

ENVIRONMENTAL PRODUCT DECLARATION

MINERAL WOOL LOOSE

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION



Mineral wool insulation products, saving energy, reducing pollution, and contributing to a sustainable environment



The North American Insulation Manufacturers Association (“NAIMA”) is the association for North American manufacturers of fiber glass, rock wool, and slag wool insulation products. The Association’s role is to promote energy efficiency and environmental preservation through the use of fiber glass, rock wool, and slag wool insulation, and to encourage the safe production and use of these materials. NAIMA advocates for improved energy efficiency in homes and buildings as the quickest and most cost effective way to reduce energy use and lower greenhouse gas emissions.

Insulation saves 12 times as much energy per pound in its first year of use as the energy used to produce it. In fact, insulation in place in U.S. buildings reduces the amount of carbon dioxide emissions by 780 million tons per year.



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MANUFACTURERS ASSOCIATION**

MINERAL WOOL LOOSE FILL

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	North American Insulation Manufacturers Association (NAIMA)
DECLARATION NUMBER	4786060412.101.1
DECLARED PRODUCT	Mineral Wool Loose Fill
REFERENCE PCR	PCR Building Envelope Thermal Insulation v1.2
DATE OF ISSUE	November 8, 2013
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
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The PCR review was conducted by:	UL Environment
	PCR was approved by Panel 333 Pfingsten Road Northbrook, IL 60611 epd@ul.com
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL	 Paul Firth
	 Tom Gloria
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	 Tom Gloria





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North American Insulation Manufacturers Association

NAIMA is the association for North American manufacturers of fiberglass and mineral wool (i.e., rock wool and slag wool) insulation products. Its role is to promote energy efficiency and environmental preservation through the use of fiberglass and mineral wool insulation, and to encourage the safe production and use of these materials.

NAIMA mineral wool members include:

Aislantes Minerales, S.A. de C.V.
D.F. Mexico
www.rolan.com

Industrial Insulation Group, LLC
Brunswick, GA
www.iig-llc.com

Roxul Inc.
Milton, Ontario
www.roxul.com

USG Interiors, Inc.
Chicago, IL
www.usg.com

Armstrong World Industries
Lancaster, PA
www.armstrong.com

Rock Wool Manufacturing Co.
Leeds, AL
www.deltainsulation.com

Thermafiber, Inc.
Wabash, IN
www.thermafiber.com

Product Definition

Product Description

Mineral wool loose fill insulation is made from molten rock and slag and spun or blown into fibers that are then processed into the final product. It is an effective insulation and meets the requirements of ASTM C764 – Mineral Fiber Loose Fill Thermal Insulation. Mineral wool loose fill insulation is inorganic and noncombustible. In addition, the fibers will not rot or absorb moisture and do not support the growth of mildew, mold, or fungus.

Manufacturing Locations

This EPD covers mineral wool loose fill produced by manufacturers in the United States. Production locations include facilities in Indiana, Minnesota, and Texas (United States). Results represent the production volume weighted average based on total mass produced by participating manufacturers.

Application and Uses

Mineral wool loose fill insulation must be applied through pneumatic means using a mechanical blowing machine. The insulation is designed for “open blow” applications such as attic spaces or closed cavity applications such as those found inside walls or covered attic floors. In both applications, to achieve the correct R-value it is extremely important that the proper weight and thickness of materials be installed.

Mineral wool loose fill can also be used in business-to-business applications for ceiling tile production.





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Installation

The thermal resistance (R-value) of mineral wool loose fill is dependent on the proper application of the required quantity of material. One of the most significant criteria for achieving the desired R-value is meeting the designated minimum weight per square foot of material. It is also important that the minimum thickness be achieved since this, along with the required weight per square foot of material, is essential to obtain the desired R-value. The correct values for coverage for each loose fill material are stated by the manufacturer in a bag label specifications chart.

Before loose fill insulation is installed, the area to be insulated is measured. Framing adjustments may be permissible in determining the net insulatable area. From these calculations, the required number of bags or pounds of insulation is determined from the bag label chart for the desired R-value. It is important that the correct number of pounds or bags of loose fill insulation be installed in order to assure that the desired R-value is achieved. This holds true in both open and closed blow installations. In addition, it is recommended that the installer blowing insulation in the attic wear a NIOSH certified dust respirator (certified N95 or greater). See OSHA's Respiratory Protection Standard.

The blower should not use a bare hand to direct the insulation stream as it emerges from the blowing hose. A gloved hand or deflector should be used instead.

Health, Safety, and Environmental Aspects during Installation

The NAIMA Product Stewardship Program's work practices apply to the manufacture, fabrication, installation, removal, and other work settings where workers are subject to exposures to mineral wool fibers. The Product Stewardship Program commits manufacturers to use product design, engineering controls, work practices, respiratory protection or a combination of any or all of these measures to bring fiber exposures to the voluntary one fiber per cubic centimeter permissible exposure limit (1 f/cc PEL).

The Product Stewardship Program specifies comprehensive work practices for those working with mineral wool fibers, including recommendations for cost effective engineering controls (when applicable), proper respirator use, use of protective clothing, and work place guidelines. In locations that require power sawing, routing, sanding, or grinding, or employ other operations that lead to dusty conditions, local exhaust ventilation should be used.

NAIMA has established an exposure database containing existing information about exposure levels categorized by product type and specific work task.

Production

Material Content

Mineral wool insulation includes both rock wool and slag wool insulation, which are produced in the same way and comprised of essentially the same raw materials but in different proportions. Manufacturers use a mechanized process to spin a molten composition of rock and slag into high temperature-resistant fibers. The similar properties of both insulation types lead to fairly similar performance attributes. The major difference is in the specific volumes of the various raw materials used to make each product.

Rock wool insulation is composed principally of fibers manufactured from a combination of aluminosilicate rock (usually basalt), blast furnace slag, and limestone or dolomite. Slag is a byproduct from steel production that would otherwise be landfilled. Binders are not used. Typically, rock wool insulation is comprised of a minimum of 70% – 75% natural rock. The remaining volume of raw material is blast furnace slag.

Slag wool insulation is composed principally of fibers manufactured by melting the primary component, blast furnace



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slag, in combination with some natural rock. Binders are not used. Typically, slag wool insulation uses approximately 70% blast furnace slag, with the remaining volume of raw materials being natural rock.

Due to the similarities between the two types of mineral wool, an aggregate view will be used throughout this document that combines both slag and rock wools.

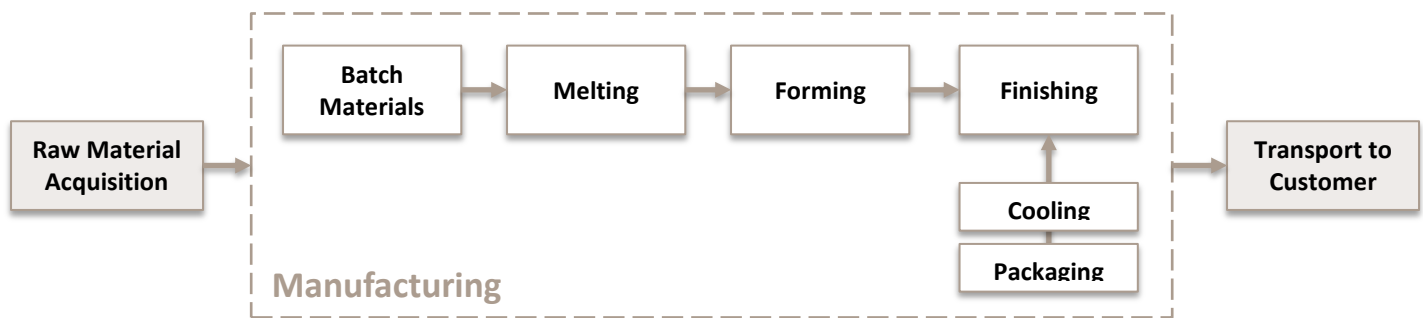
Table 1: Mineral wool loose fill material content

Component	Loose Fill Weight Percent	Recycled Resource	Mineral Resource	Renewable	Origin
Mineral Wool Batch					
Slag	87%	x			North America
Bauxite	6.2%		x		North America
Granite	4.1%		x		North America
Feldspar	2.9%		x		North America
Dedusting Agent					
Polyethylene Glycol	< 1%		x		North America

Manufacturing Process

The life cycle for loose fill mineral wool begins with raw material extraction. These batch materials are melted and formed into the end product. At finishing they cool and are packaged. The packaged product is transported to the customer at the construction site where it is installed using an electric blowing machine.

Figure 1: Mineral wool loose fill manufacturing



Health, Safety, and Environmental Aspects during Production

The NAIMA Product Stewardship Program’s work practices apply to the manufacture as well as installation and other occupational settings where workers are subject to exposures to mineral wool fibers. NAIMA has established an exposure database containing existing information about exposure levels categorized by product type and specific work task. The database establishes that manufacturing exposures are well below the voluntary PEL of 1 f/cc.





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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 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 product category rules, the functional unit for this analysis is 1 m² of insulation material with a thickness that gives an average thermal resistance $R_{SI} = 1 \text{ m}^2\text{K/W}$ and a building service life of 60 years. In imperial units, the R_{SI} value is equivalent to $R_{US} = 5.68$.

Life Cycle Stages Assessed

A cradle-to-grave life cycle analysis 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, 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

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. Building operational energy and water use are considered outside of this study's scope: any impact 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:

- Mineral wool insulation is assumed to last the lifespan of the building and is only removed upon building demolition. Since the PCR states that the building has a 60-year reference service life, the insulation is assumed to have the same reference service life.
- Results represent a production volume weighted average of mineral wool loose fill. Since the analysis was limited to data collected from specific NAIMA members, the results are not 100% representative of North American production.
- Installation is done by using a blower and is assumed to have a negligible scrap rate (0%).



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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 the impacts associated with processing (crushing and sizing) waste slag. Based on input from the participants, the energy associated with this process was estimated to be well below the 1% cut-off. Otherwise, material and energy inputs were included whenever data were available, even if they could be excluded under the cut-off criteria.

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 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. Loose fill is often compressed when packaging; therefore, distribution of the finished product is assumed to be mass-limited.

Period under Consideration

Primary data were collected on insulation materials production for the year 2007. These data were based on annual average data for the calendar year. This year was chosen as the year on which to base the EPD because the data represent full capacity production. During 2008 through 2012, manufacturers operated under capacity and at lower efficiencies due to decreased demand from the economic recession.

Background Data

The LCA model was created using GaBi 4 Software system for life cycle engineering, developed by PE INTERNATIONAL. The GaBi 4 LCI database provided the life cycle inventory data for upstream and downstream processes of the background system and is appropriate for representing the years 2002 - 2009. Proxy data used in the LCA model were limited to background data for raw material production. US 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 NAIMA's members, with seasonal variations accounted for by collecting 12 months of data. Aside from the processing of slag waste, 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

Allocation of manufacturing material and energy inputs was done on a mass-basis. Allocation of transportation was based on mass while taking into account the utilization rate.

For recycled content and disposal at end-of-life, system boundaries were drawn consistent with the cut-off allocation approach. Slag, which is used as a raw material in mineral wool loose fill production, is assumed to enter the system burden-free in that burden associated with the production of the slag itself is not allocated to the insulation life cycle. Likewise, the system boundary was drawn to include landfilling of mineral wool at end-of-life (following the polluter-



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pays principle), but exclude any avoided burdens from material or energy recovery.

Use

Mineral wool 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, and requires no maintenance. There are no parts to repair or refurbish. Any reduction in building operational energy consumption associated with insulation use need to be considered on the level of the individual building and are considered outside the scope of the LCA.

End-of-Life

At the end-of-life, insulation is removed from the deconstructed building. Wastes are then transported 20 miles and disposed in a landfill. Although recycling is feasible, there are minimal recycling programs and infrastructure; therefore, current practice is to send the waste to a landfill.

Life Cycle Assessment Results and Analysis

Use of Material and Energy Resources

Tables 2 and 3 show the primary energy demands per functional unit. Energy resource consumption is broken down by type and by resource. Figure 2 shows these values graphically.

Table 2: Primary energy demand per functional unit (by type)

Total Primary Energy	Unit	Mineral Wool Loose Fill
Non-renewable, oil, coal, natural gas	MJ	13
Non-renewable, nuclear (uranium)	MJ	0.95
Renewable, biomass	MJ	0.0002
Renewable, wind, solar, geothermal	MJ	0.07
Renewable, hydro	MJ	0.043
Total	MJ	14





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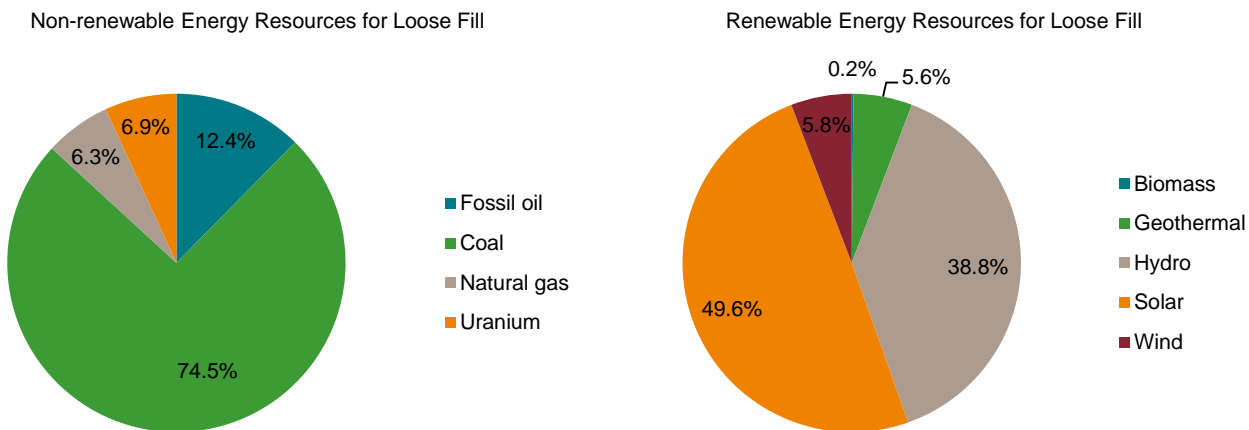
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Table 3: Primary energy demand per functional unit (by resource)

Total Primary Energy	Unit	Mineral Wool Loose Fill
Non-renewable resources		
Fossil oil	MJ	1.71E+00
Coal	MJ	1.03E+01
Natural gas	MJ	8.69E-01
Uranium	MJ	9.45E-01
Renewable resources		
Biomass	MJ	1.83E-04
Geothermal	MJ	6.25E-03
Hydropower	MJ	4.31E-02
Solar power	MJ	5.51E-02
Wind power	MJ	6.46E-03
Total	MJ	14

Figure 2: Renewable and non-renewable primary energy resources



Primary Energy by Life Cycle Stage

A breakdown of non-renewable primary energy demand by life cycle stage is shown in Figure 3. The majority of primary energy consumption is attributed to energy consumed during raw materials production and manufacturing. More energy is required to for distribution than for inbound transport of materials due to longer shipping distances as well as lower capacity utilization.



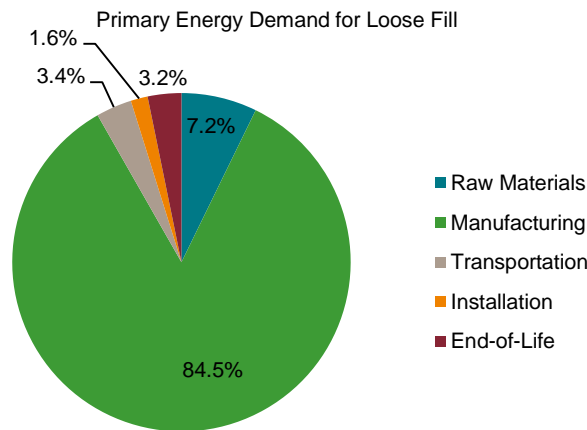


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Figure 3: Primary energy demand breakdown by life cycle stage



Life Cycle Impact Assessment

Table 4 contains life cycle impact assessment results per functional unit. Impact results were calculated using the TRACI 2.0 methodology.

Table 4: Life cycle impact category results per functional unit (TRACI 2.0)

Impact Category	Units	Raw Materials	Production	Transport	Installation	End-of-Life	Total
Global Warming	kg CO ₂ eq	6.47E-02	1.27E+00	3.34E-02	1.44E-02	4.03E-02	1.42E+00
Acidification	kg mol H ⁺ eq	2.21E-02	6.97E-01	2.33E-03	4.72E-03	5.92E-03	7.32E-01
Eutrophication	kg N eq	1.89E-05	9.93E-05	1.58E-06	1.53E-06	5.03E-06	1.26E-04
Smog Creation	kg O ₃ eq	9.65E-03	5.20E-02	7.26E-04	6.51E-04	2.27E-03	6.53E-02
Ozone Depletion	kg CFC-11 eq	1.02E-09	1.47E-08	7.66E-11	9.67E-10	1.45E-10	1.69E-08
Waste to Landfill	kg	1.04E-05	3.65E-01	–	–	1.11E+00	1.47E+00
Metered Water	L	–	4.52E-01	–	–	–	4.52E-01
Primary Energy	MJ	1.00E+00	1.17E+01	4.74E-01	2.25E-01	4.46E-01	1.39E+01

Waste to Disposal

Non-hazardous waste generated from production and at end-of-life is shown in Table 5, along with metered water consumption results per functional unit. There is no hazardous waste associated with this product.





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Table 5: Non-hazardous waste and water usage per functional unit

Impact Category	Units	Raw Materials	Production	Transport	Installation	End-of-Life	Total
Non-Hazardous Waste	kg	1.04E-05	0.36	–	–	1.1	1.5
Water Consumption	gal	–	0.12	–	–	–	0.12

Scaling to Other R-Values

Environmental performance results are presented per functional unit, defined as 1 m² of R_{SI} = 1 m²K/W insulation. In the US, insulation is typically purchased based on R-value stated in units of ft²·°F·hr/Btu. Environmental impacts per square meter of these alternative R-values can be calculated by multiplying the above results by scaling factors presented in Table 6.

Table 6: Scaling factors to other R-values

Customary US R-value	Loose fill thickness [inches]	Loose fill 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

$$\text{Loose fill impact per m}^2 \text{ (R-xx)} = \text{Impact scaling factor (R-xx)} \times \text{Loose fill impact per m}^2 \text{ (R}_{SI} = 1)$$

Interpretation

Study results are consistent with expectations for insulation products’ life cycles as these products are not associated with energy consumption during their use stage. The primary finding, across the environmental indicators and for all the products considered, was that the manufacturing stage dominated the impacts due to the energy required by the melter and finishing stages.

Eutrophication potential for loose fill mineral wool is primarily due to inbound transport of raw materials to the facility rather than production of the materials themselves. The same nitrogen oxides that affect eutrophication also account for over half of raw material smog formation potential.

Outbound transport is a minor contributor because unlike board or other insulation products, loose fill mineral wool can be compressed to optimize transport utilization. Installation, likewise, accounts for a small fraction of overall life cycle impact given that minimal resources are required to install loose fill. There is no impact associated with the use stage.





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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). No replacements are necessary; therefore, results represent the production of one (1) square meter of insulation at a thickness defined by the PCR functional unit.

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.

It is possible that this EPD will be used for comparative purposes with EPDs produced by other manufacturers. In such cases, it should be noted that even though the EPDs comply with the same PCR, there still may be differences in application that can affect comparison results.

Additional Environmental Information

Indoor Environment

According to the "Toxicological Profile for Synthetic Vitreous Fibers":

Very low levels of synthetic vitreous fibers can be found in virtually all homes, buildings, and outside air, but there is little concern regarding these low levels... As long as the [SVF] materials are not physically disturbed or breaking down, the levels of synthetic vitreous fibers in the air should be very low.

The overwhelming majority of human exposure to synthetic vitreous fibers occurs as occupational exposure through inhalation and dermal contact. Occupational exposure is estimated to be several orders of magnitude greater than environmental exposure.

The exposure of the general population (non-occupational exposure) to synthetic vitreous fibers in both indoor and outdoor air is low... Furthermore, it has been shown that the airborne levels of synthetic vitreous fibers attenuate rapidly following installation.

Health Impacts

NAIMA and its member companies are committed to ensuring that mineral wool products can be safely manufactured, installed, and used. NAIMA member companies have funded tens of millions of dollars of research at leading independent laboratories and universities in the United States and abroad. The weight of the scientific research shows no association between exposure to mineral wool fibers and respiratory disease or cancer in humans.

In October 2001, an international expert review by the International Agency for Research on Cancer (IARC) re-evaluated the 1988 IARC assessment of glass fibers and removed glass and mineral wool fibers from its list of substances "possibly carcinogenic to humans." All fiberglass and mineral wools that are commonly used for thermal and acoustical insulation are now considered not classifiable as to carcinogenicity to humans (Group 3). IARC noted specifically:

Epidemiologic studies published during the 15 years since the previous IARC Monographs review of these fibers in 1988 provide no evidence of increased risks of lung cancer or mesothelioma (cancer of the lining of the body cavities) from occupational exposures during manufacture of these materials, and inadequate evidence overall of any cancer risk.

The IARC downgrade is consistent with the conclusion reached by the U.S. National Academy of Sciences, which in 2000 found "no significant association between fiber exposure and lung cancer".



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Scientific evidence demonstrates that mineral wool is safe to manufacture, install, and use when recommended work practices are followed. Following these work practices will help to reduce irritation.¹

Building Use Stage Benefits

Sustainable insulation requires no additional energy or maintenance in order to perform during the life of service. Mineral wool insulation is effective in helping reduce heat flow, reduce unwanted noise, and control moisture.

Other Relevant Information – Fire Performance

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. Mineral wool 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, mineral wool 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 E 136 standards and test methods and are Class A product tested per ASTM E 84 and NFPA 101.

References

- | | |
|-------------|---|
| ASTM C764 | ASTM C764, Mineral Fiber Loose Fill Thermal Insulation. |
| DHHS 2004 | U.S. Department of Health and Human Services, Toxicological Profile for Synthetic Vitreous Fibers, 2004. |
| GaBi 4 | PE INTERNATIONAL AG, GaBi 4: Software-System and Database for Life Cycle Engineering. Copyright, TM. Stuttgart, Echterdingen, 2006. |
| IARC 2001 | World Health Organization, International Agency for Research on Cancer, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Man-made Vitreous Fibres, vol. 81, Lyon, 2001 |
| 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, Version 1.2, UL, October 29 th , 2013. |
| US HHS 2004 | Toxicological Profile for Synthetic Vitreous Fibers (U.S. Department of Health and Human Services, |

¹ This is a mechanical irritation and does not meet the U.S. OSHA HAZCOM definition of "Irritation" specified in Appendix A to 29 C.F.R. § 1910. 1200.

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Public Health Services, Agency for Toxic Substances and Disease Registry), September 2004, pp. 9, 181, 188.

LCA Development

The EPD and background LCA were prepared with support from PE INTERNATIONAL, Inc.

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