ENVIRONMENTAL PRODUCT DECLARATION

MECHANICAL INSULATION BOARD

1000 SERIES SPIN-GLAS® • 800 SERIES SPIN-GLAS® • PRECIPITATOR SPIN-GLAS® • LINACOUSTIC R300 • MICRO-FLEX® • INSUL-SHIELD • SPIRACOUSTIC® PLUS

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

Think JM.

Mechanical Board Insulation is designed to meet the demanding requirements of industrial applications. Typical applications include furnaces, boilers, heated vessels, ducts, tanks and other heating equipment.

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ENVIRONMENTAL PRODUCT DECLARATION

Johns Manville
A Berkshire Hathaway Company

Mechanical Insulation Board
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 WWW.UL.COM www.spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	Program Operator Rules v2.7 2022
MANUFACTURER NAME AND ADDRESS	Johns Manville 717 17th St, Denver, CO 80202
DECLARATION NUMBER	4790545973.104.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Mechanical Insulation Board, 1 m^2
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	Thermal and acoustical insulation for Ducts and Equipment. Building envelope
PRODUCT RSL DESCRIPTION (IF APPL.)	N/A
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	September 28, 2022
PERIOD OF VALIDITY	5 Years
EPD TYPE	Company specific
RANGE OF DATASET VARIABILITY	Company specific
EPD SCOPE	Cradle to gate with end-of-life options (C1-C4)
YEAR(S) OF REPORTED PRIMARY DATA	July 1, 2020 – June 30, 2021
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 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
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. Since this EPD does not analyze the use stage, no comparisons are possible. 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

For more than 160 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.

JM manufactures 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.

Product Description

Product Identification

1000 Series Spin-Glas®

1000 Series Spin-Glas is a semi-rigid, lightweight board with a density of 3.0 pounds per cubic foot. The fiber glass orientation and binder contribute to the strength of the product, enabling it to withstand challenging environments with heavy vibration.

Other benefits include:

- **Reduced product waste:** 1000 Series Spin-Glas comes in a variety of sizes which can eliminate trimming during fabrication and installation, reducing product waste.
- **Easy application:** The fiber glass board is light weight and can be attached directly on studs or clips.
- **Excellent thermal performance:** A low k-value and consistent thermal conductivity ensure thermal performance that can dramatically reduce heat-loss in equipment applications.

800 Series Spin-Glas®

800 Series Spin-Glas is a fiber glass board used in equipment insulation applications. Johns Manville offers 800 Series Spin-Glas with a density range of 1.5 lbs. to 6lbs. and with an FSK facing, an All Purpose (AP) facing, or plain/un-faced. Both the facings meet the requirements of NFPA 90A and 90B and can act as a vapor barrier.

They have a low perm-rating, which allows them to be used in chilled water and other below ambient applications. The material can be readily cut with an ordinary knife and secured with mechanical fasteners or adhesives.

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Precipitator Spin-Glas®

Precipitator Spin-Glas is a semi-rigid, lightweight, board with a density of 2.4 pounds per cubic foot. It is made from uniformly distributed glass fibers bonded with an thermosetting resin.   This creates a strong, shot-free board that is highly resistant to damage from vibration during operation and handling during installation.

Micro-Flex®

Micro-flex is a large-diameter pipe and tank wrap made from semi-rigid fiber glass with a density of 2.5 pounds per cubic foot. It is offered with either an All Purpose (AP) facing or an FSK facing. Our manufacturing process yields a fiber orientation that enables quick and easy installation insulation, while maintaining excellent compressive strength and thermal performance of the final product.

Linacoustic® R-300

Linacoustic® R-300 is a rigid fiberglass board that is specifically designed for lining HVAC plenums and air distribution ductwork, and meets or exceeds all ASTM C 1071 Type II duct liner requirements. Linacoustic R-300's airstream surface is coated with our proprietary Permacote® coating, which provides a durable and smooth surface that is resistant to the accumulation of dust and dirt. It also provides added product protection against microbial growth. Linacoustic R-300 provides exceptional durability and superior thermal and acoustical performance to help you create more comfortable and energy efficient indoor environments for commercial and residential building occupants.

Spiracoustic Plus®

Spiracoustic Plus® is a spiral duct liner system engineered to provide superior acoustical and thermal performance for spiral air duct interiors with an airstream diameter of 6 inches and larger. Spiracoustic Plus delivers significantly improved acoustical and thermal performance compared to double-wall construction, all at a competitive cost for the system. It is manufactured with evenly-spaced kerfs to allow the material to conform to the inside diameter of spiral ducts, producing a finished airstream surface. This surface is coated with our proprietary Permacote® coating, which provides a durable surface and added product protection against microbial growth. As an added benefit, the exterior surface is laminated with a tough fire-resistant FSK facing.

Product Average

This EPD is intended to represent company-specific Mechanical Insulation Board. The production data used to develop this EPD was collected from the Johns Manville production sites in Defiance, Ohio, United States. Use of this EPD is limited to Johns Manville.

Application

- **1000 Series Spin-Glas***: Designed to insulate furnaces, boilers, heated vessels, ducts, tanks, and other heated equipment that operates at temperatures up to 850°F (454°C).
- **800 Series Spin-Glas**: Ideal for flat surfaces in commercial heating, air conditioning, power and process equipment applications. Faced 800 Series Spin-Glas is designed for systems that operate at below ambient temperatures where a vapor barrier is required. In below-ambient applications, all seams should be tightly sealed with quality ASJ or FSK tapes. It should not be used in applications where it will be exposed directly to an airstream.
- **Precipitator Spin-Glas***: Engineered specifically for insulating precipitators, baghouses, scrubbers, ducts, and breechings in power generation plants. Precipitator Spin-Glas can also be used to insulate boilers, heaters, ovens and other industrial equipment that operates at temperatures at or below 850°F (454°C).
- **Micro-Flex**: Best suited for large-diameter pipe and tank wrap and applications where it will be used to insulate rounded shapes, such as pipes, tanks, ducts, vessels, and other similarly round objects and irregular shapes. Micro-Flex provides a single solution to a variety of field applications for the contractor, and the rolls can be cut to size on the job. It can be used in applications that require a vapor barrier as long as all joints and facing penetrations have been sealed.
- **R300**: R-300 is specifically designed for use as an extended performance lining insulation for HVAC plenums and air distribution ductwork.
- **Spiracoustic Plus**: A high performance acoustical and thermal liner used in round air ducts of virtually any size.

* Both 1000 Series Spin-Glas and Precipitator Spin-Glas can withstand intermittent exposure to temperatures up to 950°F (510°C) for less than an hour as long as the product has been stabilized at 850°F (454°C) for 24 hours. The first time the insulation will be used in an application that exceeds 650°F (343°C), it must be allowed to stabilize for at least two hours at 650°F (343°C) prior being used at higher temperatures.

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. C2 is assumed as 20 km by truck.

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

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

Properties of Declared Product as Delivered

Mechanical Insulation Boards are delivered to the site on pallets, in cartons or in poly packages.

Material Composition

Manufacturers of Mechanical Insulation Boards 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 thermosetting resin into high-temperature-resistant insulation board. Table 1 provides the average material content of Mechanical Insulation Boards.

Table 1: Average Mechanical Insulation Board material content

COMPONENT	CONTENT [WT. %]
Sand	8%
Borax	15%
Burnt Dolomite Lime	2%
Nepheline syenite	17%
Soda ash	4%
Fluorspar	2%
Bottle cullet	52%

Manufacturing

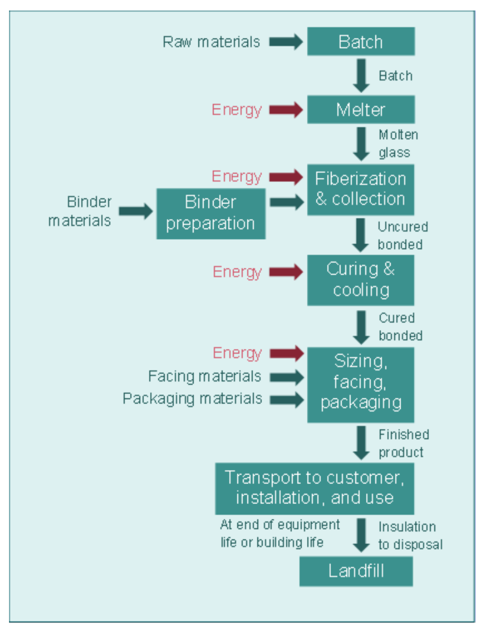
This Environmental Product Declaration (EPD) represents the production of Johns Manville mechanical insulation boards at Defiance, OH.

The life cycle of the product under study begins with the extraction and processing of the raw materials that constitute the batch. Together, these materials (sand, borax, soda ash, recycled glass, and minerals) are melted, and the molten glass is spun into fibers and coated with a thermosetting binder. The binder used in the production of the insulation is a water suspension. The bonded product is then formed into insulation of the required configuration and specifications. After curing with hot air through convection and cooling, the finished insulation is then faced with FSK (foil-scrim-kraft: paper, aluminum, latex and glass fiber) vapor barrier facing, cut to size, and sent to the packaging line.

Transport to the job site is an estimated 250 miles via truck. The insulation product is assumed to be tailored to customer specifications, leading to negligable material loss during installation. Only the packaging materials are sent to landfill. The use phase is considered to be burden-free for insulation products as they require no maintenance and have a 75-year reference service life equal to that of the entire building. When the building is demolished, the insulation is assumed to be sent to landfill.

Figure 1 illustrates the production and subsequent life cycle stages.

Figure 1: Production and life cycle stages



Packaging

The product is typically packaged with plastic wrap or paper packaging. 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 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). Distribution of the finished product is assumed to be volume-limited rather than mass-limited, with a utilization rate of 28% of mass capacity.

Product Installation

- **800/1000 Series and Precipitator Spin-Glas**: At maximum temperatures, the insulation should not exceed 6” thick. Additionally, when equipment is expected to expand to the extent that gaps form between the insulation sections, double-layer construction with staggered joints is recommended. If the product is being used in applications above 350°F (177°C), an acrid odor and some smoke may be given off during the initial heat-up to operating temperatures. This is caused by the decomposition of the phenolic binders used in the fiber glass pipe insulation. If this occurs, ensure that the area is well ventilated.
- **Micro-Flex**: In order to install Micro-Flex properly and calculate the correct stretch-out length, simply determine the circumference of the pipe, then double the thickness of the insulation being installed, and add it to the pipe circumference to ensure that the insulation can cover the entire surface. Follow standard practices for cutting a lap seam, and take care to avoid cutting through the facing. For applications that require a vapor barrier, any staples used to seal the lap seam must be coated with a vapor-retarder mastic to ensure a complete seal. All longitudinal joints should be sealed with 3-4 inch pressure-sensitive tape. In some applications, banding may be required to ensure additional securement.
- **Spiracoustic Plus®**: Johns Manville developed the unique “snap-in” round liner concept in the mid-1990s to provide a cost-effective, user-friendly lining system for the growing spiral HVAC duct market.. Full detailed installtion instructions, please refer to the Spiracoustic Plus “Spiral Duct Liner Insallation Guide” found on the JM website: https://www.jm.com/content/dam/jm/global/en/hvac-insulation/duct-liner/spiracoustic-plus/JM_HVAC_Spiracoustic_Install_Guide.pdf
- **Linacoustic® R-300**: All portions of duct designated to receive duct liner should be completely covered with Permacote Linacoustic R-300. The smooth, black Permacote surface of the Linacoustic R-300 must face the airstream. All Permacote Linacoustic R-300 should be cut to ensure tight, overlapped corner joints. The top pieces should be supported by the side pieces. Permacote Linacoustic R-300 must be adhered to the sheet metal with full coverage of an approved adhesive that meets ASTM C-916, and all exposed leading edges and transverse edges should be coated with Johns Manville SuperSeal® HV, Johns Manville SuperSeal® Edge Treatment, or an approved adhesive. The Permacote Linacoustic R-300 must be additionally secured with mechanical fasteners spaced per the schedule provided by Johns Manville. The pin length should be such as to hold the material firmly in place with minimum compression of the material.

Use

Mechanical equipment and duct 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 needs to be considered on the level of the individual equipment and is considered outside the scope of this LCA.

Reference Service Life and Estimated Building Service Life

Mechanical Insulation Boards are assumed to have a 75-year reference service life equal to that of the entire building.

Reuse, Recycling, and Energy Recovery

Mechanical Boards are typically not reused or recycled following their 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 end-of-life, insulation is removed from the deconstructed building. Wastes are then disposed in a landfill. While insulation can theoretically be reused or recycled, doing so is not common practice in the industry. Therefore, the analysis assumes that after removal, the insulation is transported to the disposal site and landfilled.

Life Cycle Assessment Background Information

Declared Unit

Per the product category rules, the declared unit for this analysis is 1 m^2 of insulation material as delivered to the job site, with a building service life of 75 years.

Table 2: Declared unit and subsequent product attributes

	Area [m^2]	Density [kg/m^3]	R_{SI} [m^{2}K/W]	R_{US} [BTU/(h °F ft^2)]	RSL [years]	Thickness [in]	Mass [kg]
Declared Unit	1	10.4	1	5.68	75	1.31	1.9

For the declared unit, the amount of mechanical board insulation material with facing is the same as that of unfaced insulation. However, for the production of mechanical board with facing, an area of facing is added during manufacturing. The declared unit of the mechanical board insulation facing is 1 m^2.

Table 3: Declared unit of facing for mechanical board insulation

	Area (m^2)	RSL [years]	Density [kg/m^2]	Mass [kg]
Declared Unit	1	75	0.0298	0.0298

System Boundary

Table 4 represents the system boundary and scope.

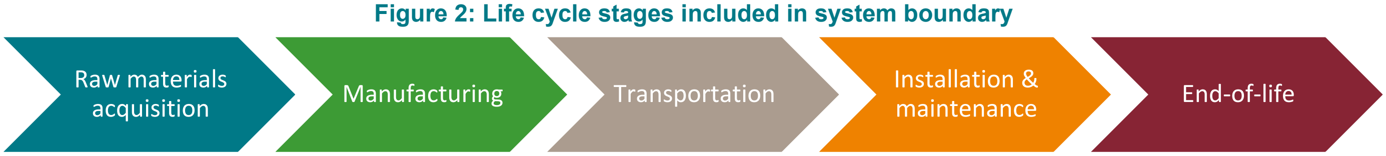
Table 4: Description of the system boundary modules

	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

Figure 2: Life cycle stages included in system boundary



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 an equipment's energy consumption is not calculated or incorporated into the analysis.

Estimates and Assumptions

The analysis uses the following assumptions:

- Insulation is assumed to have the same life as the building.
- Installation is done by hand and assumed to have a negligible scrap rate.
- If inbound transportation distances were not provided for materials used in manufacturing, a default assumption of 250 miles via truck was applied in the model.

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 5).

Table 5. 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. Otherwise, all energy and material flow data available were included in the model.

Data Sources

The LCA model was created using the GaBi 10.5. 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.

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 represent a continuous 12-months from July 1, 2020 - June 30, 2021. 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 from 2020 to 2021 calendar year. This analysis is intended to represent production in July 1, 2020 - June 30, 2021.

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 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.

Data collection was performed by Johns Manville reaching out directly to plant facility managers. Specific data were collected for raw material use; however, energy use posed a considerable challenge to attribute to the products. The only exception was natural gas, where process-level boiler and furnace energy use was available. For electricity and other facility fuel use, only site-level and multi-process data were available. These data were normalized by the mass of product manufactured at the facility over the temporal scope. Air emissions were also unavailable at the process-level; therefore, a facility air emission report was leveraged to attribute the emissions to per declared unit of product.

Comparability

No comparisons or benchmarking is included in this EPD.

Life Cycle Assessment Scenarios

Mechanical insulation board requires no maintenance, and there are no parts to repair or refurbish. The reference service life for the insulation product and its facing is the same as the building. Installation is done by hand, with only packaging waste generated during that step and no ancillary material used for installation onto the equipment (A5).

Table 6. Transport to the building site (A4)

NAME	MECHANICAL BOARD	UNIT
Fuel type	Diesel	
Liters of fuel	0.0011	L/100km
Vehicle type	Truck	
Transport distance	402	km
Gross density of products transported	10.4	kg/m^3
Weight of products transported (if gross density not reported)	N/A	kg

Volume of products transported (if gross density not reported)	N/A	m^3
Capacity utilization volume factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaging products)	> 1	-

Table 7. Installation (A5) and Reference Service Life

INSTALLATION INTO THE BUILDING (A5)	MECHANICAL BOARD	FACING	UNIT
Ancillary materials (packaging)	0.076	-	kg
REFERENCE SERVICE LIFE			
RSL	75	75	years

Table 8. End of life (C1-C4)

NAME		MECHANICAL BOARD	FACING	UNIT
Collection process (specified by type)	Collected separately	0	0	kg
	Collected with mixed construction waste	1.90	0.0298	kg
Recovery (specified by type)	Reuse	0	0	kg
	Recycling	0	0	kg
	Landfill	1.90	0.0298	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	1.90	0.0298	kg
Removals of biogenic carbon (excluding packaging)		0	0	kg CO2

Life Cycle Assessment Results

The following results are based on a functional unit of 1 m^2 of mechanical insulation board. The following results exclude biogenic carbon as there are no relevant biogenic carbon removals or emissions in the life cycle. The only relevant emissions are from paper packaging and are very small compared to the overall life cycle, so they are not reported.

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 – 1 m^2, unfaced mechanical board

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	7.24E+00	1.29E-01	4.14E-03	4.96E-03	8.37E-02
Depletion potential of the stratospheric ozone	kg CFC-11 eq	1.95E-14	2.52E-17	1.16E-18	9.75E-19	2.79E-16
Acidification potential	kg SO_2 eq	2.26E-02	6.81E-04	2.66E-06	1.39E-05	3.56E-04
Eutrophication potential	kg N eq	2.56E-03	6.20E-05	1.73E-06	1.60E-06	1.98E-05

Smog formation potential	kg O_3 eq	2.72E-01	1.58E-02	3.01E-05	3.17E-04	6.33E-03
Abiotic depletion potential for fossil resources	MJ, surplus	1.25E+01	2.36E-01	7.33E-04	9.15E-03	1.63E-01

Table 10. North American impact assessment results – 1 m², facing

MODEL: 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	5.36E-02	-	-	5.92E-06	1.69E-03
Depletion potential of the stratospheric ozone	kg CFC-11 eq	2.96E-13	-	-	1.16E-21	3.33E-19
Acidification potential	kg SO_2 eq	2.06E-04	-	-	1.66E-08	5.81E-06
Eutrophication potential	kg N eq	1.66E-05	-	-	1.91E-09	1.21E-06
Smog formation potential	kg O_3 eq	2.53E-03	-	-	3.78E-07	2.21E-05
Abiotic depletion potential for fossil resources	MJ, surplus	8.52E-02	-	-	1.09E-05	1.94E-04

Table 11. EU impact assessment results – 1 m², unfaced mechanical board

MODEL: 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	7.09E+00	1.27E-01	4.10E-03	4.91E-03	8.21E-02
Depletion potential of the stratospheric ozone	kg CFC-11 eq	1.95E-14	2.52E-17	1.16E-18	9.75E-19	2.79E-16
Acidification potential	kg SO_2 eq	1.84E-02	4.94E-04	2.23E-06	1.03E-05	3.28E-04
Eutrophication potential	kg PO_4^{-3} eq	3.77E-03	1.42E-04	1.84E-06	3.19E-06	4.40E-05
Photochemical oxidant creation potential	kg ethene eq	1.74E-03	-1.84E-04	1.03E-07	-3.45E-06	3.12E-06
Abiotic depletion potential, non-fossil resources	kg Sb-eq	1.16E+02	1.77E+00	5.96E-03	6.86E-02	1.25E+00
Abiotic depletion potential for fossil resources	MJ	2.10E-04	3.96E-08	1.68E-10	1.54E-09	3.61E-08

Table 12. EU impact assessment results – 1 m², facing

MODEL: 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	5.27E-02	-	-	5.86E-06	1.28E-03
Depletion potential of the stratospheric ozone	kg CFC-11 eq	2.96E-13	-	-	1.16E-21	3.33E-19
Acidification potential	kg SO_2 eq	2.01E-04	-	-	1.22E-08	3.54E-06
Eutrophication potential	kg PO_4^{-3} eq	2.11E-05	-	-	3.80E-09	1.57E-06
Photochemical oxidant creation potential	kg ethene eq	1.43E-05	-	-	-4.12E-09	9.41E-07
Abiotic depletion potential, non-fossil resources	kg Sb-eq	7.39E-01	-	-	8.18E-05	1.49E-03
Abiotic depletion potential for fossil resources	MJ	3.31E-07	-	-	1.83E-12	4.30E-11

Life Cycle Inventory Results

Table 13. Resource use indicators – 1 m², unfaced mechanical board

PARAMETER	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, LHV	6.93E+00	7.35E-02	4.40E-04	2.85E-03	1.06E-01

Renewable primary energy as material utilization	MJ, LHV	-	-	-	-	-
Total use of renewable primary energy resources	MJ, LHV	6.93E+00	7.35E-02	4.40E-04	2.85E-03	1.06E-01
Non-renewable primary energy as energy carrier	MJ, LHV	1.18E+02	1.78E+00	6.13E-03	6.91E-02	1.28E+00
Non-renewable primary energy as material utilization	MJ, LHV	1.58E+01	-	-	-	-
Total use of non-renewable primary energy resources	MJ, LHV	1.34E+02	1.78E+00	6.13E-03	6.91E-02	1.28E+00
Use of secondary material	kg	1.07E+00	-	-	-	-
Use of renewable secondary material	MJ, LHV	-	-	-	-	-
Use of non-renewable secondary fuels	MJ, LHV	-	-	-	-	-
Use of recovered energy	MJ, LHV	-	-	-	-	-
Use of net fresh water	m^3	3.13E-02	3.14E-04	7.48E-06	1.22E-05	1.76E-04

Table 14. Resource use indicators – 1 m^2, facing

PARAMETER	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, LHV	6.31E-01	-	-	3.39E-06	1.27E-04
Renewable primary energy as material utilization	MJ, LHV	-	-	-	-	-
Total use of renewable primary energy resources	MJ, LHV	6.31E-01	-	-	3.39E-06	1.27E-04
Non-renewable primary energy as energy carrier	MJ, LHV	7.90E-01	-	-	8.24E-05	1.52E-03
Non-renewable primary energy as material utilization	MJ, LHV	-	-	-	-	-
Total use of non-renewable primary energy resources	MJ, LHV	7.90E-01	-	-	8.24E-05	1.52E-03
Use of secondary material	kg	-	-	-	-	-
Use of renewable secondary material	MJ, LHV	-	-	-	-	-
Use of non-renewable secondary fuels	MJ, LHV	-	-	-	-	-
Use of recovered energy	MJ, LHV	-	-	-	-	-
Use of net fresh water	m^3	5.15E-04	-	-	1.45E-08	4.06E-07

Table 15. Output flows and waste categories – 1 m^2, unfaced mechanical board

PARAMETER	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	8.80E-09	1.49E-10	5.41E-13	5.77E-12	1.21E-10
Non-hazardous waste disposed	kg	8.91E-01	1.64E-04	6.54E-03	6.35E-06	1.90E+00
High level radioactive waste	kg	8.62E-06	6.01E-09	7.95E-11	2.33E-10	1.23E-08
Intermediate and low-level radioactive waste	kg	2.38E-04	1.65E-07	2.16E-09	6.40E-09	3.28E-07
Components for reuse	kg	-	-	-	-	-
Materials for recycling	kg	-	-	1.89E-03	-	-
Materials for energy recovery	kg	-	-	-	-	-
Exported energy	MJ, LHV	-	-	-	-	-

Table 16. Output flows and waste categories – 1 m², facing

PARAMETER	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	6.43E-09	-	-	6.88E-15	1.44E-13
Non-hazardous waste disposed	kg	8.93E-03	-	-	7.57E-09	1.76E-03
High level radioactive waste	kg	2.22E-08	-	-	2.77E-13	1.47E-11
Intermediate and low-level radioactive waste	kg	6.27E-07	-	-	7.63E-12	3.91E-10
Components for reuse	kg	-	-	-	-	-
Materials for recycling	kg	-	-	-	-	-
Materials for energy recovery	kg	-	-	-	-	-
Exported energy	MJ, LHV	-	-	-	-	-

Table 17. Carbon emissions and removals

	MECHANICAL BOARD INSULATION	UNIT
CCE (calcination carbon emissions)	3.69E-02	kg CO_2

Scaling to Other R-values

Environmental performance results are presented per functional unit, defined as 1 m² of insulation. In the US, insulation is typically purchased based on R-value stated in units of ft²·°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 18.

Table 18. Scaling Factors to Other R-values

CUSTOMARY US R-VALUE	THICKNESS [IN]	SCALING FACTOR PER 1 M² 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

Mechanical Insulation Board impact per m² (R-xx) = Impact scaling factor (R-xx) × Mechanical Insulation Board impact per m² (R_{SI} = 1)

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 minimal contributions to the acidification, eutrophication and smog formation potential impact categories. For other impact categories, outbound transport is a negligeable contributor.

Installation accounts for a small fraction of overall life cycle impact given that minimal resources are required to install mechanical board insulation. There is no impact associated with the use stage. While insulation can influence equipment 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 as defined by the PCR.

The use of JM's products improve energy efficiency in equipment and pipes 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 equipment and pipes 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.

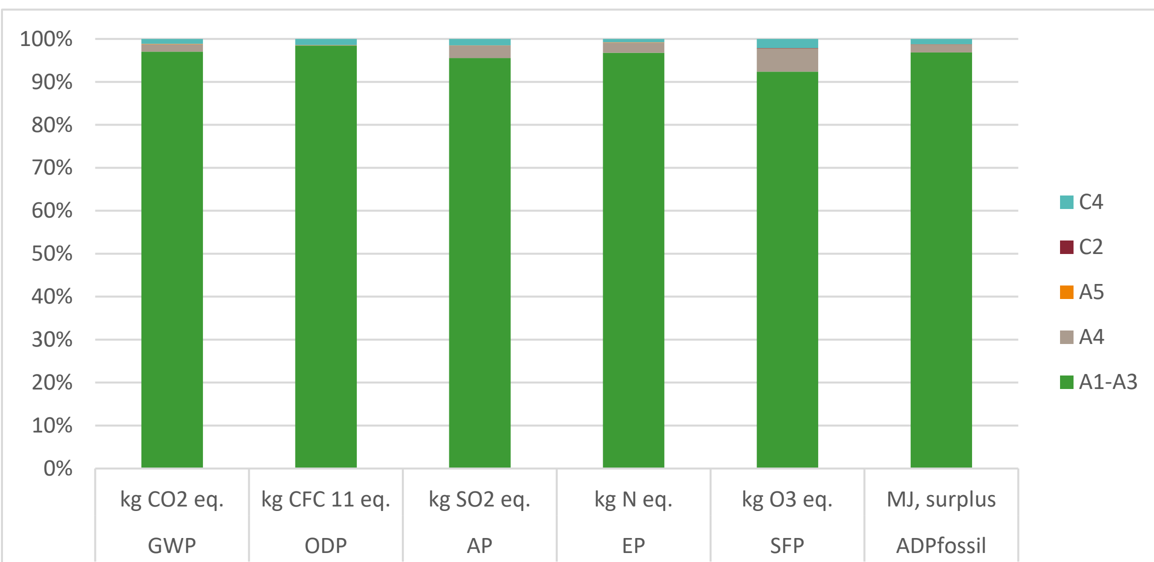


Figure 3: Results per life cycle stages for unfaced mechanical board

Additional Environmental Information

Environment and Health During Manufacturing

Johns Manville mechanical 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 Johns Manville products deliver consistent high quality.

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

The Spin-Glas product line and Micro-Flex are fiber glass are labeled as non-hazardous according to 29 CFR 1910.1200 when used as intended. They are composed of non-biopersistant (biosoluble) glass fibers, which are not designated as even possibly carcinogenic by either the International Association for the Research of Cancer, a branch of the World Health Organization, or the US National Toxicology Program

As with most fiber glass products, direct exposure to fibers or dust during handling may lead to mild, superficial irritation (itching) of the skin, eyes, or respiratory tract. This temporary mechanical irritation can be avoided by using the appropriate personal protective equipment (PPE). As such, Johns Manville recommends the following PPE precautions when handling Spin-Glas and Micro-Flex products:

- Respiratory: Under typical handling and installation conditions, respiratory protection is unnecessary.
  - The North America Insulation Manufacturers Association (NAIMA) recommends the use of NIOSH N95 respirator/dust mask when occupational exposures to glass fibers exceed 1 fiber per cc (1 f/cc) for a 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 fiber glass board and wrap insulations, discomfort or irritation can be avoided by using protective gloves.
- Eye protection: Safety glasses are recommended during fabrication and installation.
- Skin and body protection: Long-sleeved shirt and long pants are 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 fiber glass mechanical 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/

Johns Manville's Spin Glas and Micro-Flex Safety Data Sheets may be located at: https://www.jm.com/content/dam/jm/global/en/MSDS/200000002060_US_EN.pdf

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 850°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.

These products should meet NFPA 255 standards and test methods and are Class A product tested per ASTM E84.

References

European Standards. (2013). *EN 15804+A1 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.*

IARC. (2001). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Man-made Vitreous Fibres. *81*.

ISO. (2006). *ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines.*

ISO. (2009). *ISO 14040: Environmental management - Life cycle assessment - principles and frameworks.*

ISO. (2011). *ISO 14025: Environmental labels and declarations - Type III environmental declarations - principles and procedures.*

ISO. (2017). *ISO 21930 Sustainability in building construction - Environmental declaration of building products.*

Sphera. (2020). *GaBi LCA Database Documentation. Retrieved from Sphera Solutions, Inc.: http://www.gabi-software.com/america/support/gabi/.*

Sphera. (2021). Retrieved from GaBi LCA Database Documentation: http://www.gabi-software.com/america/support/gabi/

UL Environment. (2018). *Part B - Mechanical, Specialty, Thermal and Acoustic Insulation Product EPD Requirements (PCR Guidance for Building-Related Products and Services).* UL Environment, UL 10010-03.

UL Environment. (2018). *Product Category Rules for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements, v 3.2.*

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