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

**Think JM.**

*Microlite® Formaldehyde-free™ duct wrap is a lightweight, blanket-type insulation with a vapor-barrier facing. Above: Microlite FSK and PSK, manufactured in Willows, CA, and Winder, GA*
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.

<table>
<thead>
<tr>
<th>PROGRAM OPERATOR</th>
<th>UL Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION HOLDER</td>
<td>Johns Manville</td>
</tr>
<tr>
<td>DECLARATION NUMBER</td>
<td>4787305280.103.1</td>
</tr>
<tr>
<td>DECLARED PRODUCT</td>
<td>Microlite® FSK and PSK Fiber Glass Duct Wrap Insulation</td>
</tr>
<tr>
<td>REFERENCE PCR</td>
<td>Building Envelope Thermal Insulation, Mechanical Insulation (v1.3, June 2014)</td>
</tr>
<tr>
<td>DATE OF ISSUE</td>
<td>December 15, 2016</td>
</tr>
<tr>
<td>PERIOD OF VALIDITY</td>
<td>5 Years</td>
</tr>
</tbody>
</table>

**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
Duct Wrap
Product Category: Mechanical Insulation

According to ISO 14025

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

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 renewable, bio-based 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 bio-based 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.

Application and Uses

Johns Manville’s 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.

Manufacturing Locations

This EPD represents the manufacturing of JM duct wrap in Willows, CA, and Winder, GA.
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. 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 vapor barrier facing, cut to size, and sent to the packaging line. Packaging 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 60-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.

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’s Microlite FSK or PSK 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 FSK or PSK, 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 FSK or PSK data sheet (p2) (JM 2015). Refer to www.jm.com.

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.

For a full explanation of application and installation, see the Microlite FSK or PSK data sheet (p2).
Health, Safety, and Environmental Aspects during Installation

Microlite® FSK and PSK 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 FSK or PSK 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 Microlite 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 Microlite duct wrap; 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.


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 Rsi = 1 m²K/W and with a building service life (RSL) of 60 years**.
Table 1 shows the functional unit along with its specific thickness and mass reference flow.

<table>
<thead>
<tr>
<th>Functional Unit</th>
<th>Area [m²]</th>
<th>$R_{SI}$ [m²K/W]</th>
<th>$R_{US}$ [BTU/(h °F ft²)]</th>
<th>RSL [years]</th>
<th>Thickness [in]</th>
<th>Mass [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Unit</td>
<td>1</td>
<td>1</td>
<td>5.68</td>
<td>60</td>
<td>2</td>
<td>0.706</td>
</tr>
</tbody>
</table>

**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 (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

**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:

- Insulation is assumed to have a 60-year reference service life, equal to that of the building.
- 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 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.
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.

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 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 were 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-level air emission report was leveraged to attribute the emissions to per functional unit of product.

Use

Duct insulation is assumed to have a reference service life of 60 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.

End-of-Life

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 Results and Analysis

Use of Material and Energy Resources

Table 2 and Table 3 show 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>
<thead>
<tr>
<th>Material Resources</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-renewable material resources</td>
<td>kg</td>
<td>3.46</td>
</tr>
<tr>
<td>Renewable material resources</td>
<td>kg</td>
<td>9.89</td>
</tr>
<tr>
<td>Net water use</td>
<td>L (kg)</td>
<td>30.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary Energy Demand</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-renewable</strong></td>
<td>MJ</td>
<td>29.8</td>
</tr>
<tr>
<td>Crude oil</td>
<td>MJ</td>
<td>6.02</td>
</tr>
<tr>
<td>Hard coal</td>
<td>MJ</td>
<td>7.43</td>
</tr>
<tr>
<td>Lignite</td>
<td>MJ</td>
<td>0.377</td>
</tr>
<tr>
<td>Natural gas</td>
<td>MJ</td>
<td>12.4</td>
</tr>
<tr>
<td>Uranium</td>
<td>MJ</td>
<td>3.53</td>
</tr>
<tr>
<td><strong>Renewable</strong></td>
<td>MJ</td>
<td>8.93</td>
</tr>
<tr>
<td>Biomass</td>
<td>MJ</td>
<td>1.93E-11</td>
</tr>
<tr>
<td>Geothermal</td>
<td>MJ</td>
<td>0.412</td>
</tr>
<tr>
<td>Hydro power</td>
<td>MJ</td>
<td>1.56</td>
</tr>
<tr>
<td>Solar power</td>
<td>MJ</td>
<td>6.62</td>
</tr>
<tr>
<td>Wind power</td>
<td>MJ</td>
<td>0.341</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>MJ</td>
<td>38.7</td>
</tr>
</tbody>
</table>
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, e.g., sand or soda ash, 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.
Waste to Disposal

Wastes 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>
<thead>
<tr>
<th>Impact Category</th>
<th>Units</th>
<th>TOTAL</th>
<th>Raw Materials</th>
<th>Manufacturing</th>
<th>Transportation</th>
<th>Installation</th>
<th>End-of-Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous (kg)</td>
<td>kg</td>
<td>9.41E-06</td>
<td>4.66E-06</td>
<td>4.39E-06</td>
<td>2.66E-07</td>
<td>2.38E-09</td>
<td>9.72E-08</td>
</tr>
<tr>
<td>Non-hazardous (kg)</td>
<td>kg</td>
<td>0.84</td>
<td>0.07</td>
<td>0.05</td>
<td>0.00</td>
<td>0.02</td>
<td>0.70</td>
</tr>
<tr>
<td>Waste to energy</td>
<td>kg</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Life Cycle Impact Assessment

Table 5 contains life cycle impact assessment results per functional 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 SO2 eq (TRACI 2.1).

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Units</th>
<th>TOTAL</th>
<th>Raw Materials</th>
<th>Manufacturing</th>
<th>Transportation</th>
<th>Installation</th>
<th>End-of-Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidification</td>
<td>kg SO2 eq</td>
<td>0.00752</td>
<td>0.00338</td>
<td>0.00316</td>
<td>0.00068</td>
<td>2.36E-05</td>
<td>0.000275</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>kg N eq</td>
<td>0.0014</td>
<td>0.00112</td>
<td>0.00018</td>
<td>6.06E-05</td>
<td>6.25E-06</td>
<td>3.56E-05</td>
</tr>
<tr>
<td>Global Warming*</td>
<td>kg CO2 eq</td>
<td>2.03</td>
<td>0.75</td>
<td>1.09</td>
<td>0.131</td>
<td>0.00376</td>
<td>0.0578</td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td>kg CFC-11 eq</td>
<td>4.32E-10</td>
<td>1.75E-10</td>
<td>2.55E-10</td>
<td>1.12E-12</td>
<td>1.88E-14</td>
<td>7.67E-13</td>
</tr>
<tr>
<td>Smog Creation</td>
<td>kg O3 eq</td>
<td>0.133</td>
<td>0.0438</td>
<td>0.0638</td>
<td>0.0216</td>
<td>0.000131</td>
<td>0.00326</td>
</tr>
</tbody>
</table>

* Excl. biogenic carbon

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., 60 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.
Duct Wrap
Product Category: Mechanical Insulation

According to ISO 14025

References

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULE 2013</td>
<td>UL Environment, Product Category Rules for preparing an Environmental Product Declaration (EPD) for the Product Category: Building Envelope Thermal Insulation and Mechanical Insulation, UL, 2013.</td>
</tr>
</tbody>
</table>

Contact Information

Study Commissioner

Building Insulation Technical, John Elverum
+1 (800) 654-3103: Option 3
www.jm.com

LCA Practitioner

thinkstep, inc.
+1 (617) 247-4477, info@thinkstep.com
170 Milk St, 3rd floor, Boston, MA 02109
www.thinkstep.com