Environmental Product Declaration

Faced and Unfaced Light Density Blankets (Duct Wrap)

HTB 26 Spin-Glas® / Flex-Glas® P/ Flex-Glas® PC / Microlite® Formaldehyde-free™ Duct Wrap / Range-Glas® XG / Spin-Glas® WH XG

Think JM.

Microlite® FSK Formaldehyde-free™ duct wrap is a lightweight, blanket-type insulation with a foil skrim kraft (FSK) vapor-barrier facing. Above: Microlite EQ FSK, manufactured in Willows, CA, and Winder, GA

Johns Manville
A Berkshire Hathaway Company

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

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

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

PEOPLE PASSION PERFORM PROTECT

CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

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HTB 26 SPIN-GLAS® / FLEX-GLAS ® PC / MICROLITE® FORMALDEHYDE-FREE™ DUCT WRAP / RANGE-GLAS® XG / SPIN-GLAS® WH XG
DUCT WRAP – 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	4789973160.102.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Duct wrap, 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: Mechanical, Specialty, Thermal, and Acoustic Insulation EPD Requirements, UL 10010-1
DESCRIPTION OF PRODUCT APPLICATION/USE	Mechanical insulation
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	N/A
EPD SCOPE	Cradle to gate with end-of-life options (C1-C4)
YEAR(S) OF REPORTED PRIMARY DATA	Calendar Year 2020
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. 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 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

- Microlite® EQ FSK is a Formaldehyde-free™
- HTB 26 Spin-Glas®
- Spin-Glas® WH XG / Range-Glas® XG

Product Specification

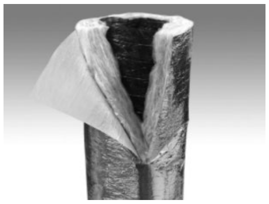
The following Johns Manville duct wrap products are covered by this environmental product declaration:

Microlite® Formaldehyde-Free™ FSK and PSK Duct Wrap

Microlite® is Formaldehyde-free™, lightweight duct wrap insulation. The blanket-type, thermal insulation has a vapor-barrier facing. The insulation is manufactured from rotary- process fiber glass and bonded with a formaldehyde free binder. The insulation does not accelerate corrosion when applied on steel surfaces, and it does not breed or promote fungi growth. The facing has a permeance of 0.02 perms*, allowing it to be used as a vapor barrier when installed on a fully sealed system.

The binder improves handling and releases less dust during on-site fabrication. Microlite manufacturing process ensures a consistent product and reliable product quality. Per ASTM E96, Procedure A for facing material prior to lamination. After lamination, permeance values may be higher.

Flex-Glas® PC



Flex-Glas PC Formaldehyde-Free® insulation is a lightweight, highly resilient, blanket that provides excellent thermal and acoustical performance.

HTB 26 Spin-Glas®

High Temperature Blanket (HTB) 26 Spin-Glas® - A lightweight, Formaldehyde-Free™ insulation blanket designed to provide excellent thermal performance in high-temperature applications requiring a low-density blanket.

Advantages:

- Low smoke and odor
- Strength
- Resistance to vibration

Spin-Glas® WH XG / Range-Glas® XG

Spin-Glas® WH XG / Range-Glas® XG is a lightweight insulation designed to provide excellent thermal performance for commercial and residential applications operating at hot-face temperatures up to 1000°F.

Advantages:

- Excellent thermal efficiency
- Excellent acoustical performance
- Easy to fabricate
- Durability provides ease of handling and installation

Product Average

This EPD is intended to represent company-specific duct wrap products. The 2020 production data used to develop this EPD consider all manufacturing activities at the Johns Manville sites in Winder (GA), Willows (CA) and McPherson (KS), United States. Results are weighted according to production totals at the three facilities. Use of this EPD is limited to Johns Manville.

Application

- **Microlite® duct wrap** is designed to be used on exterior HVAC systems or surfaces where application parameters prohibit the use of duct liner or duct board. The blanket-type insulation is ideal for spaces or surfaces where temperature control is required. The insulation can be used in applications that operate at temperatures up to 250°F
- **Flex-Glas PC** is designed for use in the manufacture of insulated flexible ducts for HVAC applications.
- **HTB 26 Spin-Glas®** is designed for high-temperature commercial, industrial, and marine applications up to 1000°F.
- **Spin-Glas® WH XG / Range-Glas® XG** is an ideal insulation for use in water heaters, ovens, ranges, storage tank insulation, and water heater pipe penetrations.

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)
- UL 723 - Surface Burning Characteristic of Building Materials
- CAN / ULC S102 - Surface flammability using Steiner Tunnel Testing
- NFPA 90 A and 90B - Standard for the Installation of Air-Conditioning and Ventilating Systems

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

- ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

Properties of Declared Product as Delivered

Duct wrap is delivered to the site of installation as packaged. Once removed from the packaging and installed, the product will recover the needed thickness to deliver the advertised R-value.

Material Composition

Table 1: Duct wrap material composition (per % weight)

COMPONENT	CONTENT [WT. %]
Sand	29.1%
Borax	13.4%
Burnt dolomitic lime	5.1%
Feldspar	4.7%
Soda ash	6.2%
Fluorspar	0.3%
External cullet	23.3%
Internal cullet	0.6%
Melter dust	12.3%
Binder	5.0%

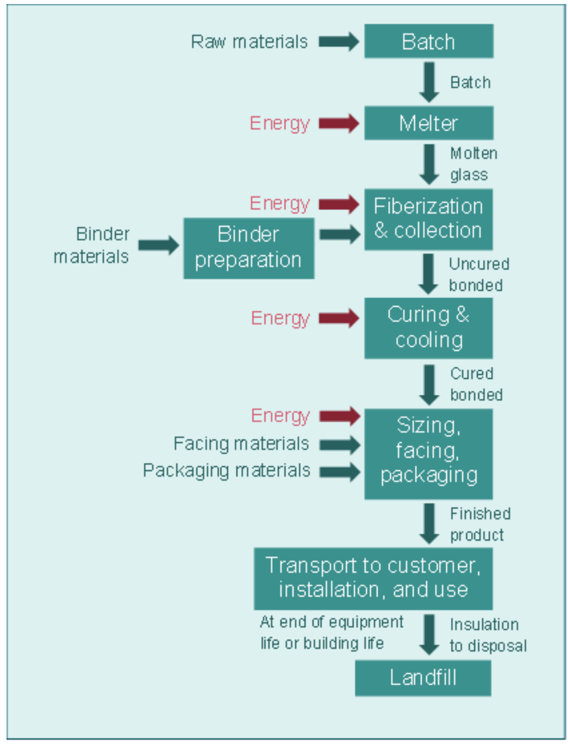
Manufacturing

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

Packaging for shipment comprises shrink film and polyester bags.

Transportation

Primary data included transportation distances via truck or rail for the transport of the raw materials to the production facilities. Transport of the finished product to the construction site is also accounted for, along with the transportation of construction wastes and the deconstructed product at end-of-life to disposal facilities. 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

Johns Manville's Microlite EQ FSK duct wrap installation must be performed in accordance with the North American Insulation Manufacturers Association's (NAIMA) *A Guide to Insulated HVAC Duct Systems* (pp 26-29) (NAIMA 2004).

When installing Microlite EQ FSK, pay close attention to insulation compression. The R-value will vary depending on how much the insulation is compressed during installation. In order to obtain the published installed R-value, the insulation should be installed using the stretch out table in the *Microlite EQ FSK* data sheet (p2) (JM 2015) (*http://www.jm.com/content/dam/jm/global/en/hvac-insulation/HVAC-documents/External%20Duct%20Insulation/Microlite%20EQ/34057_HVAC488_0915_MicroliteEQ_FSKfaced_DS_HR.PDF*).

Before applying the duct wrap, ensure that the metal duct is clean and dry and that the joints and seams are tightly sealed. Ensure that the wrap has a 2" flap that completely overlaps the facing and the insulation is snuggly butted together.

Use

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, but instead contributes to a reduction in the amount of energy required to heat and cool the building. The insulation requires no maintenance, and 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

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.

Reuse, Recycling, and Energy Recovery

When the building is demolished, the insulation is assumed to be sent to landfill. While insulation can theoretically be reused or recycled, doing so is not common practice in the industry.

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

Functional or Declared Unit

Per the PCR, the declared unit for this analysis is *1 m² of insulation material, as delivered to the job site, with a building service life* (RSL) *of 75 years*.

Table 2 shows the functional unit along with its specific thickness and mass reference flow.

Table 2: declared unit and subsequent product attributes

	AREA [M^2]	R_{SI} [M²K/W]	R_{US} [BTU/(H °F FT^2)]	RSL [YEARS]	THICKNESS [IN]	MASS [KG]
Functional Unit	1	1	5.68	75	2	0.706

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

Table 3: Declared unit of FSK facing for duct wrap

	AREA (M^2)	RSL [YEARS]	DENSITY [KG/M^2]	MASS [KG]
Declared Unit	1	75	0.0141	0.0141

System Boundary

Table 4 represents the system boundary and scope.

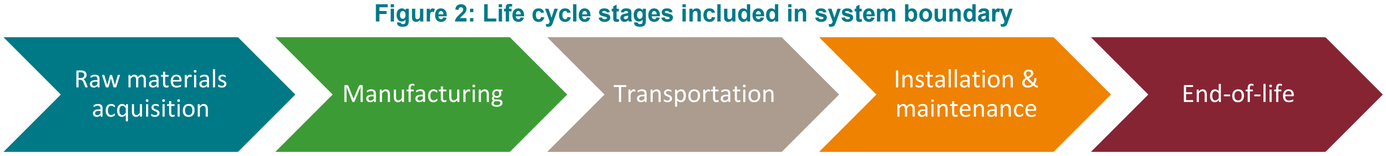
Table 4: Description of the system boundary modules

	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 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.

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 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 during the 2020 calendar year.

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

Duct wrap insulation requires no maintenance, and there are no parts to repair or refurbish. The reference service life for the duct wrap insulation and its FSK facing is 75 years. Installation is done by hand with only packaging waste generated during that step.

Table 6. Transport to the building site (A4) (density based on material properties as per Table 2)

NAME	VALUE	UNIT
Fuel type	Diesel	
Liters of fuel	0.0011	L/100km
Vehicle type	Heavy Duty Truck	
Transport distance	402	km
Capacity utilization (including empty runs, mass based	67	%
Gross density of products transported	27.5	kg/m^3

Table 7: Installation (A5) and RSL information

INSTALLATION INTO THE BUILDING (A5)	UNFACED DUCT WRAP	FSK FACING	UNIT
Ancillary materials (plastic packaging)	0.0033	-	kg
REFERENCE SERVICE LIFE			
RSL	75	75	years

Table 8: End of life (C1-C4)

NAME		UNFACED DUCT WRAP	FSK FACING	UNIT
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)		landfill	landfill	100%
Collection process (specified by type)	Collected separately	-	-	kg
	Collected with mixed construction waste	0.706	0.0141	kg
Recovery (specified by type)	Reuse	-	-	kg
	Recycling	-	-	kg
	Landfill	0.706	0.0141	kg
	Incineration	-	-	kg
	Incineration with energy recovery	-	-	kg
	Energy conversion efficiency rate	-	-	
Disposal (specified by type)	Product or material for final deposition	0.706	0.0141	kg
Removals of biogenic carbon (excluding packaging)		-	-	kg CO_2

Life Cycle Assessment Results

The following results are based on a functional unit of 1 m^2 of duct wrap insulation. 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 duct wrap

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	9.82E-01	4.87E-02	2.03E-03	1.84E-03	3.11E-02
Depletion potential of the stratospheric ozone	kg CFC-11 eq	4.56E-14	9.52E-18	5.48E-19	3.62E-19	1.04E-16
Acidification potential	kg SO_2 eq	2.41E-03	2.58E-04	2.49E-06	5.17E-06	1.32E-04
Eutrophication potential	kg N eq	4.60E-04	2.34E-05	9.71E-07	5.96E-07	7.37E-06
Smog formation potential	kg O_3 eq	5.32E-02	5.96E-03	1.84E-05	1.18E-04	2.35E-03
Abiotic depletion potential for fossil resources	MJ, surplus	1.44E+00	8.94E-02	3.42E-04	3.40E-03	6.05E-02

Table 10. North American impact assessment results – 1 m^2, FSK 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	6.34E-02	-	-	4.81E-05	1.39E-02
Depletion potential of the stratospheric ozone	kg CFC-11 eq	3.57E-13	-	-	9.44E-21	2.70E-18
Acidification potential	kg SO_2 eq	2.42E-04	-	-	1.35E-07	4.77E-05
Eutrophication potential	kg N eq	1.97E-05	-	-	1.55E-08	9.94E-06
Smog formation potential	kg O_3 eq	2.99E-03	-	-	3.07E-06	1.81E-04
Abiotic depletion potential for fossil resources	MJ, surplus	1.00E-01	-	-	8.86E-05	1.58E-03

Table 11. EU impact assessment results – 1 m^2, unfaced duct wrap

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	9.64E-01	4.81E-02	1.92E-03	1.83E-03	3.05E-02
Depletion potential of the stratospheric ozone	kg CFC-11 eq	4.56E-14	9.52E-18	5.48E-19	3.62E-19	1.04E-16
Acidification potential	kg SO_2 eq	1.93E-03	1.87E-04	1.77E-06	3.81E-06	1.22E-04
Eutrophication potential	kg PO_4^{-3} eq	4.84E-04	5.39E-05	1.10E-06	1.18E-06	1.63E-05
Photochemical oxidant creation potential	kg ethene eq	3.56E-04	-6.97E-05	2.70E-07	-1.28E-06	1.16E-06
Abiotic depletion potential, non-fossil resources	kg Sb-eq	1.36E+01	6.70E-01	2.76E-03	2.55E-02	4.65E-01
Abiotic depletion potential for fossil resources	MJ	9.78E-05	1.50E-08	7.89E-11	5.71E-10	1.34E-08

Table 12. EU impact assessment results – 1 m², FSK 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	6.23E-02	-	-	4.76E-05	1.05E-02
Depletion potential of the stratospheric ozone	kg CFC-11 eq	3.57E-13	-	-	9.44E-21	2.70E-18
Acidification potential	kg SO_2 eq	2.35E-04	-	-	9.93E-08	2.91E-05
Eutrophication potential	kg PO_4^{-3} eq	2.49E-05	-	-	3.09E-08	1.29E-05
Photochemical oxidant creation potential	kg ethene eq	1.67E-05	-	-	-3.34E-08	7.74E-06
Abiotic depletion potential, non-fossil resources	kg Sb-eq	8.69E-01	-	-	6.64E-04	1.21E-02
Abiotic depletion potential for fossil resources	MJ	3.50E-07	-	-	1.49E-11	3.50E-10

Life Cycle Inventory Results

Table 13. Resource use indicators – 1 m², unfaced duct wrap

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	2.26E+00	2.78E-02	2.08E-04	1.06E-03	3.95E-02
Renewable primary energy as material utilization	MJ, LHV	-	-	-	-	-
Total use of renewable primary energy resources	MJ, LHV	2.26E+00	2.78E-02	2.08E-04	1.06E-03	3.95E-02
Non-renewable primary energy as energy carrier	MJ, LHV	1.23E+01	6.74E-01	2.84E-03	2.57E-02	4.75E-01
Non-renewable primary energy as material utilization	MJ, LHV	2.67E+00	-	-	-	-
Total use of non-renewable primary energy resources	MJ, LHV	1.50E+01	6.74E-01	2.84E-03	2.57E-02	4.75E-01
Use of secondary material	kg	1.63E-01	-	-	-	-
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	7.53E-03	1.19E-04	3.42E-06	4.52E-06	6.53E-05

Table 14. Resource use indicators – 1 m², FSK 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	7.57E-01	-	-	2.76E-05	1.03E-03
Renewable primary energy as material utilization	MJ, LHV	-	-	-	-	-
Total use of renewable primary energy resources	MJ, LHV	7.57E-01	-	-	2.76E-05	1.03E-03
Non-renewable primary energy as energy carrier	MJ, LHV	9.30E-01	-	-	6.69E-04	1.24E-02
Non-renewable primary energy as material utilization	MJ, LHV	-	-	-	-	-
Total use of non-renewable primary energy resources	MJ, LHV	9.30E-01	-	-	6.69E-04	1.24E-02
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	6.18E-04	-	-	1.18E-07	3.32E-06

Table 15. Output flows and waste categories – 1 m^2, unfaced duct wrap

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	2.22E-09	5.64E-11	2.53E-13	2.15E-12	4.49E-11
Non-hazardous waste disposed	kg	5.62E-02	6.20E-05	2.99E-03	2.36E-06	7.08E-01
		6.70E-07	2.27E-09	3.75E-11	8.65E-11	4.58E-09
Radioactive waste disposed	kg	1.87E-05	6.25E-08	1.02E-09	2.38E-09	1.22E-07
Components for reuse	kg	-	-	-	-	-
Materials for recycling	kg	-	-	2.76E-03	-	-
Materials for energy recovery	kg	-	-	-	-	-
Exported energy	MJ, LHV	-	-	-	-	-

Table 16. Output flows and waste categories – 1 m^2, FSK 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	7.76E-09	-	-	5.59E-14	1.17E-12
Non-hazardous waste disposed	kg	1.06E-02	-	-	6.15E-08	1.42E-02
		2.61E-08	-	-	2.25E-12	1.19E-10
Radioactive waste disposed	kg	7.41E-07	-	-	6.20E-11	3.17E-09
Components for reuse	kg	-	-	-	-	-
Materials for recycling	kg	-	-	-	-	-
Materials for energy recovery	kg	-	-	-	-	-
Exported energy	MJ, LHV	-	-	-	-	-

Table 17. Carbon emissions and removals

	DUCT WRAP INSULATION	UNIT
CCE (calcination carbon emissions)	1.36E-02	kg CO_2

Facility Specific GWP results

Johns Manville's duct wrap product is manufactured at two different facilities. The results presented below represent a production-weighted average of these facilities. To understand how the GWP may vary between sites, facility-specific GWP100 results are presented below.

Table 18. Facility-specific GWP results– 1 m^2, unfaced duct wrap

IPCC AR5 GWP100 (kg CO_2 eq)	A1- A3 Product Stage	A4 Product Delivery	A5 Construction Stage	C2 Transport to End of Life	C4 Disposal at End of Life
McPherson, Kansas, United States	1.16E+00	4.71E-02	6.95E-05	1.84E-03	3.11E-02
Winder, Georgia, United States	7.83E-01	4.80E-02	2.09E-03	1.84E-03	3.11E-02
Willows, California, United States	1.79E+00	6.05E-02	9.85E-03	1.84E-03	3.11E-02

Scaling to Other R-values

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

Environmental impacts per meter of these alternative R-values can be calculated by multiplying the results by scaling factors presented in Table 19.

Table 19. Scaling Factors to Other R-values

Customary US R-value	Thickness [in]	Scaling factor per 1 m 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

$$\text{Duct wrap insulation impact per m (R-xx)} = \text{Impact scaling factor (R-xx)} \times \text{Duct wrap insulation impact per m } (R_{SI} = 1)$$

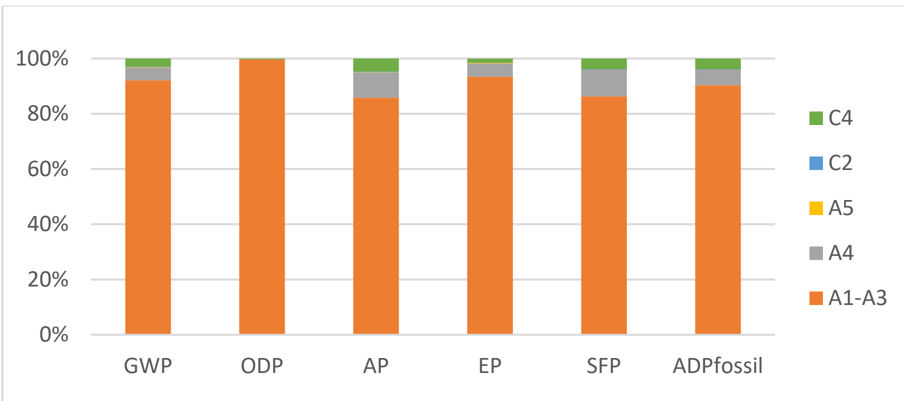
LCA Interpretation

Manufacturing represents the largest share of TRACI impact categories, except Acidification Potential (AP) and Eutrophication Potential (EP) which are dominated by upstream raw material production. Impacts from manufacturing come in large part from electricity whose upstream generation contributes largely to AP, Global Warming Potential (GWP) and Ozone Depletion Potential (ODP). Air emissions from the melter process drive the manufacturing share of Smog Formation Potential (SFP).

Upstream production of raw materials contributes significant shares to all impact categories. This life cycle stage's dominance of EP is due to a largely bio-based binder resin. That binder resin also contributes significantly to GWP. The aluminum content in the FSK facer material also contributes to GWP as well as AP, ODP and SFP.

Transportation represents a minor impact driver due to emissions. Installation accounts for a negligible fraction of overall life cycle impact given that minimal resources are required to install the mechanical 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). Therefore, no replacements are necessary. At end-of-life (EoL), insulation is removed from the building and landfilled. Non-hazardous waste was dominated by the EoL disposal of the entire product in addition to waste generated during manufacturing and installation. Hazardous waste is driven by waste from raw material production and manufacturing; however, the amount of hazardous waste generated is a small fraction of the total waste produced.

Figure 3: Results for unfaced duct wrap per life cycle stages (TRACI 2.1)



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.

Environment and Health During Installation

Microlite® EQ FSK fiber glass duct wrap is 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 Agency for the Research on Cancer, a branch of the World Health Organization, or the National Toxicology Program, a component of the US Department of Health and Human Service.

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 Microlite EQ FSK duct wrap:

- **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 duct wrap products, discomfort or irritation can be avoided by using protective gloves.
- **Eye protection**: Safety glasses are recommended during fabrication and installation.
- **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 injesting duct wrap; however, should injestion 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 Microlite EQ FSK safety data sheets may be located at:
https://www.jm.com/content/dam/jm/global/en/MSDS/200000002117_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 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.

Environmental Activities and Certifications

- GreenGuard Gold certification
- Coast Guard / IMO approved

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