Environmental Product Declaration

OEM Insulation Board

OEM Whispertone® Wallboard • Equipment Spin-Glas® • Duracore® • Tuf-Glas® / Valulite® • Spiral SG Double Wall Insulation • OEM SG Series Spin-Glas® Fiber Glass Insulation

Think JM.

Johns Manville's insulation is designed to be used in a HVAC equipment, office interior and specialty applications thermal and acoustic performance.

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

CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

Johns Manville
A Berkshire Hathaway Company

OEM INSULATION BOARD
MECHANICAL 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	4790545973.103.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	OEM 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	Building envelope thermal insulation; ceiling tile production
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

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. 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) 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. JM operates 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 OEM insulation board products are covered by this environmental product declaration:

- OEM / Whispertone® Wallboard
- Equipment Spin-Glas®
- DuraCore®
- Tuf-Glas® / Valulite®
- Spiral SG Double Wall Insulation
- OEM / SG Series Spin-Glas® Fiber Glass Insulation

Product Specification

Whispertone® Wallboard

Whispertone Wallboard is a rigid board insulation manufactured with a smooth top surface and uniform color. Whispertone Wallboard provides superior thermal and acoustic performance. These boards are designed for use in a wide range of acoustical panel, office interior, and HVAC equipment applications. Whispertone Wallboard can be produced plain, with a top facing only or, in some sizes, faced on both the top and bottom.

Advantages:

- Excellent acoustical performance
- High tensile strength
- Uniform density distribution
- Excellent dimensional stability
- Moisture and fungi resistance
- Easy handling and fabrication
- Puncture resistance
- Average 56% post-consumer recycled content

Equipment Spin-Glas® Board

Equipment Spin-Glas Board is a rigid board insulation designed to provide superior thermal and acoustical performance for a variety of appliance, HVAC and office interior applications. Equipment Spin-Glas Board can be manufactured to meet your specific size requirements and is available plain, with an FSK facing, or with a black acrylic coating.

Advantages:

- **Easy to Handle and Install:** It can be readily cut with a knife and secured with mechanical fasteners or adhesives. It can be firmly bonded to metals, plastic or other materials with commercial adhesives or mechanical fastening devices.
- **Durable:** These glass fibers are resistant to the effects of moisture, oil, grease and most acids. Because these fibers are highly resilient, they resist settling, breakdown or sagging from vibration.
- **Recycled Content:** Average 56% post-consumer recycled content.

SG-Series Spin-Glas®

SG Series Spin-Glas® insulation is a lightweight blanket for use in many diverse Original Equipment Manufacturer double-wall applications including transportation, appliance, HVAC and specialty equipment. SG Series Spin-Glas provides superior thermal and acoustical performance and is available in a wide range of densities and thicknesses.

Advantages:

- **Easy to Handle and Install:** SG-Series blankets resist damage and are easily cut with a knife, shear, or steel rule die. The fiber glass blanket is light weight, accommodates a variety of space requirements and readily conforms to curved and irregular shapes.
- **Sustainability:** GREENGUARD certified; average 56% post-consumer recycled content.

DuraCore®

DuraCore® insulation is a lightweight, highly resilient product designed for superior core strength. It is manufactured with good fiber and binder distribution to produce a stronger insulation with enhanced core strength that makes it stiffer and less susceptible to delamination.

Advantages:

- **Excellent core strength:** DuraCore meets typical industry standards for tensile and core strength, which makes the product more resistance to damage during lamination and installation.
- **Low dust:** DuraCore is designed to be readily cut in die presses or with a knife. The product resist settling, breakdown, sagging from vibration, and damage from impact.
- **Sustainability:** GREENGUARD certified; average 56% post-consumer recycled content.

Tuf-Glas® / Valulite®

Tuf-Glas®/ Valulite® fiberglass insulation is a lightweight, highly resilient, blanket manufactured using a rotary process which provides good core strength. This product can be used in a variety of applications that require good thermal and acoustical efficiency in a minimal space.

Advantages:

- Good Thermal and Acoustical Performance
- Good Tensile and Core Strength
- Uniform Density Distribution
- Ease of Handling
- GREENGUARD certified; 56% post-consumer recycle content

Product Average

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

Flow Diagram

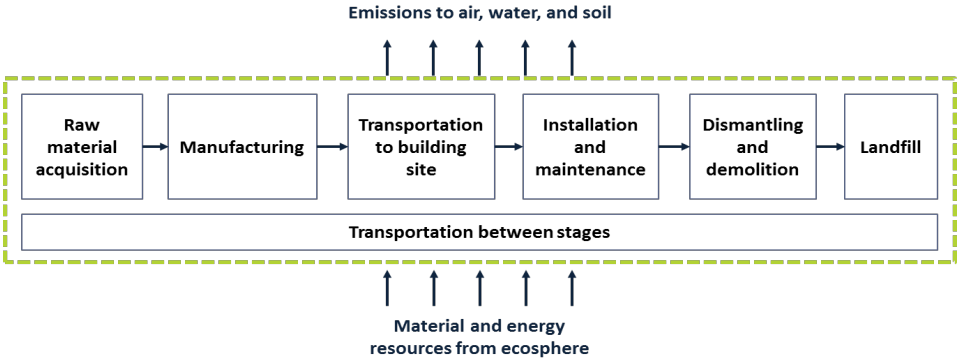


Figure 1: Flow diagram for manufacturing of OEM insulation board

Application

- **Whispertone Wallboard**: Designed as an acoustical panel with a smooth top surface and uniform color that is ideal for use in applications such as office partitions, ceiling and wall panels. Whispertone Wallboard is resilient and resists settling, breakdown, and damage from impact.
- **Equipment Spin-Glas Board**: Ideal for flat surfaces in commercial and residential appliance, HVAC equipment, office interior, specialty and transportation applications that require good acoustical and thermal performance. FSK faced Equipment Spin-Glas boards are designed for systems that operate up to 150°F and where a vapor-barrier is required. Black acrylic coated insulation boards are designed for use in airstream applications rated to a maximum of 5000 fpm. Unfaced Equipment Spin-Glas boards are designed for applications that operate at or below 350°F and should not be used in applications where it will be exposed

directly to an airstream.

- **DuraCore®**: Designed for excellent core strength that make this product stiffer and less susceptible to damage during fabrication and installation. The blanket conforms easily around corners and curved surfaces and is readily cut in die presses or with a knife.
- **Tuf-Glas® / Valulite®**: This product can be used in a variety of applications that require good thermal and acoustical efficiency in a minimal space. Tuf-Glas/Valulite meets typical industry standard for tensile and core strength, which makes the product resistant to damage during lamination and installation.
- **SG Series Spin-Glas**: SG Series Spin-Glas can be used in a variety of double-wall panel applications in appliance, HVAC, office interior, and transportation equipment where good thermal and acoustic performance is required.

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 C1071 – Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)

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

- ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
- UL 723 - Standard for Test for Surface Burning Characteristic of Building Materials test
- CAN / ULC S102 - Standard Test Method for Potential Heat of Building Materials
- NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems
- NFPA 90B is the Stnadard for the Installation of Warm Air Heating and Air Conditioning Systems

Properties of Declared Product as Delivered

OEM insulation board is delivered to the fabrication site as packaged. Once removed from the packaging and installed, the product will recover the needed thickness to deliver the advertised R-value.

Material Composition

Manufacturers of OEM Insulation Board 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 OEM insulation boards.

Table 1: OEM 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

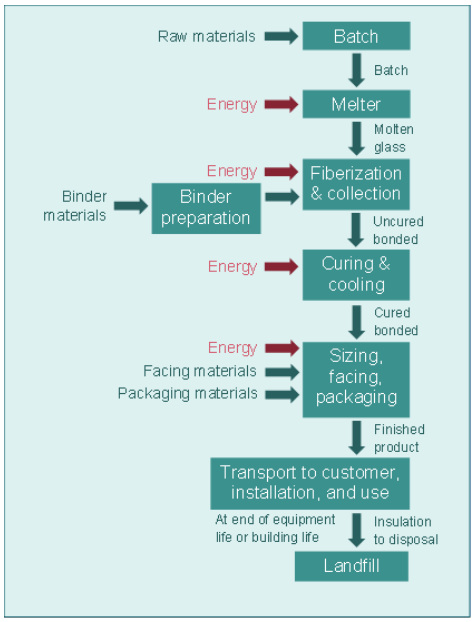
This Environmental Product Declaration (EPD) represents the production of Johns Manville OEM insulation boards at Defiance, OH.

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 2 illustrates the production and subsequent life cycle stages.

Figure 2: Production and life cycle stages



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.

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

- **Whispertone Wallboard**: Designed as an acoustical panel with a smooth top surface and uniform color that is ideal for use in applications such as office partitions, ceiling and wall panels. Whispertone Wallboard is resilient and resists settling, breakdown, and damage from impact.
- **Equipment Spin-Glas Board**: FSK faced Equipment Spin-Glas boards are designed for systems that operate up to 150°F and where a vapor-barrier is required. Black acrylic coated insulation boards are designed for use in airstream applications rated to a maximum of 5000 fpm. Unfaced Equipment Spin-Glas boards are designed for applications that operate at or below 350°F and should not be used in applications where it will be exposed directly to an airstream.
- **DuraCore:** DuraCore is designed to provide excellent core strength. The product should be faced when used in HVAC Equipment applications where it will be exposed directly to an airstream. Unfaced DuraCore insulation is rated to a maximum operating temperature of 350°F.
- **Tuf-Glas/Valulite:** Tuf-Glas/Valulite can be used in a variety of applications requiring good thermal and acoustical performance with minimal space requirements. The product should be faced when exposed directly to an airstream in HVAC Equipment applications. Unfaced Tuf-Glas/Valulite insulation is rated to a maximum operating temperature of 350°F.
- **SG Series Spin-Glas**: SG Series Spin-Glas can be used in a variety of double-wall panel applications in appliance, HVAC, office interior, and transportation equipment where good thermal and acoustic performance is required. The product is rated to a maximum operating temperature of 350°F.

Use

OEM insulation board insulations are 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 building and is considered outside the scope of this LCA.

Reference Service Life and Estimated Building Service Life

OEM Insulation Board is assumed to have a reference service life of 75 years, equal to that of the building.

Reuse, Recycling, and Energy Recovery

OEM Insulation Boards 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.

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 OEM insulation material as delivered to the job site, with a building service life of 75 years.

Table 2: Functional unit and subsequent product characteristics

	Area [m^2]	Density [kg/m^3]	R_{SI} [m^2K/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 OEM 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 3 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 3: 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 a building'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 a 75-year reference service life, equal to that of 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 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%.

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 for each manufacturer represent a continuous 12-months over the 2020 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 from 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

OEM insulation board requires no maintenance, and there are no parts to repair or refurbish. The reference service life for the OEM insulation board product and its facing is 75 years. Installation is done by hand with only packaging waste generated and no ancillary materials used during that step.

Table 6. Transport to the building site (A4)

NAME	VALUE	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)	OEM BOARD	FACING	UNIT
Ancillary materials (packaging)	0.076	-	kg
REFERENCE SERVICE LIFE			
RSL	75	75	years

Table 8. End of life (C1-C4)

NAME		OEM 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

Life Cycle Assessment Results

The following results are based on a declared unit of 1 m^2 of OEM insulation board and 1 m^2 of facing. 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 OEM 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 m^2, 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 m^2, unfaced OEM 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 OEM 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 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
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 OEM 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		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 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
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		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

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

Scaling to Other R-values

Environmental performance results are presented per declared unit, defined as 1 m^2 of insulation product. 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 18.

Table 18. Scaling Factors to Other R-values

CUSTOMARY US R-VALUE	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

OEM Insulation Board impact per m^2 (R-xx)	=	Impact scaling factor (R-xx)	×	OEM Insulation Boards impact per m^2 (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 minor contributions to the acidification, eutrophication 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 OEM board insulation. 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 as defined by the PCR.

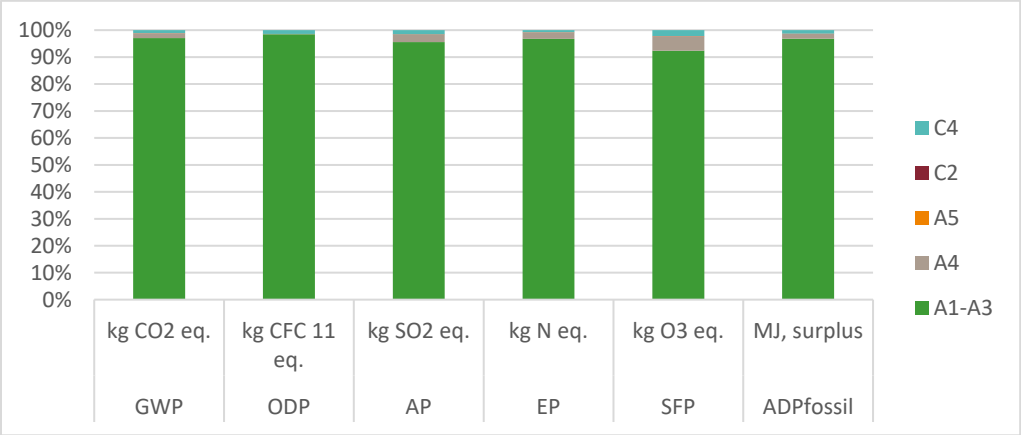


Figure 4: Results per life cycle stage for 1 m^2 of unfaced OEM board

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.

Additional Environmental Information

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.

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 and Whispertone fiber glass product lines are labeled as non-hazardous according to 29 CFR 1910.1200 when used as intended. The glass fibers are non-biopersistant (biosoluble) 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 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 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 or Whispertone Wall Board:

- **Respiratory**: Under typical handling and installation conditions, respiratory protection is unnecessary.
    - The North American Insulation Manufacturers Association (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 fiber glass board 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 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 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 OEM Insulation Safety Data Sheets may be located at:
https://www.jm.com/content/dam/jm/global/en/MSDS/200000002061_US_EN.pdf

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