ENVIRONMENTAL PRODUCT DECLARATION

HVAC EQUIPMENT INSULATION

MICROMAT® • MICROMAT® RX

Think JM.

Micromat® fiber glass insulation is used to improve thermal and acoustical control in HVAC equipment. Above: Micromat roll, manufactured in Cleburne, Texas

Johns Manville
A Berkshire Hathaway Company

At Johns Manville, product performance and corporate accountability are top priorities. We ensure that each of our HVAC equipment 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

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

Johns Manville

HVAC Equipment Insulation – Micromat® • Micromat® RX
Product Category: Mechanical Insulation

According to ISO 14025

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. 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, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	Johns Manville
DECLARATION NUMBER	4787305280.102.1
DECLARED PRODUCT	HVAC Equipment Insulation – Micromat® • Micromat® RX
REFERENCE PCR	Building Envelope Thermal Insulation, Mechanical Insulation (v1.3, June 2014)
DATE OF ISSUE	December 15, 2016
PERIOD OF VALIDITY	5 Years
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by:	UL Environment PCR Review Panel epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	Wade Stout, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas P. Gloria, Industrial Ecology Consultants

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Product Definition

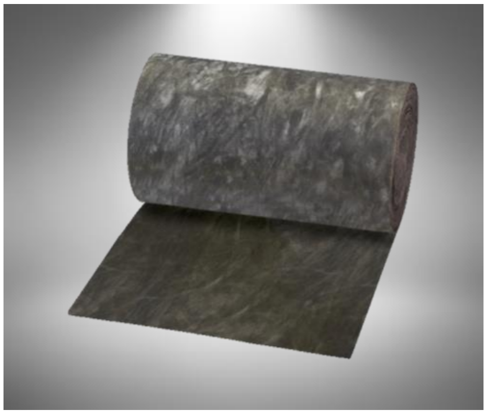
Company Description

For more than 150 years, Johns Manville (JM) has been dedicated to providing products that improve energy efficiency, and contribute to the health and comfort of building occupants.

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

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

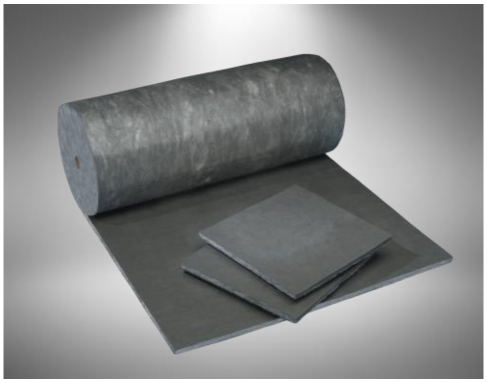
Product Description



Micromat®

Micromat is a flexible, resilient, blanket-type fiber glass insulation, faced on the airstream side with a smooth, resilient, nonwoven glass mat. The airstream glass mat surface includes an EPA registered, immobilzed antimicrobial agent to protect the product against damage from microbial growth. Micromat provides superior thermal and acoustical performance for HVAC equipment applications. Inherent resiliency and flexibility make Micromat liners resist settling, breakdown, and sagging from vibration and damage from impact.

- Resistent to fungi
- Unaffected by oil, grease, and most acids
- Smooth surface provides low air friction
- Rated for 5,000 fpm air velocity



Micromat® RX

Micromat RX is a flexible fiber glass insulation with a resilient mat facing that is coated with an acrylic coating with an EPA-registered immobilized antimicrobial agent. The acrylic coating provides excellent moisture resistance, and the anti-microbial agent provides added product protection against damage from microbial growth.

Micromat RX offers the same advantages as Micromat, with these additional benefits:

- Added moisture resistance
- Durable acrylic coating resists damage

Application and Uses

Micromat® and Micromat® RX are HVAC equipment liners specifically designed to improve thermal and acoustical performance.This reduces energy consumption and improves indoor environmental quality for building occupants. They can be used in applications that operate at temperatures ranging from below ambient to 250°F (121°C).

The insulation can be used in the following HVAC equipment applications:

- Furnaces (commercial/residential)
- Air conditioners
- Mixing boxes
- Fan coils
- VAV boxes Roof Curbs
- Other HVAC equipment

Manufacturing Location

This Environmental Product Declaration (EPD) represents the production of Johns Manville HVAC equipment insulation at Cleburne, TX.

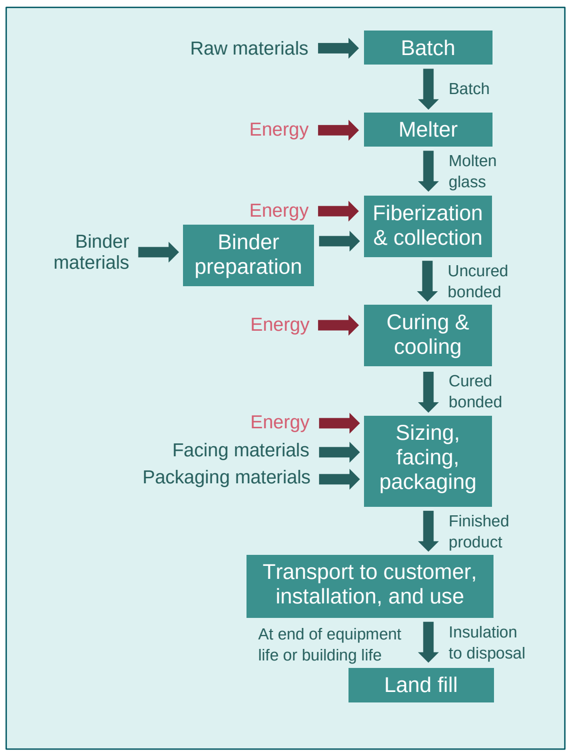
Description of Production and Subsequent Life Cycle Stages

The life cycle of the product under study begins with the extraction and processing of the raw materials that constitute the batch and transportation of those materials to the manufacturing plant (hereafter referred to as “Raw material acquisition”). Together, these materials (sand, borax, soda ash, recycled glass, and minerals) are melted, the molten glass is formed into fibers and a thermosetting binder is applied. The bonded product is then formed into insulation of the required configuration and specifications. After curing with hot air through convection and cooling, the product is cut into the desired width, faced with an acrylic latex coating (if applicable), and sent to the packaging line. Packaging of the finished product for shipment comprises shrink film and polyester bags.

Transport to the job site is an estimated 700 miles via truck. The insulation product is assumed to be tailored to customer specifications, leading to negligible 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 service life equal to that of the useful life of the equipment. When the equipment is replaced 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



Health, Safety, and Environmental Aspects during Production

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.

Installation

Johns Manville HVAC equipment insulation can be firmly bonded to metals, plastics, and other materials with commercial adhesives or mechanical fasteners. Micromat and Micromat RX are highly durable HVAC equipment liners. This facilitates efficient fabrication and installation.

- **Minimizes Pre-installation Damage.** The durable, glass-mat facing is resistant to damage that can occur during in-shop handling, fabrication, jobsite shipping and installation.
- **Easy to Fabricate.** Micromat and Micromat RX are lightweight and easy to handle. The fiber glass is consistent throughout the core, making it easier to cut to any size or shape with a knife, steel rule die, shears, or automated cutting technology.

Health, Safety, and Environmental Aspects during Installation

The Micromat and Micromat RX are fiber glass HVAC equipment liner products that are labeled as non-hazardous according to 29 CFR 1910.1200 when used as intended. The glass fibers are non-biopersistant (biosoluable) 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 Services.

As with most fiber glass products, direct exposure to fibers or dust during handling may lead to temporary, 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 Micromat HVAC equipment insulation:

- **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 Micromat 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 ingesting or swallowing Micromat HVAC equipment 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.

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The NAIMA safety recommendations may be found at: *http://ampersand.glhserver.com/~admin13/insulation-knowledge-base/health-and-safety-aspects/product-stewardship-program-for-worker-protection.html*

Johns Manville's Micromat Safety Data Sheets may be located at:
https://msds.jm.com/irj/go/km/docs/documents/Public/MSDS/200000002087_US_EN.pdf

Life Cycle Assessment – Product System and Modeling

A "cradle-to-grave" life cycle assessment (LCA) was conducted for this EPD. The analysis was done according to the product category rule (PCR) for building envelope thermal insulation and mechanical insulation and followed LCA principles, requirements and guidelines laid out in the ISO 14040/14044 standards. As such, EPDs of construction products may not be comparable if they do not comply with the same PCR or if they are from different programs.

While the intent of the PCR is to increase comparability, there may still be differences among EPDs that comply with the same PCR (e.g., due to differences in system boundaries, background data, etc.).

Functional Unit

Per the PCR, the functional unit for this analysis is ***1 m² of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m²K/W and with a building service life of 60 years***. Table 1 shows the functional unit along with its reference service life (RSL), specific thickness and mass reference flow.

Table 1: Functional unit and subsequent product attributes

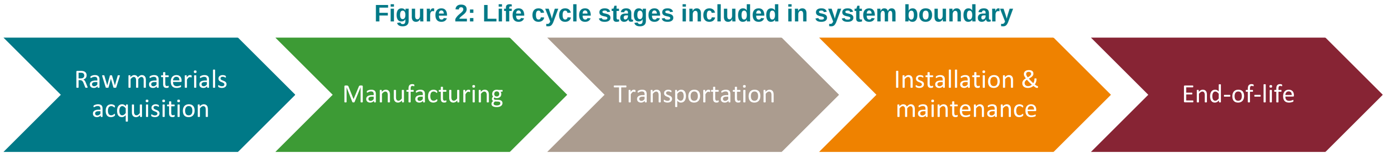
	Area [m^2]	R_{SI} [m^{2}K/W]	R_{US} [BTU/(h °F ft^2)]	RSL [years]	Thickness [in]	Mass [kg]
Functional Unit	1	1	5.68	60	1.35	0.942

Life Cycle Stages Assessed

A cradle-to-grave life cycle assessment was conducted, from extraction of natural resources to final disposal. Within these boundaries the following stages were included:

- **Raw materials acquisition:** Raw material supply (incl. virgin and recycled materials), inbound transport
- **Manufacturing:** Production of insulation, packaging of finished product, manufacturing waste, releases to the 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



System Boundaries

This study covers the entire life cycle of the products, including raw material acquisition and manufacturing, transportation to the building site, installation and maintenance, and finally end-of-life treatment. Additionally, transportation between stages has been accounted for, including raw material transport to the manufacturing facility and end-of-life transport to the landfill. Manufacturing facility overhead is included. 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.

Assumptions

The analysis uses the following assumptions:

- For the purpose of this declaration, the insulation material is assumed to have a service life equal to that of the building. This assumption is commonly used for EPDs published under the same PCR. It means that the insulation material is designed to meet its functional requirements for 60 years before replacement, while the system which it insulates may have to be replaced prior to that.
- Installation is done by hand and assumed to have a negligible scrap rate (0%).

Cut-off Criteria

Processes or activities that contribute no more than 2% of the total mass and 1% of the total energy may be omitted under PCR cut-off criteria. If omitted material flows have relevant contributions to the selected impact categories, their exclusion must be justified by a sensitivity analysis.

Cut-off criteria were applied to capital equipment production and maintenance under the assumption that the impacts associated with these aspects were sufficiently small to fall below cut-off when scaled down to the functional unit. All energy and material flow data available were included in the model.

Transportation

Reported transportation distances via truck and rail are included for the inbound transport of raw materials to the production facility. Distribution of the finished product to the construction site is estimated at 700 miles via heavy-duty truck and assumed to be volume-limited rather than mass-limited, with a utilization rate of 28% of mass capacity.

Period under Consideration

Primary data were collected on insulation production in 2014.

Background Data

The LCA model was created using the GaBi ts software system for life cycle engineering, developed by thinkstep. The GaBi 2015 LCI database provided the life cycle inventory data for upstream and downstream processes of the background system. US-specific background data were used whenever possible, with European or global data substituted as proxies as necessary.

Data Quality

Data quality and representativeness are considered to be good to high. Foreground data were collected from Johns Manville's manufacturing facility, with seasonal variations accounted for by collecting 12 months-worth of data. Aside from capital equipment, no data were omitted under cut-off criteria. All primary data were collected with the same level of detail while all background data were sourced from the GaBi databases. Allocation and other methodological choices were made consistently throughout the model.

Allocation

Data collection was performed by Johns Manville reaching out directly to plant facility manager. Specific data were collected for raw material use; however, energy use posed a considerable challenge to attribute to the EPD 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 functional unit of product.

Use

HVAC equipment insulation is assumed to have a reference service life equal to that of the useful life of the equipment. 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.

End-of-Life

At end-of-life, insulation is removed from the deconstructed equipment or 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 Results and Analysis

Use of Material and Energy Resources

Table 2 and Table 3 show the material resource use and primary energy demands per functional unit, respectively. Energy resource consumption is broken down by type and by resource. Figures 3 and 4 illustrate the results graphically.

Table 2: Material resource use per functional unit

Material Resources	Unit	Value
Non-renewable material resources	kg	6.09
Renewable material resources	kg	25
Net water use	L (kg)	17.5

Table 3: Primary energy demand per functional unit

Primary Energy Demand	Unit	Value
Non-renewable	***MJ***	***79.7***
Crude oil	MJ	12.7
Hard coal	MJ	5.48
Lignite	MJ	1.87
Natural gas	MJ	57.9
Uranium	MJ	1.74
Subtotal	*MJ*	*79.7*
Renewable	***MJ***	***1.47***
Biomass	MJ	2.95E-11
Geothermal	MJ	0.00956
Hydro power	MJ	0.138
Solar power	MJ	0.6
Wind power	MJ	0.725
Subtotal	*MJ*	*1.47*
Total	***MJ***	***81***

Figure 3: Non-renewable primary energy resources

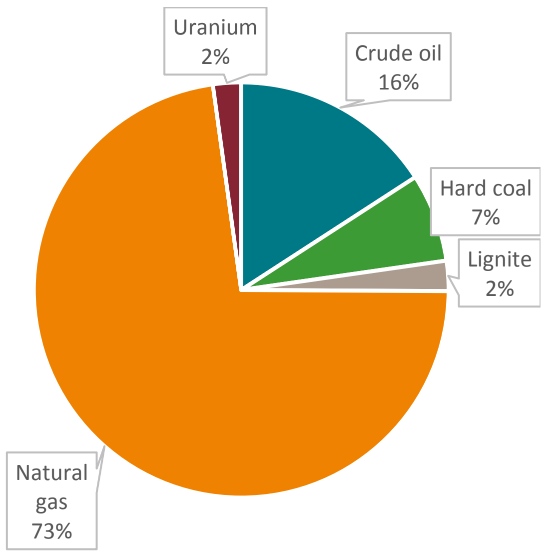
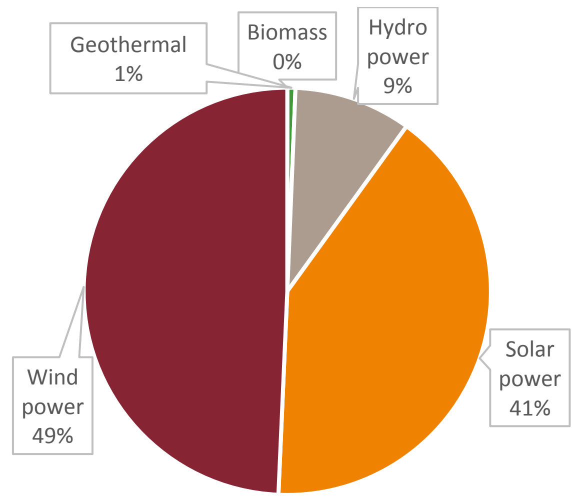


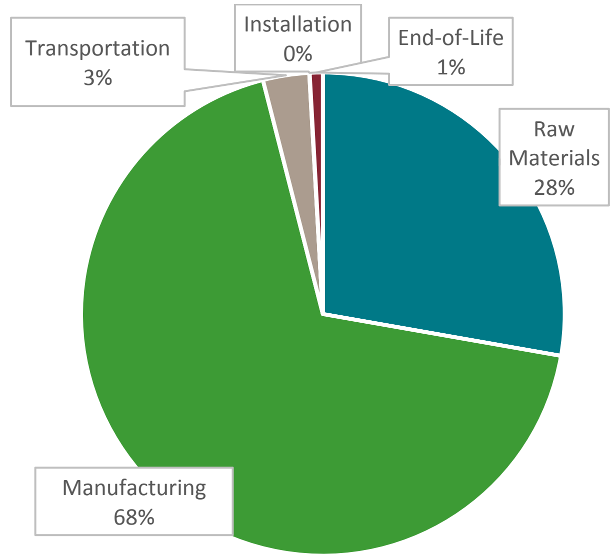
Figure 4: Renewable primary energy resources



Primary Energy by Life Cycle Stage

Primary energy demand contribution over the life cycle of the product is shown in Figure 5. Manufacturing is the dominant contributor overall; however, raw material supply is significant as well. In the manufacturing stage, electricity consumption, natural gas and other fossil fuel combustion are considered. Raw materials require energy in their extraction and refining. Moreover, materials such as plastic and biomass can be used as energy resources and the value of this energy is included in the primary energy demand indicator.

Figure 5: Primary energy demand breakdown by life cycle stage



Waste to Disposal

Waste generated from cradle-to-grave are shown in Table 4. There is a significant mass of non-hazardous waste at end-of-life which represents the product itself when the insulation is decommissioned and discarded to landfill.

Table 4: Waste to disposal/energy per functional unit

Impact Category	Units	TOTAL	Raw Materials	Manufac-turing	Transporta-tion	Installation	End-of-Life
Hazardous (kg)	kg	**1.73E-05**	3.56E-06	1.32E-05	3.55E-07	2.96E-09	1.30E-07
Non-hazardous (kg)	kg	**1.22**	0.04	**0.22**	0.00	0.02	0.94
Waste to energy	kg	**0**	-	-	-	-	-

Life Cycle Impact Assessment

Table 5 contains life cycle impact assessment results per declared unit. Impact results were calculated using the TRACI 2.1 methodology. Note: Since the publishing of the guiding PCR, the unit for acidification in TRACI has changed from *kg mol* H^+ *eq* (TRACI 2.0) to *kg* SO_2 *eq* (TRACI 2.1).

Table 5: Life cycle impact category results per functional unit (TRACI 2.1)

Impact Category	Units	TOTAL	Raw Materials	Manufac-turing	Transporta-tion	Installation	End-of-Life
Acidification	kg SO_2 eq	**0.0367**	0.00465	0.0309	0.000907	0.0000151	0.0002
Eutrophication	kg N eq	**0.00266**	0.000643	0.00192	0.0000808	0.00000573	0.0000109
Global Warming*	kg CO_2 eq	**4.85**	1.24	3.39	0.175	0.000971	0.0426
Ozone Depletion	kg CFC-11 eq	**1.65E-10**	3.41E-11	1.28E-10	1.5E-12	2.33E-14	1.02E-12
Smog Creation	kg O_3 eq	**0.305**	0.0765	0.196	0.0288	0.000127	0.00389

* Excl. biogenic carbon

Interpretation

Manufacturing drives all TRACI impact categories. Electricity generation and natural gas combustion dominate global warming and ozone depletion, respectively. For acidification, eutrophication and smog formation potentials, the reported NO_x facility air emissions are the dominant contributor. There is significant contribution to all impact categories from upstream production of raw materials, largely attributed to acrylic latex coating, soda ash, phenol formaldehyde, burnt dolomite, and borax; however, the relative contributions vary depending on the impact category. There are unique exceptions, such as soybean-oil derived dedusting oil contributing to eutrophication and tailpipe emissions from transportation contributing to smog formation potential.

Transportation to the installation site represents a minor driver of impacts. Installation accounts for a negligable impact fraction given that minimal resources are required to install the 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 useful life of the equipment. 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 functional unit of product. Non-hazardous waste also accounts for 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.

References

GaBi ts software 2016	thinkstep AG, GaBi ts software: Software-System and Database for Life Cycle Engineering. Copyright, TM. Stuttgart, Echterdingen, 1992-2016.
ISO 14025	ISO 14025:2011-10, Environmental labels and declarations — Type III environmental declarations — Principles and procedures.
ISO 14040	ISO 14040:2009-11, Environmental management — Life cycle assessment — Principles and framework.
ISO 14044	ISO 14044:2006-10, Environmental management — Life cycle assessment — Requirements and guidelines.
ULE 2013	UL Environment, Product Category Rules for preparing an Environmental Product Declaration (EPD) for the Product Category: Building Envelope Thermal Insulation, UL, 2013.
Johns Manville 2013	Johns Manville. HSE-103FS Microbiological Resistance Testing Indoor Environmental Quality. Accessed Dec 2015. *http://www.jm.com/content/dam/jm/global/en/hvac-insulation/HVAC-documents/Resources/AHS-445_Microbiological%20Resistance%20Testing%20Fact%20Sheet.pdf*

Contact Information

Study Commissioner

Johns Manville

Building Insulation Technical, John Elverum

+1 (800) 654-3103: Option 3

www.jm.com

LCA Practitioner

thinkstep

thinkstep, inc.

+1 (617) 247-4477, info@thinkstep.com

170 Milk St, 3rd floor, Boston, MA 02109

www.thinkstep.com