Environmental Product Declaration

FIBERGLASS BATTS

JOHNS MANVILLE

Fiberglass batts insulation is an effective blanket insulation that is installed into wall, ceiling and attic cavities as insulation. They provide effective thermal insulation, helping to keep buildings warm in the winter and cool in the summer.

Johns Manville
A Berkshire Hathaway Company

Johns Manville (JM) is a global manufacturer of premium-quality building products for insulation, roofing, fibers and nonwovens for commercial, industrial and residential applications.

We ensure that each of our 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.

The use of JM's products improves energy efficiency in homes and buildings as the quickest and most cost-effective way to reduce energy use and lower greenhouse gas emissions.

People ● Passion ● Perform ● Protect

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UL.COM/EPD

FIBERGLASS BATTS AND ROLLS
BUILDING ENVELOPE THERMAL INSULATION

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

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL ENVIRONMENT 333 PFINGSTEN ROAD NORTHBROOK, IL 60611 https://www.ul.com https://spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v.2.5 March 2020
MANUFACTURER NAME AND ADDRESS	Johns Manville 717 17th St, Denver, CO 80202
DECLARATION NUMBER	4789973160.101.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Fiberglass batts, 1 m^2 R_{SI}-1
REFERENCE PCR AND VERSION NUMBER	Part B: Building Envelope Thermal Insulation EPD Requirements, UL 10010-1
DESCRIPTION OF PRODUCT APPLICATION/USE	Building envelope thermal insulation; ceiling tile production
PRODUCT RSL DESCRIPTION (IF APPL.)	N/A
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	January 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 (CUP 2021.2)
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1 and IPCC AR5

The PCR review was conducted by:	UL Environment PCR Review Panel epd@ulenvironment.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.

1. Product Definition and Information

1.1. Description of Company/Organization

For more than 150 years, Johns Manville (JM) 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 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.

1.2. Product Description

Product Identification

Fiberglass batts insulation is a blanket insulation produced from ranging R-values (thermal resistance). Fiberglass is inorganic and noncombustible. In addition, the fibers will not rot or absorb moisture and do not support the growth of mildew, mold, or fungus.

The following Johns Manville fiberglass batt products are covered by this environmental product declaration:

- Unfaced Fiberglass
- Kraft Faced Fiberglass
- Panel Deck FSK-25
- FSK-25
- ComfortTherm®
- Cavity-SHIELD™

Figure 1: Cavity-SHIELD™ fiberglass

Product Specification

Fiberglass batts insulation is an effective insulation and meets the requirements of ASTM 665 – Fiber Batts Thermal Insulation. The batts can be easily placed and cut, trimmed and shaped to fit small or irregular spaces. The batts are made to be easily installed by pressure fitting between framing, with no fastening required.

Product Average

This EPD is intended to represent company-specific fiberglass batts. Use of this EPD is limited to Johns Manville.

Flow Diagram

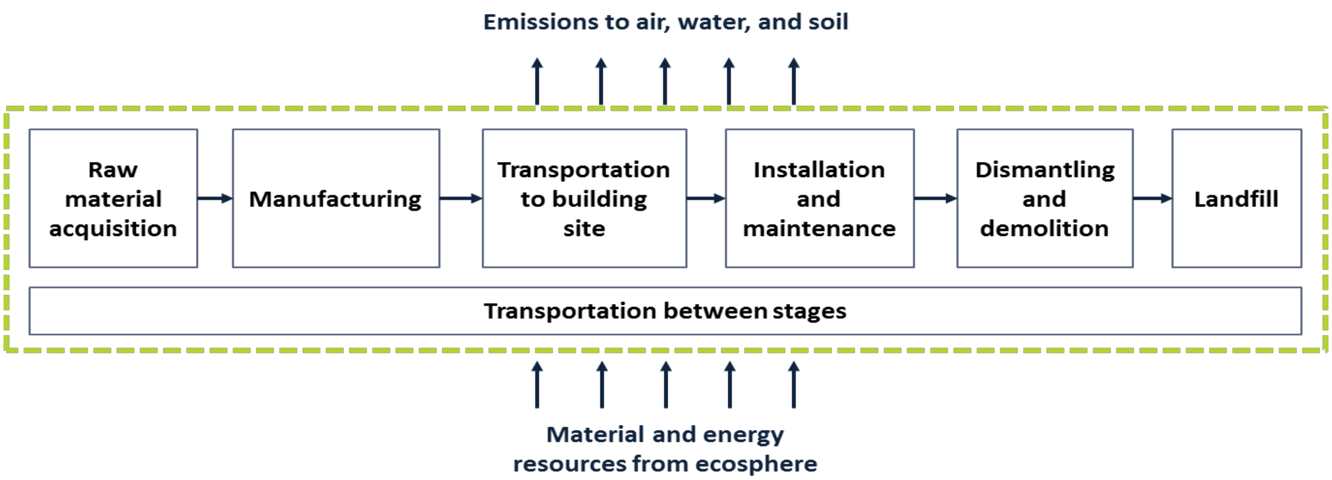

Figure 2: Flow diagram for manufacturing of fiberglass batt

1.3. Application

Whatever the method employed to manufacture fiberglass, the small-diameter, tangled glass fibers 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. The fiberglass batts are then installed into wall, ceiling and attic cavities as insulation. As a result, fiberglass provides effective thermal insulation, helping to keep buildings warm in the winter and cool in the summer. The insulation of homes and buildings against heat loss and heat gain represents the largest single use for fiberglass products. In fact, up to 70 percent of industry output is for these applications. Sound reduction is also an important use of these products.

1.4. 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.

Per the product category rules (UL Environment, 2018), the assessment was conducted using a building service life of 75 years. Allocation of manufacturing material and energy inputs was done on a mass basis. Allocation of transportation was based on mass while considering the utilization rate.

For recycled content and disposal at end-of-life, system boundaries were drawn consistent with the cut-off allocation approach. Additional details can be found in section 2.8. No known flows are deliberately excluded from this EPD.

1.5. Technical Requirements

The technical specifications apply to products considered in this EPD:

- ASTM C665 – Standard Specification for Mineral Fiber Thermal Insulation for Light Frame Construction and Manufactured Housing

Additionally, the the following fire-related standards and test methods apply:

- ASTM E136 – Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
- ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

1.6. Properties of Declared Product as Delivered

Batts and rolls insulation is delivered to the site of installation in compression packaged batts, blanckets and rolls. Once removed from the packaging and installed, the product will recover the needed thickness to deliver the advertised R-value.

1.7. Material Composition

Manufacturers of fiberglass batt and roll insulation use a mechanized process to spin a molten composition of sand, soda ash, and recycled glass cullet along with the materials mentioned in Table 1, bonded by a binding agent into high-temperature-resistant fibers.

Table 1 provides the average material content of fiberglass batts.

Table 1: Fiberglass batts material content

COMPONENT	BATTS [WT. %]
Silica Sand	21%
Feldspar	17%
Soda Ash	9.5%
Borax	14%
Fluorspar	2%
External Cullet	26%
Dolomitic lime	4.5%
Binder (Acrylic)	6%

1.8. Manufacturing

This EPD covers fiberglass batts produced in the United States and Canada. Two facilities located in Kansas and New Jersey (United States) were considered in the analysis. These facilities were chosen as JM's manufacturing locations that sell fiberglass batt product on the market.

To produce batt insulation, the glass component raw materials are melted and glass is spun into fibers and then a binder is applied, the product is cured, cut to size and packaged to create the batts and rolls. For fiberglass batts with facer, the facer is applied to the batt after curing but before sizing and packaging. The binder component raw materials are mixed up and injected into the process below the fiberization of the glass.

The life cycle for fiberglass batt and roll products begins with raw material extraction. These batch materials are melted and formed into the end product. At finishing they are cooled and packaged (see flow diagram in Figure 2). The packaged product is transported to the customer at the construction site where it is installed manually.

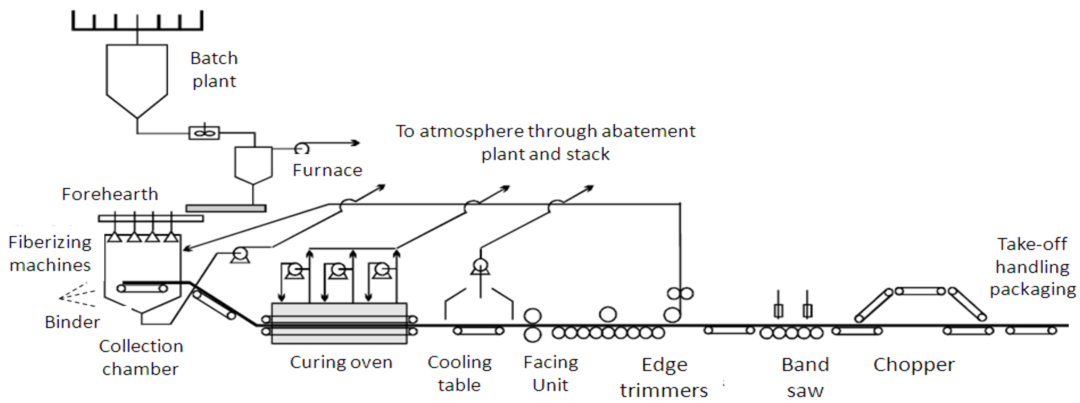

Figure 3: Manufacturing process steps

1.9. Packaging

The product is typically packaged with plastic wrap. 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.

1.10. Transportation

Average transportation distances via truck and rail are included for the transport of the raw materials to production facilities. Transport of the finished product 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). Additional information is provided in Table 4.

1.11. Product Installation

Batt and roll insulation are easy to handle and install. Sized for installation in either wood or metal frame construction, unfaced insulation is friction fit into place. Faced insulation may be either friction fit or stapled into place. Trimming and fabrication can be done with a utility knife and can be cut to fit into odd-shaped cavities and small spaces. Packaging disposal is included as part of the installation module. No product loss is assumed since any extra product can be used in subsequent jobs. For additional information, please refer to Table 5.

1.12. Use

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.

1.13. Reference Service Life and Estimated Building Service Life

Fiberglass batts insulation is assumed to have a reference service life of 75 years, equal to that of the building.

1.14. Reuse, Recycling, and Energy Recovery

Fiberglass batts are 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.

1.15. 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).

2. Life Cycle Assessment Background Information

2.1. Functional or Declared Unit

Per the product category rules, the functional unit for this analysis is 1 m^2 of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m^2K/W and a building service life of 75 years. In imperial units, the R_{SI} value is equivalent to R_{US} = 5.68.

Table 2: Functional unit

NAME	VALUE	UNIT
Functional unit	1 m^2 of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m^2K/W	
Mass (unfaced)	1.3807	kg
Mass (faced)	1.416	kg

2.2. System Boundary

A cradle-to-installation with end-of-life system boundary was used for the analysis. Within these boundaries the following stages were included:

- Product stage: modules A1 to A3
- Construction stage: modules A4 and A5
- End-of-life stage: modules C1 to C4

Each module includes provision of all relevant materials, products and energy. Impacts and aspects related to wastage (i.e. production, transport and waste processing and end-of-life stage of lost waste products and materials) are considered in the module in which the wastage occurs. Building operational energy and water use are considered outside of this study's scope: any impact the use of insulation may have on a building's energy consumption is not calculated or incorporated into the analysis.

The end-of-life stage modules C1 and C3 are declared as having zero impact as deconstruction is done manually and the insulation is not recycled. Consequently, there are no direct emissions associated with these modules.

Per the PCR, capital goods and infrastructure flows are assumed to not significantly affect LCA results or conclusions and thus excluded from the analysis.

2.3. 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.
- Batt material is cut and installed by hand and installation is assumed to have a negligible scrap rate (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 3. 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%

2.4. Cut-off Criteria

For the processes within the system boundary, all available energy and material flow data have been included in the model. In cases where no matching life cycle inventories are available to represent a flow, proxy data have been applied based on conservative assumptions regarding environmental impacts.

Cut-off criteria, however, were applied to exclude capital goods and infrastructure as these are assumed to not significantly affect LCA results nor conclusions. In addition, biogenic carbon has also been excluded as the overall difference in GWP result is less than 2%.

2.5. Data Sources

The LCA model was created using the GaBi 10.5.1.124. 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 CUP 2021.2 database. Primary manufacturing data were provided by Johns Manville.

2.6. 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.

2.7. Period under Review

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

2.8. Allocation

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

For recycled content and disposal at end-of-life, system boundaries were drawn consistent with the cut-off allocation approach. 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.

2.9. Comparability (Optional)

No comparisons or benchmarking is included in this EPD. LCA results across EPDs can be calculated with different background databases, modeling assumptions, geographic scope and time periods, all of which are valid and acceptable according to the Product Category Rules (PCR) and ISO standards. Caution should be used when attempting to compare EPD results.

3. Life Cycle Assessment Scenarios

Table 4. Transport to the building site (A4)

NAME	BATTS (UNFACED)	BATTS (FACED)	UNIT
Fuel type	Diesel	Diesel	
Liters of fuel	36	36	L/100km
Vehicle type	Truck	Truck	
Transport distance	949.76	1101.41	km
Gross density of products transported	10.4	12.01	kg/m^3
Weight of products transported (if gross density not reported)	N/A	N/A	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 5. Installation into the building (A5)

NAME	BATTS (UNFACED)	BATTS (FACED)	UNIT
Ancillary materials	0	0	kg
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)	0	0	m^3
Other resources	0	0	kg
Electricity consumption	0	0	kWh
Other energy carriers	0	0	MJ
Product loss per functional unit	0	10	%
Waste materials at the construction site before waste processing, generated by product installation	0	0.047	kg
Output materials resulting from on-site waste processing Recycling Incineration Landfill	 0 0 0.44	 0 0 0.421	 kg kg kg
Biogenic carbon contained in packaging	0.43	0.43	kg CO_2
Direct emissions to ambient air, soil and water	0	0	kg
VOC content	0	0	µg/m^3

Table 6. Reference Service Life

NAME	BATTS (UNFACED)	BATTS (FACED)	UNIT
RSL	75	75	years

Table 7. End of life (C1-C4)

NAME		BATTS (UNFACED)	BATTS (FACED)	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	0.440	0.468	kg
Recovery (specified by type)	Reuse	0	0	kg
	Recycling	0	0	kg
	Landfill	0.440	0.468	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	0.440	0.468	kg
Removals of biogenic carbon (excluding packaging)		0	0	kg CO2

4. Life Cycle Assessment Results

Table 8. Description of the system boundary modules. X = included in EPD scope; MND = module not declared (i.e., excluded from EPD scope)

	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

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

Biogenic carbon is not reported in global warming potential (GWP) as fiberglass products do not typically contain bio-based materials. As such, carbon emissions and removals are not declared.

4.1. Life Cycle Impact Assessment Results

Table 9. North American Impact Assessment Results for 1 m² of Fiberglass Batts (unfaced; R_{SI} = 1 m²K/W)

TRACI v2.1	UNITS	TOTAL	A1	A2	A3	A4	A5	C2	C4
GWP	kg CO2 eq.	**1.20E+00**	2.98E-01	1.79E-02	8.26E-01	7.16E-03	2.43E-02	6.63E-03	2.27E-02
ODP	kg CFC 11 eq.	**9.57E-15**	5.71E-16	3.70E-18	8.92E-15	1.51E-18	6.62E-18	1.40E-18	5.98E-17
AP	kg SO2 eq.	**2.04E-03**	8.70E-04	1.09E-04	8.46E-04	1.40E-05	1.11E-04	1.30E-05	7.77E-05
EP	kg N eq.	**1.97E-04**	6.72E-05	9.61E-06	9.07E-05	2.01E-06	1.94E-05	1.86E-06	6.57E-06
SFP	kg O3 eq.	**3.77E-02**	1.17E-02	3.63E-03	1.99E-02	3.17E-04	4.49E-04	2.93E-04	1.36E-03
ADPf	MJ	**2.16E+00**	6.87E-01	3.47E-02	1.37E+00	1.42E-02	5.19E-03	1.31E-02	3.50E-02

Table 10. North American Impact Assessment Results for 1 m² of Fiberglass Batts (faced; R_{SI} = 1 m²K/W)

TRACI v2.1	UNITS	TOTAL	A1	A2	A3	A4	A5	C2	C4
GWP	kg CO2 eq.	**1.19E+00**	3.11E-01	1.80E-02	7.96E-01	7.61E-03	2.58E-02	7.06E-03	2.48E-02
ODP	kg CFC 11 eq.	**1.53E-13**	1.46E-13	3.72E-18	7.63E-15	1.61E-18	7.04E-18	1.49E-18	6.38E-17
AP	kg SO2 eq.	**2.09E-03**	9.26E-04	1.07E-04	8.26E-04	1.49E-05	1.18E-04	1.38E-05	8.30E-05
EP	kg N eq.	**2.04E-04**	7.56E-05	9.53E-06	8.70E-05	2.13E-06	2.06E-05	1.98E-06	7.25E-06
SFP	kg O3 eq.	**3.82E-02**	1.28E-02	3.58E-03	1.93E-02	3.37E-04	4.78E-04	3.12E-04	1.45E-03
ADPf	MJ	**2.17E+00**	7.17E-01	3.49E-02	1.35E+00	1.51E-02	5.52E-03	1.40E-02	3.73E-02

Table 11. EN 15804 Impact Assessment Results for 1 m2 of Fiberglass Batts (unfaced; RSI = 1 m2K/W)

CML	UNITS	TOTAL	A1	A2	A3	A4	A5	C2	C4
$ADP_{elements}$	kg Sb eq.	7.48E-05	7.45E-05	5.82E-09	2.40E-07	2.38E-09	1.07E-09	2.21E-09	7.76E-09
ADP_{fossil}	MJ	1.84E+01	5.36E+00	2.60E-01	1.23E+01	1.06E-01	3.96E-02	9.85E-02	2.69E-01
AP	kg SO2 eq.	1.72E-03	7.36E-04	7.90E-05	7.41E-04	1.05E-05	7.31E-05	9.72E-06	7.13E-05
EP	kg P eq.	3.07E-04	1.09E-04	2.25E-05	1.30E-04	3.54E-06	2.67E-05	3.27E-06	1.17E-05
GWP	kg CO2 eq.	1.22E+00	3.01E-01	1.80E-02	8.31E-01	7.16E-03	3.77E-02	6.62E-03	2.27E-02
ODP	kg R11 eq.	9.57E-15	5.71E-16	3.70E-18	8.92E-15	1.51E-18	6.62E-18	1.40E-18	5.98E-17
POCP	kg Eth eq.	3.84E-04	3.51E-05	4.05E-06	3.29E-04	-2.94E-06	2.11E-05	-2.72E-06	7.57E-07

Table 10. EN 15804 Impact Assessment Results for 1 m2 of Fiberglass Batts (faced; RSI = 1 m2K/W)

CML	Units	Total	A1	A2	A3	A4	A5	C2	C4
$ADP_{elements}$	kg Sb eq.	**7.54E-05**	7.52E-05	5.85E-09	2.36E-07	2.53E-09	1.14E-09	2.35E-09	8.28E-09
ADP_{fossil}	MJ	**1.84E+01**	5.59E+00	2.61E-01	1.20E+01	1.13E-01	4.21E-02	1.05E-01	2.87E-01
AP	kg SO2 eq.	**1.76E-03**	7.85E-04	7.80E-05	7.24E-04	1.12E-05	7.77E-05	1.04E-05	7.61E-05
EP	kg P eq.	**3.17E-04**	1.19E-04	2.23E-05	1.27E-04	3.76E-06	2.83E-05	3.49E-06	1.28E-05
GWP	kg CO2 eq.	**1.20E+00**	3.02E-01	1.81E-02	8.01E-01	7.61E-03	4.01E-02	7.06E-03	2.48E-02
ODP	kg R11 eq.	**1.49E-13**	1.42E-13	3.72E-18	7.63E-15	1.61E-18	7.04E-18	1.49E-18	6.38E-17
POCP	kg Eth eq.	**3.50E-04**	3.20E-05	3.77E-06	2.97E-04	-3.13E-06	2.24E-05	-2.90E-06	8.00E-07

4.2. Life Cycle Inventory Results

Table 13. Resource Use for 1 m² of Fiberglass Batts (unfaced; R_{SI} = 1 m²K/W)

	Units	Total	A1	A2	A3	A4	A5	C2	C4
RPRe	MJ	**1.47E+00**	2.09E-01	1.08E-02	1.22E+00	4.42E-03	2.90E-03	4.09E-03	2.28E-02
RPRm	MJ	**-**	-	-	-	-	-	-	-
RPRt	MJ	**1.47E+00**	2.09E-01	1.08E-02	1.22E+00	4.42E-03	2.90E-03	4.09E-03	2.28E-02
NRPRe	MJ	**2.00E+01**	4.94E+00	2.62E-01	1.43E+01	1.07E-01	4.03E-02	9.92E-02	2.75E-01
NRPRm	MJ	**6.11E-01**	6.11E-01	-	-	-	-	-	-
NRPRt	MJ	**2.06E+01**	5.55E+00	2.62E-01	1.43E+01	1.07E-01	4.03E-02	9.92E-02	2.75E-01
SM	kg	**6.52E-02**	6.52E-02	**-**	-	-	-	-	-
RSF	MJ	**-**	-	-	-	-	-	-	-
NRSF	MJ	**-**	-	-	-	-	-	-	-
RE	MJ	**-**	-	-	-	-	-	-	-
FW	m³	**4.21E-03**	1.01E-03	4.61E-05	3.06E-03	1.89E-05	9.35E-06	1.75E-05	4.71E-05

Table 14. Resource Use for 1 m² of Fiberglass Batts (faced; R_{SI} = 1 m²K/W)

	Units	Total	A1	A2	A3	A4	A5	C2	C4
RPRe	MJ	**1.68E+00**	4.66E-01	1.09E-02	1.17E+00	4.70E-03	3.09E-03	4.36E-03	2.43E-02
RPRm	MJ	**-**	-	-	-	-	-	-	-

RPRt	MJ	**1.68E+00**	4.66E-01	1.09E-02	1.17E+00	4.70E-03	3.09E-03	4.36E-03	2.43E-02
NRPRe	MJ	**2.00E+01**	5.20E+00	2.63E-01	1.40E+01	1.14E-01	4.29E-02	1.06E-01	2.94E-01
NRPRm	MJ	**6.01E-01**	6.01E-01	-	-	-	-	-	-
NRPRt	MJ	**2.06E+01**	5.80E+00	2.63E-01	1.40E+01	1.14E-01	4.29E-02	1.06E-01	2.94E-01
SM	kg	**6.74E-02**	6.74E-02	-	-	-	-	-	-
RSF	MJ	**-**	-	-	-	-	-	-	-
NRSF	MJ	**-**	-	-	-	-	-	-	-
RE	MJ	**-**	-	-	-	-	-	-	-
FW	m^3	**4.23E-03**	1.12E-03	4.64E-05	2.96E-03	2.01E-05	9.94E-06	1.86E-05	5.12E-05

Table 15. Output Flows and Waste Categories for 1 m^2 of Fiberglass Batts (unfaced; R_{SI} = 1 m^2K/W)

	UNITS	TOTAL	A1	A2	A3	A4	A5	C2	C4
HWD	kg	**3.56E-04**	1.18E-09	2.19E-11	3.56E-04	8.96E-12	3.70E-12	8.29E-12	2.60E-11
NHWD	kg	**5.14E-01**	1.81E-02	2.41E-05	1.05E-02	9.86E-06	7.88E-02	9.12E-06	4.06E-01
HLRW	kg	**1.03E-06**	8.93E-08	8.83E-10	9.38E-07	3.61E-10	3.22E-10	-	-
ILLRW	kg	**8.62E-04**	7.68E-05	7.44E-07	7.84E-04	3.04E-07	2.77E-07	-	-
CRU	kg	**-**	-	-	-	-	-	-	-
MFR	kg	**3.15E-02**	-	-	3.15E-02	-	-	-	-
MER	kg	**-**	-	-	-	-	-	-	-
EE	MJ	**-**	-	-	-	-	-	-	-

Table 16. Output Flows and Waste Categories for 1 m^2 of Fiberglass Batts (faced; R_{SI} = 1 m^2K/W)

	UNITS	TOTAL	A1	A2	A3	A4	A5	C2	C4
HWD	kg	**2.91E-04**	3.28E-09	2.20E-11	2.91E-04	9.53E-12	3.93E-12	8.84E-12	2.77E-11
NHWD	kg	**5.49E-01**	1.91E-02	2.42E-05	1.32E-02	1.05E-05	8.38E-02	9.73E-06	4.33E-01
HLRW	kg	**6.58E-07**	5.59E-08	5.35E-10	6.01E-07	2.04E-10	1.81E-10	-	-
ILLRW	kg	**5.50E-04**	4.71E-05	4.50E-07	5.02E-04	1.72E-07	1.56E-07	-	-
CRU	kg	**-**	-	-	-	-	-	-	-
MFR	kg	**2.57E-02**	-	-	2.57E-02	-	-	-	-
MER	kg	**-**	-	-	-	-	-	-	-

EE	MJ	-	-	-	-	-	-	-	-

4.3. Facility specific GWP results

Johns Manville's fiberglass batt product is manufactured at two different facilities. The results presented below represent a production-weighted average of these facilities. To produce batt insulation, the glass component raw materials are melted and formed into the final product. The binder component raw materials are mixed up and injected into the process, after which the product with the combined components is cured, sized and then packaged. The facer is applied to the batt after curing but before sizing and packaging.

To understand how the GWP may vary between sites, facility specific GWP100 results are presented below.

Table 17. Facility-specific GWP100 results, per 1 m^2 of Fiberglass Batts (unfaced; R_{SI} = 1 m^{2}K/W)

GWP 100 (kg CO2 eq)	Total	A1	A2	A3	A4	A5	C2	C4
McPherson	**1.35E+00**	3.12E-01	1.96E-02	9.58E-01	7.16E-03	2.43E-02	6.57E-03	2.09E-02
Penbryn	**9.06E-01**	2.69E-01	1.45E-02	5.58E-01	7.16E-03	2.43E-02	6.74E-03	2.65E-02

Table 18. Facility-specific GWP100 results, per 1 m^2 of Fiberglass Batts (faced; R_{SI} = 1 m^{2}K/W)

GWP 100 (kg CO2 eq)	Total	A1	A2	A3	A4	A5	C2	C4
McPherson	**1.41E+00**	3.35E-01	2.05E-02	9.88E-01	7.61E-03	2.58E-02	6.98E-03	2.21E-02
Penbryn	**9.48E-01**	2.85E-01	1.52E-02	5.79E-01	7.61E-03	2.58E-02	7.16E-03	2.79E-02

4.4. Scaling to Other R-values

Environmental performance results are presented per functional unit, defined as 1 m^2 of R_{SI} = 1 m^{2}K/W insulation. In the US, insulation is typically purchased based on R-value stated in units of ft^2·°F·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 19.

Table 19. Scaling Factors to Other R-values

Customary US R-value	Batts Thickness [in]	Scaling Factor per 1 m^2 of R_{SI} = 1
R-11	3.2	2.20
R-13	3.8	2.64
R-19	5.6	3.52
R-22	6.5	4.40

R-30	8.8	5.72
R-38	11.2	7.48
R-49	14.4	9.68

$$\text{Batt impact per } m^2 \text{ (R-xx)} = \text{Impact scaling factor (R-xx)} \times \text{Batt impact per } m^2 \ (R_{SI} = 1)$$

5. LCA Interpretation

The manufacturing stage dominates the majority of impact categories due to 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 batts. 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.

The use of JM's products improve energy efficiency in homes and buildings as the quickest and most cost-effective way to reduce energy use and lower greenhouse gas emissions.

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.

6. Additional Environmental Information

6.1. Mandatory Environmental Information

Fiberglass batts 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).

6.2. 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.

6.3. 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.

6.4. Environment and Health During Installation

Fiberglass product lines are labeled as non-hazardous according to 29 CFR 1910.1200 if 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.

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 esxposures 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 activiites 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 repreated contact when handling these fiberglass batts and wrap insulations, 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 recommeneded to avoid skin irritation on unprotected areas.
- **Hygiene measures:** In any industrial settting, 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 swalloing fiberglass insulation; however, should ingestion occur, rince 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/

6.5. 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 in excess of 2,000°F. Because these products have a high melting temperature, they can be used in a wide variety of applications that call for these unique properties.

Due to these properties, fiberglass insulation can be used as passive fire protection in many buildings. Manufacturers of these products encourage a balanced design, which includes a combination of active, detective, and passive fire protection in building codes to ensure the safety of building occupants.

These products should meet NFPA 220 and ASTM E136 standards and test methods and are Class A product tested per ASTM E84 and NFPA 101.

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