Environmental Product Declaration

Fiberglass Loose Fill

Climate Pro® • Attic Protector® • JM Spider® Plus

At Johns Manville, product performance and corporate accountability are top priorities. We ensure that each of our insulation products not only performs, but also contributes to the health, safety, and sustainability of the environments where they are used.

We strive to ensure that our products meet the rigorous demands of their applications while focusing on finding new ways to reduce our environmental footprint, and we want to provide you with reliable materials that will allow you to do the same.

As a company, we are committed to evolving to help create a sustainable world for our future. When it comes to making decisions about your environmental impact, don't just think insulation, think JM.

PEOPLE • PASSION • PERFORM • PROTECT

CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

Johns Manville
A Berkshire Hathaway Company

CLIMATE PRO® • ATTIC PROTECTOR® • JM SPIDER® PLUS
FIBERGLASS LOOSE FILL – BUILDING ENVELOPE THERMAL AND ACOUSTIC INSULATION

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

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL ENVIRONMENT 333 PFINGSTEN RD, NORTHBROOK, IL 60062 WWW.UL.COM WWW.SPOT.UL.COM
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	Program Operator Rules v 2.7 2022
MANUFACTURER NAME AND ADDRESS	Johns Manville 717 17th St, Denver, CO 80202
DECLARATION NUMBER	4789973160.110.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Fiberglass loose fill, 1 m^2 R_{SI}-1
REFERENCE PCR AND VERSION NUMBER	Part A: Product Category Rules for Building-Related Products and Services, UL 10010, v3.2 Part B: Building Envelope Thermal Insulation EPD Requirements, UL 10010-1
DESCRIPTION OF PRODUCT APPLICATION/USE	Building attic and wall thermal insulation, spray-applied acoustic treatment
PRODUCT RSL DESCRIPTION (IF APPL.)	N/A
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	October 1, 2022
PERIOD OF VALIDITY	5 Years
EPD TYPE	Company specific
RANGE OF DATASET VARIABILITY	Company specific
EPD SCOPE	Cradle to installation with end-of-life
YEAR(S) OF REPORTED PRIMARY DATA	2019
LCA SOFTWARE & VERSION NUMBER	GaBi 10.5
LCI DATABASE(S) & VERSION NUMBER	GaBi 2021.2 (CUP 2021.2)
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1 and CML v4.2

The PCR review was conducted by:	UL Environment PCR Review Panel epd@ul.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Cooper McCollum, UL Environment
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Sphera Solutions Inc
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	James Mellentine, Thrive ESG

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

Product Definition and Information

Description of Company/Organization

For more than 160 years, Johns Manville (JM), a Berkshire Hathaway company, has been dedicated to providing products that create stronger buildings, improve energy efficiency, and contribute to the health and comfort of building occupants.

We manufacture premium-quality building and mechanical insulation, commercial roofing, glass fibers and nonwoven materials for commercial, industrial, and residential applications. JM products are used in a wide variety of industries including building products, aerospace, automotive and transportation, filtration, commercial interiors, waterproofing and wind energy.

JM employs over 7,000 people globally and provides products to more than 85 countries. We operate 44 manufacturing facilities in North America, Europe, and China. Since 1988, JM's global headquarters has been located in downtown Denver, Colorado.

Product Description

Product Identification

The following Johns Manville fiberglass loose fill insulation products are covered by this environmental product declaration:

- Climate Pro®
- Attic Protector®
- JM Spider® PLUS
- JM Spider® PLUS (Canada)

Product Specification

Climate Pro®

Johns Manville Climate Pro® Formaldehyde-free™ blow-in, loose-fill fiberglass insulation offers thermal and sound control along with fire resistance. One bag of Climate Pro provides 77.1 square feet of R-30 coverage. Engineered for professional use with high-volume blowing machines, it's ideal for attics, nonconforming spaces and hard-to-reach areas making the job faster and easier.

Advantages:

- **Easy Installation**: Insulates attics or spaces of all shapes and sizes without cutting or fitting.
- **Complete Coverage**: Effective in tight spaces, areas with large amounts of cross-bridging, or small gaps and voids.
- **Thermally Efficient**: Effective resistance to heat transfer. No settling; no loss of R-value following installation.
- **Formaldehyde-free**: Will not off-gas formaldehyde in the indoor environment.
- **Sound Control**: Reduces sound transmission through exterior and interior walls, floor and ceiling assemblies.
- **Fire-Resistant**: Flame Spread of 5 or less and Smoke Developed of 5 or less.

- **Resilient Inorganic Glass Fibers**: No rotting, mildew or deterioration. Also noncorrosive to pipes, wiring and metal studs.
- **Superior Performance**: Stable bonded glass fibers will not slump, settle or break down during applications.

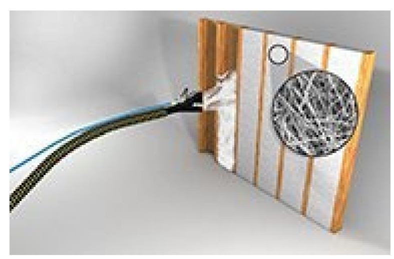
Attic Protector®

Johns Manville Formaldehyde-free™ Attic Protector® blow-in loose-fill fiberglass insulation is a premium alternative to cellulose. It's blown into attics, nonconforming spaces and hard-to-reach areas, like corners, edges and around framing. When it's applied to the recommended thickness and specifications, it improves energy efficiency. And unlike cellulose, it won't settle, decay or provide food for animals or microbes. It's effective for the life of the home.

Advantages:

- **Formaldehyde-free**: will not off-gas formaldehyde in the indoor environment.
- **Thermally Efficient**: provides effective resistance to heat transfer. Unlike cellulose products, JM Attic Protector® insulation does not settle, for no loss of R-value after installation.
- **Sound Control**: reduces transmission of sound through exterior and interior walls, and floor and ceiling assemblies for superior sound control.
- **Fire Resistant and Noncombustible**: See Specification Compliance.
- **Noncorrosive**: does not accelerate corrosion of pipes, wiring or metal studs.
- **Resilient Inorganic Glass Fibers**: cannot rot, mildew, or otherwise deteriorate.
- **Easy to Install**: quickly insulates attics or spaces of any size or shape without cutting or fitting.
- **Complete coverage**: effective in tight spaces, areas with large amounts of cross-bridging or areas with small gaps and voids.

Spider® PLUS / Spider® PLUS (Canada)



Johns Manville Spider® PLUS Formaldehyde-free™ blow-in fiberglass insulation uses interlocking fiber technology to fill all gaps and voids quickly with no adhesive or netting for a faster installation. Spider Plus provides complete coverage, with no shrinking or settling, resulting in superior thermal performance and sound control. Designed for use in wood- and metal-frame construction, engineered- wood construction and manufactured homes.

Advantages:

- **Fast Drying**: Dries immediately once installed.
- **Complete Coverage**: Effective in tight spaces, areas with large amounts of cross-bridging or small gaps and voids.
- **Thermally Efficient**: Effective resistance to heat transfer, with R-values up to R-25 in a 6" cavity.
- **Formaldehyde-free**: Will not off-gas formaldehyde in the indoor environment.
- **Sound Control**: Reduces sound transmission through exterior and interior walls, floor and ceiling assemblies.
- **Fire-Resistant**: Flame Spread of 25 or less and Smoke Developed of 50 or less.
- **Resilient Inorganic Glass**: No rotting, mildew or deterioration. Also noncorrosive to pipes, wiring and metal studs.

Product Average

This EPD is intended to represent Johns Manville fiberglass loose fill products. The vertical average is calculated based on the mass of product manufactured by Johns Manville. Use of this EPD is limited to Johns Manville.

Flow Diagram

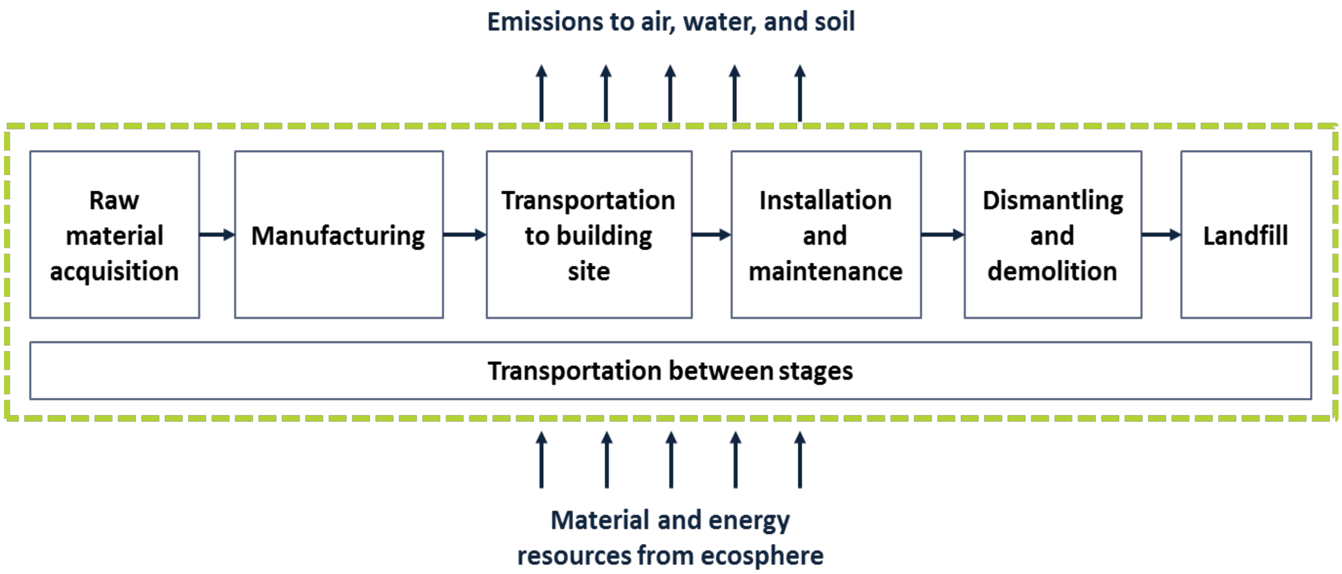


Figure 1: Flow diagram for manufacturing of fiberglass loose fill

Application

Whatever the method employed to manufacture glass wools, the small-diameter, tangled fibers of these vitreous wools form a porous resilient mass in which millions of small air pockets are trapped. These air pockets create an effective barrier against the transmission of both heat energy and sound energy. As a result, glass wools provide effective thermal insulation, helping to keep buildings warm in the winter and cool in the summer. The insulation of homes, other buildings, objects, and industrial processes against heat loss and heat gain represents the largest single use for glass wool products. Sound reduction is also an important use of these products.

Declaration of Methodological Framework

This EPD is declared under a “cradle-to-installation with end-of-life” system boundary. As such, it includes life cycle stages A1-A5 and C1-C4. It should be noted here that, C1 and C3 are to be reported as zero as they are assumed to fall below the cut-off criteria defined by ISO 21930.

Per the product category rules (UL Environment, 2018), the assessment was conducted using a building service life of 75 years.

Technical Requirements

The following technical specification apply to products considered in this EPD:

- ASTM C764 – Standard Specification for Mineral Fiber Loose-Fill Thermal Insulation
- CAN/ULC-S702-14 AMD1 Type 5 – Standard for Mineral Fibre Thermal Insulation for Buildings
- CAN/ULC-S102.2 – Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
- ULC-S129-95 – Standard Method of Test for Smoulder Resistance of Insulation (Basket Method)

Properties of Declared Product as Delivered

Loose fill is generally shipped in plastic wrap, containing between 25 lbs (11.3 kg) and 31.5lbs (14.3 kg) of product.

Material Composition

Fiberglass loose fill insulation is made from sand, silica, and cullet, then spun into fibers that are then processed into the final product. Fiberglass is inorganic and noncombustible.

In addition, the fibers contain no binder, will not rot or absorb moisture and do not support the growth of mildew, mold, or fungus. The product is blown into the cavity or building space, and thus is not purchased with a facer.

Table 1 provides the average material content in fiberglass loose fill.

Table 1: Fiberglass loose fill material content

COMPONENT	LOOSEFILL [WT.%]
Fiberglass batch	
Silica sand	11%
Soda ash	10%
Nepheline syenite	13%
Borax	14%
External cullet	48%
Manganese dioxide	0%
Burnt dolomitic lime	4%

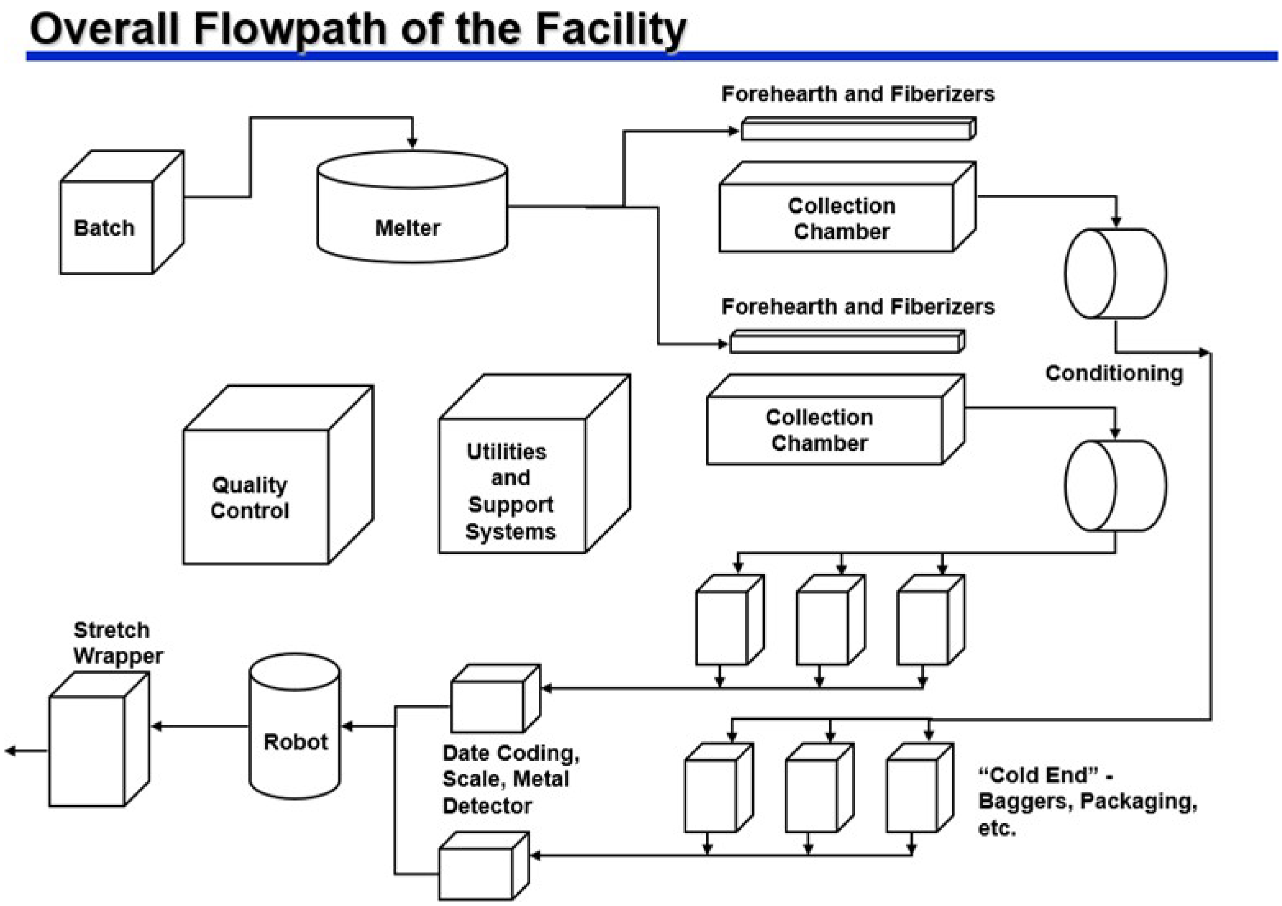
Manufacturing

This EPD covers fiberglass loose fill produced by Johns Manville in the United States and Canada at two facilities:

- Innisfail, AB, Canada
- Richmond, IN, United States.

The life cycle for loose fill begins with raw material extraction and sourcing. As described in Figure 2 below, these batch materials are combined and melted to form molten glass. The molten glass is then fiberized, conditioned and packaged. The packaged product is transported to a distributor, contractor, or retail customer where it is eventually installed using a blowing machine.

Figure 2: Description of loose fill insulation manufacturing



Packaging

The product is typically packaged with plastic wrap, although cardboard separators are occasionally used. Packaging materials are not assumed to be reused. Since no primary data are available, the disposal assumptions provided in Part A (UL Environment, 2018) are used.

Transportation

Average transportation distances are included for the transport of the raw materials to production facilities. Transport of the finished product of 647 miles via truck to the construction site is also accounted for, along with the transport of construction wastes and the deconstructed product at end-of-life to disposal facilities (20 miles via truck). Loose fill is compressed when packaging; therefore, distribution of the finished product is assumed to be mass-limited.

Product Installation

The thermal resistance (R-value) of fiberglass loose fill is dependent on the proper application of the required quantity of material. One of the most significant criteria for achieving the desired R-value is meeting the designated minimum weight per square foot of material. It is also important that the minimum thickness be achieved since this, along with the required weight per square foot of material, is essential to obtain the desired R-value. The correct values for coverage for each loose fill material are stated by the manufacturer in a bag label specifications chart.

Before loose fill insulation is installed, the area to be insulated is measured. Framing adjustments may be permissible in determining the net insulatable area. From these calculations, the required number of bags or pounds of insulation is determined from the bag label chart for the desired R-value. It is important that the correct number of pounds or bags of loose fill insulation be installed in order to assure that the desired R-value is achieved. This holds true in both open and closed blow installations. In addition, it is recommended that the installer blowing insulation in the attic wear a NIOSH certified dust respirator (certified N95 or greater). See OSHA's Respiratory Protection Standard.

Packaging disposal is included as part of the installation module. No product loss is assumed during installation. For additional information, please refer to Table 6.

Use

Fiberglass loose full insulation is assumed to have a reference service life of 75 years, equal to that of the building. Once installed, insulation does not directly consume energy, and requires no maintenance. There are no parts to repair or refurbish. Any reduction in building operational energy consumption associated with insulation use need to be considered on the level of the individual building and are considered outside the scope of the LCA, although it has been proven that properly installed building insulation significantly reduces the amount of energy that is consumed by a structure.

Reference Service Life and Estimated Building Service Life

The use phase is considered to be burden-free for insulation products as they require no maintenance and have a reference service life of 75 years, equal to that of the building.

Reuse, Recycling, and Energy Recovery

Fiberglass loose fill is typically not reused or recycled following its removal from a building. Although recycling is feasible, there are minimal recycling programs and infrastructure; therefore, current practice is to send the waste to a landfill. Thus, reuse, recycling, and energy recovery are not applicable for this product.

Disposal

At the end-of-life, insulation is removed from the deconstructed building. The waste is then transported 20 miles and disposed in a landfill per PCR requirements (UL Environment, 2018) (see Table 3). Landfill and incineration emissions from paper, plastic, and wood packaging are allocated to installation (module A5).

Life Cycle Assessment Background Information

Functional or Declared Unit

Per the PCR, the functional unit for this analysis is ***1 m² of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m²K/W and with a building service life of 75 years***. Table shows the functional unit along with its specific mass reference flow.

Table 2: Functional unit and subsequent product attributes

	AREA [M²]	R_{SI} [M² K/W]	R_{US} [BTU/(H °F FT²)]	RSL [YEARS]	THICKNESS [IN]	MASS [KG]
Functional unit	1	1	5.68	75	0.781	0.46

System Boundary

Table 3 represents the system boundary and scope.

Table 3: Description of the system boundary modules

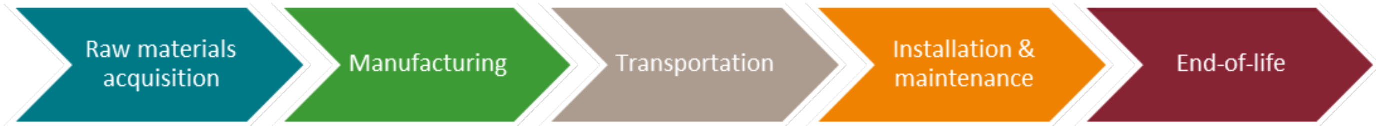
	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
EPD Type	X	X	X	X	X	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	MND

This study covers the life cycle of the products from cradle to gate (installation) with end-of-life options. Within these boundaries, the following stages were included as per Figure 2 below:

- **Raw materials acquisition:** Raw material supply (including virgin and recycled materials), inbound transport
- **Manufacturing:** Production of insulation, product packaging, manufacturing waste, releases to environment
- **Transportation:** Distribution of the insulation product from the manufacturer to a distributor (if applicable) and from there, to the building site
- **Installation and Maintenance:** Installation process, installation wastes and releases to the environment, maintenance under normal conditions
- **End-of-Life:** Dismantling/demolition, transport to final disposal site, final disposition

Building operational energy and water use are considered outside of this study's scope: any beneficial impact that the use of insulation may have on a building's energy consumption is not calculated or incorporated into the analysis.

Figure 3: Life cycle stages included in the system boundary



Estimates and Assumptions

The analysis uses the following assumptions:

- If inbound transportation distances were not provided for materials used in manufacturing, a default assumption of 500 miles (800 km) transport via truck was applied in the model.
- Installation is done by using a blower and is assumed to have a negligeable scrap rate of 0%.
- Since primary data were not available to describe end-of-life treatment, the default values specified by the PCR Part A (UL Environment, 2018) were applied (Table 3).
- Fiberglass insulation is assumed to last the lifespan of the building and is only removed upon building demolition. Since the PCR states that the building has a 75-year reference service life, the insulation is assumed to have the same reference service life.

Table 4. Default end-of-life assumptions from the PCR

COMPONENT	RECYCLED	LANDFILLED	INCINERATED
Product	0%	100%	0%
Paper packaging	75%	20%	5%
Plastic packaging	15%	68%	17%

Cut-off Criteria

Cut-off criteria were applied to capital equipment production and maintenance under the assumption that the impacts associated with these aspects were sufficiently small enough to fall below cut-off when scaled down to the functional unit. All energy and material flow data available were included in the model. In addition, biogenic carbon has also been excluded as the overall difference in GWP result is less than 2%.

Data Sources

The LCA model was created using the GaBi 10 software system for life cycle engineering, developed by Sphera Inc. (Sphera, 2021). Background life cycle inventory data for raw materials and processes were obtained from the GaBi 2021 (CUP2021.2) database. Primary manufacturing data were provided by Johns Manville.

Data Quality

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

Geographical Coverage

In order to satisfy cut-off criteria, proxy datasets were used as needed for raw material inputs to address lack of data for a specific material or for a specific geographical region. These proxy datasets were chosen for their representativeness of the actual product. Additionally, European data or global data were used when North American data (for raw materials sourced in the US) were not available.

Temporal Coverage

Foreground data for each manufacturer represent a continuous 12-months over the 2019 calendar year. The majority of background datasets are based on data from the last 10 years (since 2017).

Technological Coverage

The primary data represent production of the products under evaluation. Secondary data were chosen to be specific to the technologies in question (or appropriate proxy data used where necessary).

Completeness

Foreground processes were checked for mass balance and completeness of the emissions inventory. No data were knowingly omitted.

Period under Review

Primary data collected represent production during the 2019 calendar year. This analysis is intended to represent production in 2019.

Allocation

No multi-output (i.e., co-product) allocation was performed in the foreground system of this study. No known flows are deliberately excluded from this EPD.

Allocation of background data (energy and materials) taken from the GaBi 2021 databases is documented online at https://sphera.com/wp-content/uploads/2020/04/Modeling-Principles-GaBi-Databases-2021.pdf.

Allocation of manufacturing material and energy inputs was done on a mass-basis. Allocation of transportation was based on mass while taking into account the utilization rate.

For recycled content and disposal at end-of-life, system boundaries were drawn consistent with the cut-off allocation approach. Sand and cullet, which are used as raw materials in fiberglass loose fill production, are assumed to enter the system burden-free in that burden associated with the production of the sand and cullet itself is not allocated to the insulation life cycle. Likewise, the system boundary was drawn to include landfilling of fiberglass at end-of-life (following the polluter-pays principle) but exclude any avoided burdens from material or energy recovery.

Comparability

No comparison or benchmarking is included in this EPD.

Life Cycle Assessment Scenarios

Fiberglass loose fill insulation requires no maintenance, and there are not parts to repair or refurbish. The reference service life for the fiberglass loose fill insulation product is 75 years. Installation is done with a blowing wool machine and is assumed to have a negligeable scrap rate (0%) during that stage.

Table 5. Transport to the building site (A4)

NAME	INNISFAIL VALUE	RICHMOND VALUE	UNIT
Fuel type	Diesel	Diesel	
Liters of fuel	0.0011	0.0011	L/100km
Vehicle type	Truck	Truck	
Transport distance	1041	1041	km
Truck capacity utilization (including empty runs, mass based)	78	78	%
Gross density of products transported	N/A	N/A	kg/m^3
Weight of products transported (if gross density not reported)	0.46	0.46	kg
Volume of products transported (if gross density not reported)	N/A	N/A	m^3
Capacity utilization volume factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaging products)	> 1	> 1	-

Table 6. Installation into the building (A5)

NAME	INNISFAIL VALUE	RICHMOND VALUE	UNIT
Ancillary materials	-	-	kg
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)	-	-	m^3
Other resources	-	-	kg
Electricity consumption	0.017	0.017	kWh
Other energy carriers	-	-	MJ
Product loss per functional unit	0	0	%
Waste materials at the construction site before waste processing, generated by product installation	-	-	kg
Output materials resulting from on-site waste processing: Recycling Incineration Landfill	 - - -	 - - -	 kg kg kg
Biogenic carbon contained in packaging	5.23E-05	5.23E-05	kg CO_2
Direct emissions to ambient air, soil and water	0	0	kg
VOC content	0	0	µg/m^3

Table 7. Reference Service Life

NAME	INNISFAIL VALUE	RICHMOND VALUE	UNIT
RSL	75	75	years

Table 8. End of life (C1-C4)

NAME		INNISFAIL	RICHMOND	UNIT
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)				
Collection process (specified by type)	Collected separately	0	0	kg
	Collected with mixed construction waste	0.46	0.46	kg
Recovery (specified by type)	Reuse	0	0	kg
	Recycling	0	0	kg
	Landfill	0.46	0.46	kg
	Incineration	0	0	kg
	Incineration with energy recovery	0	0	kg
	Energy conversion efficiency rate	N/A	N/A	
Disposal (specified by type)	Product or material for final deposition	0.46	0.46	kg
Removals of biogenic carbon (excluding packaging)		0		0

Life Cycle Assessment Results

The following results are based on a functional unit of 1 m^2 of fiberglass loose fill insulation. The following results exclude biogenic carbon as there are no relevant biogenic carbon removals or emissions in the life cycle. There is no calcination, carbonation and combustion of waste from non-renewable sources.

Impact assessment and other results are shown for a cradle-to-installation with end-of-life options (C1-C4). Modules C1 and C3 are not associated with any impact and are therefore declared as zero.

Life Cycle Impact Assessment Results

Table 9. North American Impact Assessment Results

TRACI v2.1	UNITS	A1- A3 PRODUCT STAGE	A4 PRODUCT DELIVERY	A5 CONSTRUCTION STAGE	C2 TRANSPORT TO END OF LIFE	C4 DISPOSAL AT END OF LIFE
Global warming potential	kg CO_2 eq.	5.51E-01	7.60E-03	8.14E-11	7.68E-03	2.28E-02
Depletion potential of the stratospheric ozone layer	kg CFC 11 eq.	1.39E-12	1.58E-18	5.64E-25	1.60E-18	6.83E-17
Acidification potential	kg SO_2 eq.	1.10E-03	1.46E-05	1.17E-13	1.48E-05	8.76E-05
Eutrophication potential	kg N eq.	1.30E-04	2.13E-06	1.16E-14	2.15E-06	1.55E-05
Smog formation potential	kg O_3 eq.	2.12E-02	3.31E-04	1.74E-12	3.35E-04	1.55E-03
Abiotic depletion potential for fossil resources	MJ	1.18E+00	1.49E-02	8.86E-11	1.50E-02	3.99E-02

Table 10. European Impact Assessment Results

CML v4.2	UNITS	A1- A3 PRODUCT STAGE	A4 PRODUCT DELIVERY	A5 CONSTRUCTION STAGE	C2 TRANSPORT TO END OF LIFE	C4 DISPOSAL AT END OF LIFE
Global warming potential	kg CO_2 eq.	5.39E-01	7.51E-03	8.00E-11	7.59E-03	2.24E-02
Depletion potential of the stratospheric ozone layer	kg R11 eq.	1.20E-12	1.58E-18	5.64E-25	1.60E-18	6.83E-17
Acidification potential	kg SO_2 eq.	1.01E-03	1.10E-05	1.13E-13	1.11E-05	8.06E-05

Eutrophication potential	kg P eq.	1.71E-04	3.70E-06	1.25E-14	3.74E-06	1.18E-05
Photochemical ozone creation potential	kg Ethene eq.	1.07E-04	-3.08E-06	8.41E-15	-3.11E-06	7.84E-07
Abiotic depletion potential, elements	kg Sb eq.	7.60E-05	2.49E-09	1.97E-17	2.52E-09	8.84E-09
Abiotic depletion potential, fossil resources	MJ	9.63E+00	1.11E-01	1.04E-09	1.12E-01	3.07E-01

Life Cycle Inventory Results

Table 11. Resource Use

	UNITS	A1- A3 PRODUCT STAGE	A4 PRODUCT DELIVERY	A5 CONSTRUCTION STAGE	C2 TRANSPORT TO END OF LIFE	C4 DISPOSAL AT END OF LIFE
Renewable primary energy as energy carrier	MJ	1.46E+00	4.62E-03	2.56E-10	4.67E-03	2.60E-02
Renewable primary energy as material utilization	MJ	-	-	-	-	-
Total use of renewable primary energy resources	MJ	1.46E+00	4.62E-03	2.56E-10	4.67E-03	2.60E-02
Non-renewable primary energy as energy carrier	MJ	1.15E+01	1.12E-01	1.36E-09	1.13E-01	3.13E-01
Non-renewable primary energy as material utilization	MJ	8.71E-02	-	-	-	-
Total use of non-renewable primary energy resources	MJ	1.16E+01	1.12E-01	1.36E-09	1.13E-01	3.13E-01
Use of secondary material	kg	2.29E-01	-	-	-	-
Use of renewable secondary fuels	MJ	-	-	-	-	-
Use of non-renewable secondary fuels	MJ	-	-	-	-	-
Use of recovered energy	MJ	-	-	-	-	-
Use of net fresh water	m^3	4.82E-03	1.97E-05	5.13E-13	1.99E-05	4.71E-05

Table 12. Output Flows and Waste Categories

	UNITS	A1- A3 PRODUCT STAGE	A4 PRODUCT DELIVERY	A5 CONSTRUCTION STAGE	C2 TRANSPORT TO END OF LIFE	C4 DISPOSAL AT END OF LIFE
Hazardous waste disposed	kg	7.70E-05	9.37E-12	1.26E-19	9.47E-12	2.96E-11
Non-hazardous waste disposed	kg	1.87E-02	1.03E-05	3.95E-13	1.04E-05	4.65E-01
Radioactive waste disposed	kg	9.47E-07	3.78E-10	1.50E-16	3.82E-10	3.03E-09
Intermediate and Low-Level Radioactive Waste	kg	1.70E-05	6.89E-09	2.74E-15	6.96E-09	5.38E-08
Components for re-use	kg	-	-	-	-	-
Materials for recycling	kg	1.46E-05	-	-	-	-
Materials for energy recovery	kg	-	-	-	-	-
Exported electrical energy	MJ	-	-	-	-	7.08E-03

Facility specific GWP results

Johns Manville's loosefill product is manufactured at two different facilities. The results presented below represent a production-weighted average of these facilities. To understand how the GWP may vary between sites, facility-specific GWP100 results are presented below. Modules C1 and C3 are not associated with any impact and are therefore declared as zero.

Table 13. Facility-specific GWP100 results, per 1 m^2 (one square meter)

GWP 100 (kg CO_2 eq)	A1- A3 Product Stage	A4 Product Delivery	A5 Construction Stage	C2 Transport to End of Life	C4 Disposal at End of Life
Innisfail, AB Canada	4.90E-01	7.60E-03	1.06E-10	7.67E-03	2.24E-02
Richmond, IN	5.91E-01	7.60E-03	6.56E-11	7.69E-03	2.30E-02

Scaling to Other R-values

Environmental performance results are presented per functional unit, defined as 1 m^2 of R_{SI} = 1 m^2K/W insulation. In the US, insulation is typically purchased based on R-value stated in units of $ft^2 \cdot °F \cdot hr/Btu$. Environmental impacts per square meter of these alternative R-values can be calculated by multiplying the above results by scaling factors presented in Table 13.

Table 14. Scaling Factors to Other R-values

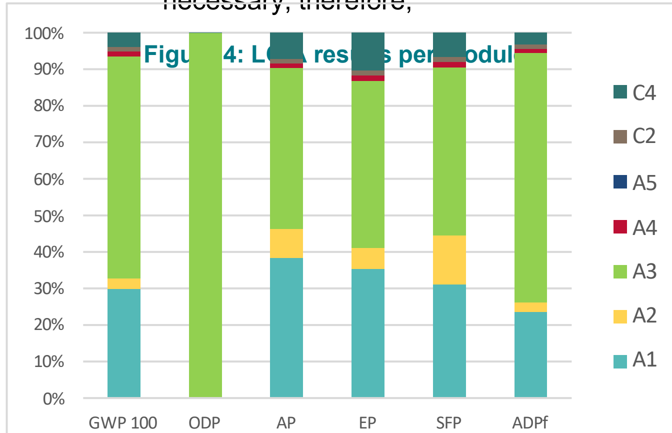
Customary US R-value	Loose Fill Thickness [in]	Scaling Factor per 1 m^2 of R_{SI} = 1
R-11	4.2	2.20
R-13	4.9	2.64
R-19	7.0	3.52
R-22	8.1	4.40
R-30	10.8	5.72
R-38	13.4	7.48
R-49	16.9	9.68

$$\text{Loose fill impact per } m^2 \text{ (R-xx)} = \text{Impact scaling factor (R-xx)} \times \text{Loose fill impact per } m^2 \ (R_S = 1)$$

LCA Interpretation

The manufacturing stages (A1-A3) dominate the majority of impact categories due to the upstream raw material production and the energy required by the melter and finishing stages. Outbound transport accounts for relevant contributions to the eutrophication potential and smog formation potential impact categories. For other impact categories, outbound transport is a minor contributor.

Installation accounts for a small fraction of overall life cycle impact given that minimal resources are required to install loose fill. There is no impact associated with the use stage. While insulation can influence building energy performance, this aspect is outside the scope of this study. Additionally, it is assumed that insulation does not require any maintenance to achieve its reference service life, which is modeled as being equal to that of the building (i.e., 75 years). No replacements are necessary; therefore,



results represent the production of one (1) square meter of insulation at a thickness defined by the PCR functional unit.

At end-of-life, insulation is removed from the building and landfilled. Waste was dominated by the end-of-life disposal of the product. Non-hazardous waste also accounts for waste generated during manufacturing and installation.

Additional Environmental Information

Mandatory Environmental Information

Fiberglass loose fill does not contain substances classified as hazardous waste under the Resource Conservation and Recovery Act (RCRA) (EPA, n.d.). Release of substances from fiberglass to air, soil, or water is not a concern (US DHHS, 2004).

Environment and Health During Manufacturing

Johns Manville insulation products are designed, manufactured and tested in our own facilities, which are certified and registered to the stringent ISO 9001 (ANSI/ASQC 90) and ISO 14001 quality and environmental standards. These certifications, along with regular, independent third-party auditing for compliance, is your assurance that JM products deliver consistent high quality. JM also has a rigorous internal product stewardship process, as well as participation with NAIMA as part of their industry product stewardship efforts.

Building Use Stage Benefits

Sustainable insulation requires no additional energy or maintenance in order to perform during the life of service. Fiberglass insulation is effective in helping reduce heat flow, reduce unwanted noise, and control moisture.

Environment and Health During Installation

Fiberglass product lines are labeled as non-hazardous according to 29 CFR 1910. 1200 was used as intended. The glass fibers are non-biopersistant (biosoluable) and are not designated as carcinogenic by the International Association for the Research of Cancer, a branch of the World Health Organization. This claim is also supported by the NTP Report Carcinogens Glass Wool Substance Profile.

As with most fiberglass products, direct exposure to fibers or dust during handling may lead to mild, superficial irritation (itching) of the skin, eyes, or respiratory tract. This irritation can be avoided by using the appropriate personal protective equipment (PPE). As such, JM recommends the following PPE precautions when handling fiberglass.

- **Respiratory:** Under typical handling and installation conditions, respiratory protection is unnecessary.
  - The North American Insulation Manufacturers Assocation (NAIMA) recommends use of a NIOSH N95 respirator/dust mask when occupational exposures to glass fibers exceed 1 fiber per cubic centimeter (1 f/cc) for an 8-hour time weighted average. Although data from the NAIMA exposure database confirm that manufacturing, fabrication, and installation activities related to this product will not result in fiber concentrations over 1 f/cc, workers may choose to use such a respirator/dust mask for comfort.

- **Hand protection:** for prolonged or repeated contact when handling these fiberglass loose fill insulation products, discomfort or irritation can be avoided by using protective gloves.

- **Eye protection:** Safety glasses should be worn during fabrication and installation.
- **Skin and body protection:** long-sleeved clothing is recommended to avoid skin irritation on unprotected areas.
- **Hygiene measures:** In any industrial setting, good hygiene practices can facilitate safer and healthier working environments. We recommend practicing appropriate hygiene under any manufacturing, fabrication or installation setting.
- **Ingestion:** Avoid ingesting or swallowing fiberglass insulation; however, should ingestion occur, rinse your mouth thoroughly with water to remove dust or fibers and drink plenty of water to help reduce irritation. Should symptoms persist, call a physician.

The NAIMA safety recommendations may be found at: https://insulationinstitute.org.about-naima/health-and-safety/

Extraordinary Effects

Fire

The performance of building materials in a fire is a key factor in protecting the occupants of the building and allowing them to escape safely. Fiberglass insulation is naturally non-combustible and remains this way for the life of the product without the addition of harsh and potentially dangerous chemical fire retardants. The insulation can resist temperatures up to 1000°F.

These products should meet NFPA 220 and ASTM E136 standards and test methods and are Class A product tested per NFPA 101. This product meets FHC specification per ASTM E84 and CAN/ULC S102.2.

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