This EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers or programs, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the construction works level per ISO 21930:2017 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis."*

5.6 Documentation

All documentation requirements outlined in ISO 21930:2017[1] Clause 5.6 shall be met, including those of the project report (also discussed in Section 10 of this sub-category PCR).

6 PCR DEVELOPMENT AND USE

6.1 Core PCR structure

Per ISO 21930:2017[1] Clause 6.1, this sub-category PCR discloses all required elements and utilizes the same format and definitions to ensure conformance.

6.2 Relation between core PCR and sub-category PCR

Per the rules outlined in ISO 21930:2017[1] Clause 6.2, this subcategory PCR utilizes the same structure and references the fenestration assemblies.

6.3 Development of sub-category PCR

The PCR at hand was formally developed by a panel of representatives of fenestration product industry members and manufacturers, raw material suppliers, standards development groups, regulators, and other interested parties and conforms to ISO 21930:2017[1] requirements. This panel interacted with NSF International and members of WDMA, FGIA, and NGA. Appropriate LCIA methodologies were selected based on manufacturing region and will be addressed herein.

7 PCR FOR LCA

7.1 Methodological framework

7.1.1 LCA modeling and calculation

As stipulated by ISO 21930:2017,[1] the LCA approach shall be attributional and system boundary shall follow both the modularity and polluter pays principles. These principles are discussed in greater detail in ISO 21930:2017 in Clause 7.1.1 and Table 1.

7.1.2 Functional unit

ISO 21930:2017[1] Clause 7.1.2 does not apply.

7.1.3 Declared unit

As stipulated in ISO 21930:2017[1] Clause 7.1.3, with the following clarifications:

The declared unit is the appropriate standard frame and glazing area for the relevant fenestration sub-type referenced in Section 1 Table 1 of this sub-category PCR, as referenced in ANSI/NFRC 100[5] Table 4.3 **normalized to one square meter (1 m^2)** of fenestration assemblies (including frame and glass). Glazing beads and stops, sealants, gaskets, and other parts that retain or support the glazing are considered as part of the framing assembly and not the glazing assembly. The product shall also meet the relevant performance standards in ANSI/NFRC 100 per the identified sub-type. Any fenestration assembly product type not shown in Table 1 are outside of the scope of this PCR.

Since manufacturers may make only the frame and since specific glazing may be a function of region and customer preferences, the EPD results shall disclose the LCIA results described in Section 7.3 as a total for the system and the separately for both the frame and glazing in the EPD. This allows for better transparency for both industry and users of the EPDs.

Fenestration assemblies especially in the residential market, include insect screens. However they are not required for the primary function as defined by the PCR. Therefore they shall not be included as part of the declared unit.

> NOTE — Doors may be considerate part of fenestration assemblies where applicable (e.g., French doors, sliding doors, etc.).

7.1.4 Reference service life

As stipulated in ISO 21930:2017[1] Clause 7.1.4, with the following clarification:

Since this PCR does not address Module B (Use), the RSL of the fenestration assembly is not addressed. However, if a warranty period exists for the window or fenestration assembly, this information shall be included in the EPD either in the product description or additional environmental information.

7.1.5 System boundary with nature

See ISO 21930:2017[1] Clause 7.1.5.

7.1.6 System boundary between products systems

As stipulated in ISO 21930:2017[1] Clause 7.1.6.

7.1.7 System boundaries and technical information for scenarios

7.1.7.1 General

See ISO 21930:2017[1] Clause 7.1.7.1

7.1.7.2 A1-A3, production stage

As stipulated in ISO 21930:2017[1] Clause 7.1.7.2, with the following clarification:

The material acquisition, preprocessing, intermediate processing, and processing stage (production stage) starts when the raw materials are extracted from nature (e.g., bauxite ore), and ends when the intermediate materials (e.g., aluminum, glass, etc.) reach the gate of the production facility and are processed into the final nternationa product and packaged for shipping. During production, the product undergoes the transformation from intermediate material to the final fenestration assembly; additionally, any co-products or wastes formed during production shall be accounted for in this stage. Other fenestration assembly technologies may have different or additional steps and they shall be accounted for in the product stage.

Materials can be considered either “primary” or “secondary.”

The following shall include the materials and energy use along with the transportation to the point of use:

- production of the final fenestration assemblies by combining the intermediates;
- other ancillary materials used during production; and
- primary packaging of the final product.

Inbound transportation (A2) shall be included in the LCI for the production stage. All transportation, including interfacility transport, prior to the material being shipped to the application site, shall also be included.

If more than one primary data point is available for inbound transportation distances of a raw material, an average

distance weighted by the transported mass may be calculated and the methodology disclosed in the EPD. All transportation by truck shall be reported ias round-trip. If primary data are not feasibly obtainable, transport distances listed in Table 2 shall be used for inbound raw material transports to facilities located in the United States. For processes outside of the United States, appropriate regional or national transportation distance and mode(s) shall be used where primary data are unavailable. If different vehicle classes or more than one transportation mode is required, then the LCA model shall use multiple transportation datasets to represent these, provided that separate LCI datasets are available for the vehicles, modes, or both.

Table 2
North American Default Material Transport Distances from 2017 U.S. DOT Shipment Characteristics by Standard Classification of Transported Goods (SCTG) Commodity Code

Raw material/ Classification grouping		**Distance (kilometers)**		
		Rail	**Truck***	**Water**
Raw materials	Any material used where no primary source data is available	579 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]	412 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]	525 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]
Plastics (inc. polymer-based materials; exc. Textiles)		592 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]	332 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]	842 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]
Metals (for frames, etc.)	32 base metal in primary or semifinal forms and in finished basic shapes	550 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]	390 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]	538 miles in 2017 U.S. DOT Commodity Flow Survey Table 21[1]

Table 21[1] Geographic Area Series: Shipment Characteristics by Origin Geography by Destination Geography by Commodity by Mode: 2017as referenced from The 2017 Commodity Flow Survey Tables: <https://data.census.gov/cedsci/table>

NOTE: This table is not meant to represent all materials that may be found in windows.

*Truck distances represent round trip distances, as the assumption is made that the delivery truck returns empty after making the delivery

NOTE: Water distances were approximated based on available data and may represent water, deep sea, or multiple waterway distances.

Waste and scrap created during raw material manufacturing (A1) and emissions associated with transporting them to point of disposal shall be accounted for in this stage.

See Section 7.2 for information relating to data quality guidelines. In the United States, the 2012 EPA WARM model gives an average transport end of life distance as 32 km (19.9 mi). This value shall be used for manufacturing facilities located in the United States when primary data or other representative data are not available, and waste transports are not included in the secondary dataset.

Waste and scrap created during product manufacturing (A3) shall be included in the LCA model. Primary data on process yields and scrap rates shall be used if available. If waste materials are recycled, landfilled, combusted,or composted, the transportation distances shall use the 32 km (19.9 mi) value given by WARM model for the United States, and the appropriate regionally or nationally representative value outside of the United States unless primary data has been obtained, in which case the primary data shall be used. Any landfill emissions shall be assumed to be accumulated over 100 years after the material was deposited in or on the landfill site.

Due to the limited availability of data relative to waste generation, recycling and disposal of fenestration assemblies, a conservative default of 100% to landfill shall be used.

7.1.8 Criteria for the inclusion and exclusion of inputs and outputs

As stipulated by ISO 21930:2017[1] Clause 7.1.8 with the following clarifications:

Cut-off rules shall not be applied in order to hide data. Any application of the criteria for the exclusion of inputs and outputs shall be documented. The cut-off rules shall be justified and documented in the EPD and project report.

In cases of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1% of renewable primary resource (energy), 1% nonrenewable primary resource (energy) usage, 1% of the total mass input of that unit process and 1% of environmental impacts. The total of neglected input flows per module shall be a maximum of 5% of energy usage, mass and environmental impacts. When assumptions are used in combination with plausibility considerations and expert judgement to demonstrate compliance with these criteria, the assumptions shall be conservative.

Additionally, for intentionally added materials characterized as hazardous by the TRI,[10] cut-off rules shall not be applied, and such substances shall be included in the inventory regardless of the percent of total mass.

[10] <www.epa.gov/toxics-release-inventory-tri-program>

If this PCR is being applied in a region outside of the US, an appropriate regional legislation regarding material hazards shall be used.

7.1.9 Selection of data and data quality requirements

As stipulated in ISO 21930[1] Clause 7.1.9, with the following:

Primary data (site-specific or representative averages) shall be used for facilities and processes under operational control of the reporting company. However, generic data may be used for facility operations that contribute less than 10% of the total production output of the product being reported by the EPD. For facilities and processes outside of the operational control of the reporting company, secondary data may be used. For products that are manufactured wholly or largely outside of the reporting company control (e.g., contracted products or significant assemblies), primary data are highly encouraged; however, representative secondary data may be used in lieu of primary data.

Suitable data quality assessment frameworks include (but are not limited to):

- USLCI Database;[9]
- ILCD Handbook[11]; and
- WRI product standard.[7]

Suitable data quality assessment frameworks include (but are not limited to):

1. The information obtained from the manufacturing process(es) shall be average annual values per declared unit, and it shall not be more than five years old. Any secondary data that is used shall be less than five years old. If data older than five years is used from a secondary source, justification shall be included to address why newer data are not available.
2. Data should represent the technology(ies) and process(es) in current use.
3. Data quality assessment shall conform to ISO 14044:2006[1] Clause 4.2.3.6.
4. Data quality assessment shall, at a minimum, address the following:

    - time-related coverage: age of data and the minimum length of time over which data was collected;

[11] International Reference Life Cycle Data System. European Commission, Charlemagne building, Rue de la Loi 170, 1040 Brussels, Belgium. <https://eplca.jrc.ec.europa.eu/ilcd.html>

- geographical coverage: geographical area from which data for unit processes was collected to satisfy the goal of the study;
- technology coverage: specific technology or technology mix; and
- uncertainty of the information (e.g., data, models and assumptions): shall include quantitative estimation of uncertainty (optional).

Table 3
Criteria to evaluate the data quality indicators

		Highest score ←				Lowest score →
Indicator		**1**	**2**	**3**	**4**	**5**
Flow reliability		Verified[1] data based on measurements	Verified data based on a calculation **or** non-verified data based on measurements	Non-verified data based on a calculation	Documented estimate	Undocumented estimate
Flow representativeness	**Temporal correlation**	< 3 years of difference[2]	< 6 years of difference	< 10 years of difference	< 15 years of difference	Age of data unknown or > 15 years
	Geographical correlation	Data from same resolution **and** same area of study	Within one level of resolution **and** a related area of study[3]	Within two levels of resolution **and** a related area of study	Outside of two levels of resolution **but** a related area of study	From a different or unknown area of study
	Technical correlation	All technology categories[4] are equivalent	**Three** of the technology categories are equivalent	**Two** of the technology categories are equivalent	**One** of the technology categories is equivalent	**None** of the technology categories are equivalent
	Data collection methods	Representative data from > 80% of the relevant market,[5] over an adequate period[6]	Representative data from 60% to 79% of the relevant market, over an adequate period **or** representative data from > 80% of the relevant market, over a shorter period of time	Representative data from 40% to 59% of the relevant market, over an adequate period **or** representative data from 60% to 79% of the relevant market, over a shorter period of time	Representative data from < 40% of the relevant market, over an adequate period of time **or** representative data from 40% to 59% of the relevant market, over a shorter period of time	Unknown **or** data from a small number of sites **and** from shorter periods

Source: Bicalho, Tereza & Sauer, Ildo Luís & Rambaud, Alexandre & Altukhova, Yulia. (2017). LCA data quality: A management science perspective. Journal of Cleaner Production. 156. 10.1016/j.jclepro.2017.03.229.

Electrical energy data shall use US Federal LCA Commons[12] fuel use and power data, or similar data to represent electrical energy production for the United States. Preference shall be given to datasets that include transmission and distribution losses. For regions other than the United States and Canada, country- or region-specific processes shall be used for the manufacturing stage provided they are representative. The sources for electricity and the calculation procedure shall be documented.

Data gaps shall be assess and disclosed.

Credit shall not be applied to LCA baseline when “green” power certificates are used, but certificates should be reported in the Additional Environmental Information section. Green power certificates shall be available and provided to the program operator for the entire period of EPD validity.

In addition, any LCIs used in the LCA for modeling the glazing shall be disclosed in both the LCA Report and EPD.

7.1.10 Units

International System of Units (SI units) shall be used for both the LCA and the EPD as described in ISO 21930:2017[1] Clause 7.1.10. Quantities shall be represented with three valid digits expressed in scientific notation. Optionally, EPDs may provide both US imperial and metric units using the following conversion factors, may include NIST table, or similar.

Convert from:	Convert to:	Multiply by:
cubic yard (yd^3)	cubic meter (m^3)	7.645 549 E-01
square foot (ft^2)	square meter (m^2)	9.290 304 E-02
foot (ft)	meter (m)	3.048 E-01
British Thermal Unit (BTU)	megajoule (MJ)	1.055 056 E-03

[12] US Federal LCA Commons.<https://www.lcacommons.gov>

Convert from:	Convert to:	Multiply by:
pound (lb)	kilogram (kg)	4.535 924 E-01
Source: NIST: http://physics.nist.gov/Pubs/SP811/appenB9.html		

7.2 Inventory analysis

All data collection and calculation procedures outlined in ISO 14044:2006[1] and ISO 21930:2017 shall apply to EPDs created using this sub-category PCR.

7.2.1 Data collection

As stipulated by ISO 21930:2017[1] Clause 7.2, with the following clarifications:

Given the relevance of the fenestration assembly's assumed durability, shape, size, and function, most assumptions in this PCR will have a minimal impact on the overall results of the EPD. The industry has gone to great lengths to define the crucial assumptions using industry best practices, however data gaps, when they occur, shall be assessed and documented..

7.2.2 Calculation procedures

As stipulated in ISO 21930:2017[1] Clause 7.2.2

7.2.3 Allocation situations

As stipulated in ISO 21930:2017[1] Clause 7.2.3

7.2.4 Principles for allocation for both allocation situations

As stipulated in ISO 21930:2017[1] Clause 7.2.4

7.2.5 Allocation for co-products

As stipulated in ISO 21930:2017[1] Clause 7.2.5 with the following amendment:

In cases were allocation cannot be avoided, the following hierarchy of allocation methods is preferred:

- mass, or other biophysical relationship; and
- economic value.

For example, if a site manufacturers five different products and the specific product being assessed only represents 10% of the site's output. Then 10% of the impacts occurring at that manufacturing site shall be applied to that product's LCA impacts and accounting.

Deviation from these allocation rules shall be documented and justified.

7.2.6 Allocation between product systems

As stipulated in ISO 21930:2017[1] Clause 7.2.6

7.2.7 Biogenic carbon

As stipulated by ISO 21930:2017[1] Clause 7.2.7, with the following additions:

Any delayed emissions from a temporary carbon sequestration (through wood content or paper-based packaging material that eventually degrades, for example) shall be reported under "Additional Environmental Information."

7.2.8 Carbonation

As stipulated by ISO 21930:2017[1] Clause 7.2.8.

7.2.9 Delayed emissions

As stipulated in ISO 21930:2017[1] Clause 7.2.9

7.2.10 Resource use

As stipulated in ISO 21930:2017[1] Clause 7.2.10

7.2.11 Greenhouse gas emissions rom land-use change

As stipulated by ISO 21930:2017[1] Clause 7.2.11, with the following additions:

A fenestration assembly containing wood from a forest that is not managed, may have negative CO_2e associated with the carbon flows in Stage A1, but if that product is assumed to breakdown (i.e., release the carbon) at end of life, that release shall be modeled as described in ISO 21930:2017 Clause 7.2.7 even though it would occur outside the cradle-gate scope of this reference PCR, and reported under “Additional Environmental Information”.

The above example would also apply to packaging material made from biomaterials.

7.2.12 Additional inventory indicators

As per ISO 21930:2017[1] Clauses 7.2.12 for emissions and removals of carbons, 7.2.13 for consumption of freshwater, and 7.2.14 for waste categories and output flows, with the following clarification:

With cradle-to-gate scope quantities of high-level or intermediate/low-level radioactive waste shall be reported by A1-A3 modules for the frame and glazing separately, as well as by system total.

Given concerns about inconsistent or nonexistent waste flows in commercially available LCIs, the following statement shall accompany the waste metrics in the results section or as a footnote following the waste metric reporting of the EPD:

> *“Significant data limitations currently exist within the LCI data used to generate waste metrics for Life Cycle Assessments and Environmental Product Declarations. The waste metrics were calculated in a way conformant with the requirements of ISO 21930:2017, but these values represent rough estimates and are for informational purposes only. As such, no decisions regarding actual cradle-gate waste performance between products should be derived from these reported values.”*

If relevant to the product system assessed by the EPD, carbon uptake and emission shall be reported as described in Sections 7.2.3 through 7.2.5 of this reference PCR and conformant with ISO 21930:2017.

7.3 Impact assessment indicators describing main environmental impacts derived from LCA

As per ISO 21930:2017[1] Clause 7.3 with the following clarifications:

Table 3
Mandatory impact areas

Impact category and abbreviation	Default international characterization method	Default North American market characterization method	Default European market characterization method as provided in:
Global warming potential (GWP 100)	IPCC[30]	TRACI	EN 15804
Ozone depletion potential (ODP)	WMO[34]	TRACI	EN 15804
Eutrophication potential (EP)	Heijungs et al.[31]	TRACI	EN 15804
Acidification potential (AP)	Hauschild and Wenzel[32]	TRACI	EN 15804
Photochemical oxidant creation potential (POCP)	Goedkoop et al.[41]	TRACI	EN 15804
Source: ISO 21930:2017 Clause 7.3, Table 5, pg 54.			

LCIA category indicator results shall be reported separately as cradle-to-gate scope by modules A1-A3, total life cycle, and separately for the framing and glazing as described in Section 7.1.2.

8 ADDITIONAL ENVIRONMENTAL INFORMATION

EPDs developed using this PCR shall include, where relevant, additional information related to environmental issues, other than the environmental information derived from LCA, LCI or information modules. Identification of the

significant environmental aspects shall conform to ISO 21930:2017[1] Clause 8.4 and ISO 14025:2006 Clause 7.2.4. EPDs may also include the potential effects of emissions on human health and toxicity as described below.

An EPD shall also include, where relevant:

- any data on fenestration product performance (where environmentally significant);
- instructions and limits for efficient use;
- organization's adherence to any environmental management system, including a statement showing where an interested party can find additional information on the system;
- other environmental certification programs applied to the building product and a statement indicating where an interested party can find details of the certification program;
- other environmental activities of the organization, such as participation in recycling or recovery programs, provided details of these programs are readily available to the purchaser or user and contact information is provided; and
- preferred waste management option for unused or old/used fenestration assemblies.

8.1 Mandatory environmental information

Full BOM, such as reporting certain aspects of material composition of the assessed fenestration assemblies, shall be disclosed in percentage of total weight.

Per ISO 21930:2017[1] Clause 10.3, ingredients or compounds that are proprietary and covered by intellectual property rights or similar legal restrictions do not have to be disclosed in the EPD.

8.1.1 Emissions to water, soil, and to indoor air

Per ISO 21930:2017[1] Clause 8.4.2, any releases to ground water and surface water and indoor air shall meet all relevant international standards

9 CONTENT OF AN EPD

9.1 General

As stipulated by ISO 21930:2017[1] Clause 9.1.

9.2 Declaration of general information

As stipulated by ISO 21930:2017[1] Clause 9.2 with the following additions:

Product Name with brief description (include picture)	
Manufacturer Name and Address (include site of manufacture if different)	
Program Operator	
General Program instructions and Version Number	
Declaration Number	
Functional /Declared Unit	
Reference PCR and Version Number	
Product's intended Application and Use	
Bill of Materials (BOM) full disclosure to cut-off rules	
Product RSL	
Markets of Applicability	
Date of Issue	
Period of Validity	
EPD Type and Scope	
Year of reported manufacturer primary data	
LCA Software and Version Number	
Cut-off criteria and assumptions	
Assumptions for the seletion and use of proxy data	
LCI Database and Version Number	
Allocation rules	
LCIA Methodology and Version Number	
Data Quality Assessment (poor, fair, good, very good)	
The sub-category PCR review was conducted by:	
This declaration was independently verified in accordance with ISO 14025: 2006. ISO 21930:2017 serves as the core PCR. Sub-category PCR: Fenestration Assembly Product Category Rules ☐ Internal ☒ External	
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	
Explanatory material may be obtained from the following:	

1. CAS numbers, quantities, and description of any hazardous substances contained within the product system.
2. Description of product's intended use and any product codes if relevant.

3. Additional product attributes:
    - components for reuse;
    - materials for recycling;
    - materials for energy recovery; and
    - recovered energy from the product system – shall be based on existing technology and current practices.

To avoid misinterpretation of results, a company shall include a disclaimer:

> *"This EPD meets all comparability requirements stated in ISO 14025:2006. However, differences in certain assumptions, data quality, and variability between LCA data sets may still exist. As such, caution should be exercised when evaluating EPDs from different manufacturers or programs, as the EPD results may not be entirely comparable. Any EPD comparison must be carried out at the construction works level per ISO 21930:2017 guidelines. The results of this EPD reflect an average performance by the product and its actual impacts may vary on a case-to-case basis."*

9.3 Declaration of the methodological framework

As specified in Impact Assessment Categories, Clause 7.5:

1. Climate change [kg CO_2-eq.]
2. Depletion of the stratospheric ozone layer [kg CFC-11 eq. / kg of emission]
3. Acidification of land and water sources [kg SO_2-eq.]
4. Eutrophication [kg N eq. / kg of emission]
5. Formation of smog [kg O_3 eq. / kg of emission]

A table summarizing the life cycle stages considered shall be included in the EPD:

Product stage			Construction process stage		Use stage							End of life stage				Beyond the system boundary
Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction/ demolition	Transport	Waste processing	Disposal of waste	Potential net benefits of reuse, recycling, and/or energy recovery beyond the system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	O	O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	O

X = required
O = optional
NA = not applicable

Figure 1
Cradle-to-gate required and optional modules

9.4 Declaration of technical information and scenarios

As stipulated by ISO 21930:2017[1] Clause 9.4, with the following additions:

As described in product description, Section 1.

9.5 Declaration of environmental indicators derived from LCA

As specified in parameters to be declared in the EPD, Clause 8.2, sorted by:

- depletion of nonrenewable energy resources (MJ);
- depletion nonrenewable material resources (kg);
- use of renewable material resources (kg);
- use of renewable primary energy (MJ);
- consumption of freshwater (m3);
- hazardous waste (kg);
- nonhazardous waste (kg);

- high-level radioactive waste (kg); and
- intermediate and low-level radioactive waste (kg).
- biogenic CO_2, reporting the removals and emissions associated with biogenic carbon content contained within biobased products, occurring in each module;
- biogenic CO_2, reporting the removals and emissions associated with biogenic carbon content contained within the biobased packaging, occurring in each module;
- CO_2 from calcination and carbonation, reporting the emissions and uptake of CO_2 from calcination and carbonation occurring in the relevant modules;
- biogenic CO_2, reporting the emissions from combustion of waste from renewable sources used in product processes; and
- CO_2 emissions from combustion of waste from non-renewable sources used in product processes.

9.6 Declaration of additional environmental information

As stipulated by ISO 21930:2017[1] Clause 9.6.

10 PROJECT REPORT

Per ISO 21930:2017[1] Clause 10.

A project report shall be created and externally verified per the requirements of ISO 21930:2017 Clause 10.

This report shall be submitted for external validation before the EPD is created and published. The project report is not publicly disclosed and may contain confidential information. ISO 21930:2017 Clause 13 details what information must be publicly reported through the EPD.

11 VERIFICATION AND VALIDITY OF AN EPD

All verification of EPD, LCA, LCI and additional environmental information shall conform to the following ISO 14025:2006[1] Clause 8 provisions:

- PCR review including a review of the LCA, LCI, information modules and additional environmental; information on which the PCR are based; see ISO 14025:2006 Clause 8.1.2;

- independent verification of data from LCA, LCI and information modules, and of additional environmental information; see ISO 14025:2006 Clause 8.1.3;
- independent verification of the EPD the independent verifier shall generate a verification report stipulating the conclusion of the verification, see ISO 14025:2006 Clause 8.1.4;
- process, while adhering to the obligations of ISO 14025:2006 Clause 8.3, covering rules for data confidentiality;
- this report shall be available to any person upon request; and
- competence of third-party PCR review panel, according to provisions given in ISO 14025:2006 Clause 8.2.3, and independent verifier of the EPD, according to provisions given in ISO 14025:2006 Clause 8.2.2.

11.1 Period of validity for the EPD

The validity of the EPD shall be reported in the EPD and shall not exceed a five (5) year period from the date of issuance. Any changes in formulations that result in shifts in any of the environmental impact categories by more than ± 10% shall require an update to the EPD. The EPD shall be reviewed and reissued every five years from the date of issuance or earlier, as appropriate.

12 REFERENCES

ISO Standards[1]

ISO 14021:2016 Environmental Labels and Declarations — Self-declared Environmental Claims (Type II Environmental Labeling)

ISO 14025:2006 Environmental Labels and Declarations — Type III Environmental Declarations — Principles and Procedures

ISO 14040:2006/AMD 1:2020, Environmental management – Life cycle assessment – Principles and framework

ISO 14044:2006/AMD 1:2017/AMD 2:2022, Environmental management – Life cycle assessment – Requirements and guidelines

ISO 21930:2017 Sustainability in Building Construction — Environmental Declaration of Building Products

Other References

Salazar, James & Taraneh Sowlati. *A review of life-cycle assessment of windows (Practicalities and Possibilities).* Forest Products Journal. Oct, 2008[13]

AAMA/WDMA/CS 101/I.S.2/A440-17[4]

ANSI/ASHRAE/IESNA Standard 90.1-2010[14]

[13] <www.researchgate.net/publication/279541212_A_review_of_life-cycle_assessment_of_windows>

[14] ASHRAE. 180 Technology Parkway NW, Peachtree Corners, Georgia 30092. <www.ashrae.org>

APPENDIX A: FENESTRATION INDUSTRY-SPECIFIC GUIDANCE ON GREENHOUSE GAS REPORTING (INFORMATIVE)

- Include GHG emissions from land-use changes, when significant, in the quantification of GWP.
- Use internationally recognized methods, such as, Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.
- Declare this contribution to GWP in the EPD under additional invironmental information, labeled GWP (land-use change), including a short interpretation of the data.

Use of wood from sustainability managed forests is preferred, examples assessment and certification programs include:

- CSA Group (CSA),
- Forest Stewardship Council (FSC),
- Sustainable Forestry initiative (SFI) Standards, and
- all other standards globally endorsed by the Programme for the Endorsement of Forest Certification International (PEFC International) and the FSC.

APPENDIX B: TECHNICAL REVIEW COMMITTEE

The following individuals participated in the review committee from March 2021 through April 2023.

Industry

Richard Braunstein, Oldcastle Building Envelope
Ray Garries, Global Fenestration Advisors
Michael Hammond, Vitro Architectural Glass
James Larsen, Cardinal Glass Industries
Kayla Natividad, Pilkington North America
Daniel Raap, Amesbury Truth
Helen Sanders, Technoform North America
Sue Schreiber, Kolbe & Kolbe Millwork Co., Inc.
Kevin Seiling, Veka, Inc.
Jon Smiega, Andersen Corporation
Brian Tobias, Tubelite, Inc.
Ben Wallace, Marvin

Trade Associations

Steve Orlowski, Window & Door Manufacturers Association (WDMA)
Craig Drumheller, Window & Door Manufacturers Association (WDMA)
Jason Seals, Fenestration and Glazing Industry Alliance (FGIA)
Urmilla Sowell, Glass Association of North America (GANA)

Users

Mark Fragoso, Akiva Building Consultants, Inc.

LCA Expertise

Doug Mazeffa, Sherwin-Williams Company
Ivan Zuniga, Kawneer

NSF International

Andrea Burr

***THE HOPE OF MANKIND** rests in the ability of man to define and seek out the environment which will permit him to live with fellow creatures of the earth, in health, in peace, and in mutual respect.*