

THEODORE CEMENT PLANT

ENVIRONMENTAL PRODUCT DECLARATION



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ABOUT THIS EPD

This is a cradle-to-gate environmental product declaration for Portland (Type I/II and Type III), Blended (Type IL and IS) and Masonry (Type S and N) cements as produced at Amrize Cement's Theodore, AL plant. The life cycle assessment was prepared according to ISO 14025:2006, ISO 21930:2017 (the core PCR) and the NSF product category rules for Portland, Blended, Masonry, Mortar and Plastic (Stucco) Cements (subcategory PCR). This environmental product declaration (EPD) is intended for business-to-business audiences.

GENERAL SUMMARY

EPD Commissioner and Owner



Amrize Cement Inc.
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Amrize provided both LCI and meta-data for limestone quarrying, clinker production and cement manufacture for reference year 2019. The owner of the declaration is liable for the underlying information and evidence.

For any explanatory material, regarding this EPD, please contact Sonia Gagnon (sonia.gagnon@amrize.com).

Product Group and Name

Cement, UN CPC 3744.

Product Definition

Portland cement is defined as a hydraulic cement produced by pulverizing clinker, consisting essentially of crystalline hydraulic calcium silicates, and usually containing one or more of the following: water, calcium sulfate, up to 5% limestone, and processing additions (NSF PCR 2020, ASTM C150, ASTM C219).

Portland Cement *Type I*—For use when the special properties specified for any other type are not required.

Portland Cement *Type II*—For general use, more especially when moderate sulfate resistance is desired.

Portland Cement *Type III*—For use when high early strength is desired.

Some cements are designated with a combined type classification, such as Type I/II, indicating that the cement meets the requirements of the indicated types and is being offered as suitable for use when either type is desired.

Blended cement is a hydraulic cement consisting of two or more inorganic constituents (at least one of which is not Portland cement or Portland cement clinker) which separately or in combination contribute to the strength gaining properties of the cement, (made with or without other constituents, processing additions and functional additions, by intergrinding or other blending).

Type IL (ASTM C595) — is a Portland-limestone cement and is a hydraulic cement in which the limestone content is more than 5 % but less than or equal to 15 % by mass of the blended cement.

Masonry cement is hydraulic cement manufactured for use in mortars for masonry construction or in plasters, or both, which contains a plasticizing material and, possibly, other performance-enhancing addition(s). Mortar cements are produced in Type N, Type S, and Type M classifications for use in preparation of ASTM Specification C270.

Product Category Rules (PCR) NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [2].

Date of Issue & Validity Period 02/26/2021 – 5 years

Declared Unit 1 metric ton of cement

EPD AND PROJECT REPORT INFORMATION

Program Operator ASTM International

Declaration Number EPD 176

Declaration Type Cradle-to-gate (modules A1 to A3). Facility and product-specific.

Applicable Countries United States

Product Applicability Portland cement is the basic ingredient of concrete. Concrete, one of the most widely used construction materials in the world, is formed when Portland cement creates a paste with water that binds with sand and rock to harden.

Content of the Declaration This declaration follows Section 9; Content of an EPD, NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [2].

This EPD was independently verified by ASTM in accordance with ISO 14025 and the reference PCR:

Internal External ☒ X

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The Project Report Cradle-to-Gate Life Cycle Assessment of Amrize Cement's US Cement Plants Prepared for Amrize Cement Inc., February 2021 (Revised May 2022).

LCA report and EPD Prepared by:

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This EPD project report is independently verified by in accordance with ISO 14025, ISO 14040/44, and the reference PCR:

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Industrial Ecology Consultants
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PCR INFORMATION

Program Operator	NSF International
Reference PCR	Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [2].
PCR review was conducted by:	Thomas P. Gloria, PhD (Chair), Industrial Ecology Consultants, t.gloria@industrial-ecology.com Mr. Jack Geibig, EcoForm Mr. Bill Stough, Sustainable Research Group

AMRIZE & PRODUCTION FACILITY

Facility Name:	Amrize Cement, Theodore Plant 3051 Hamilton Boulevard, Theodore, AL 36582
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PRODUCT DESCRIPTION

This EPD reports environmental transparency information for five cement types produced by Amrize at its Theodore, AL plant. Cements are hydraulic binders and are manufactured by grinding cement clinker and other main or minor constituents into a finely ground, usually grey colored mineral powder. When mixed with water, cement acts as a glue to bind together the sand, gravel or crushed stone to form concrete, one of the most durable, resilient and widely used construction materials in the world. The Table below sets out each cement type constituents and applicable standards. All Theodore cements are sold in bulk.

PRODUCTS AND STANDARDS

Inputs	Portland Type I/II ASTM C150	Portland Type III ASTM C150	Blended Type IL ASTM C595	Masonry Type N ASTM C91	Masonry Type S ASTM C91	Blended Type IS(22) ASTM C595
Clinker	92%	93%	84%	49%	67%	71%
Gypsum	5%	6%	5%	4%	4%	7%
Limestone	3%	1%	11%	47%	29%	2%
Slag	0%	0%	0%	0%	0%	20%
Other	<1%	<1%	<1%	<1%	<1%	<1%
Total	100%	100%	100%	100%	100%	100%

Applicable Standards:

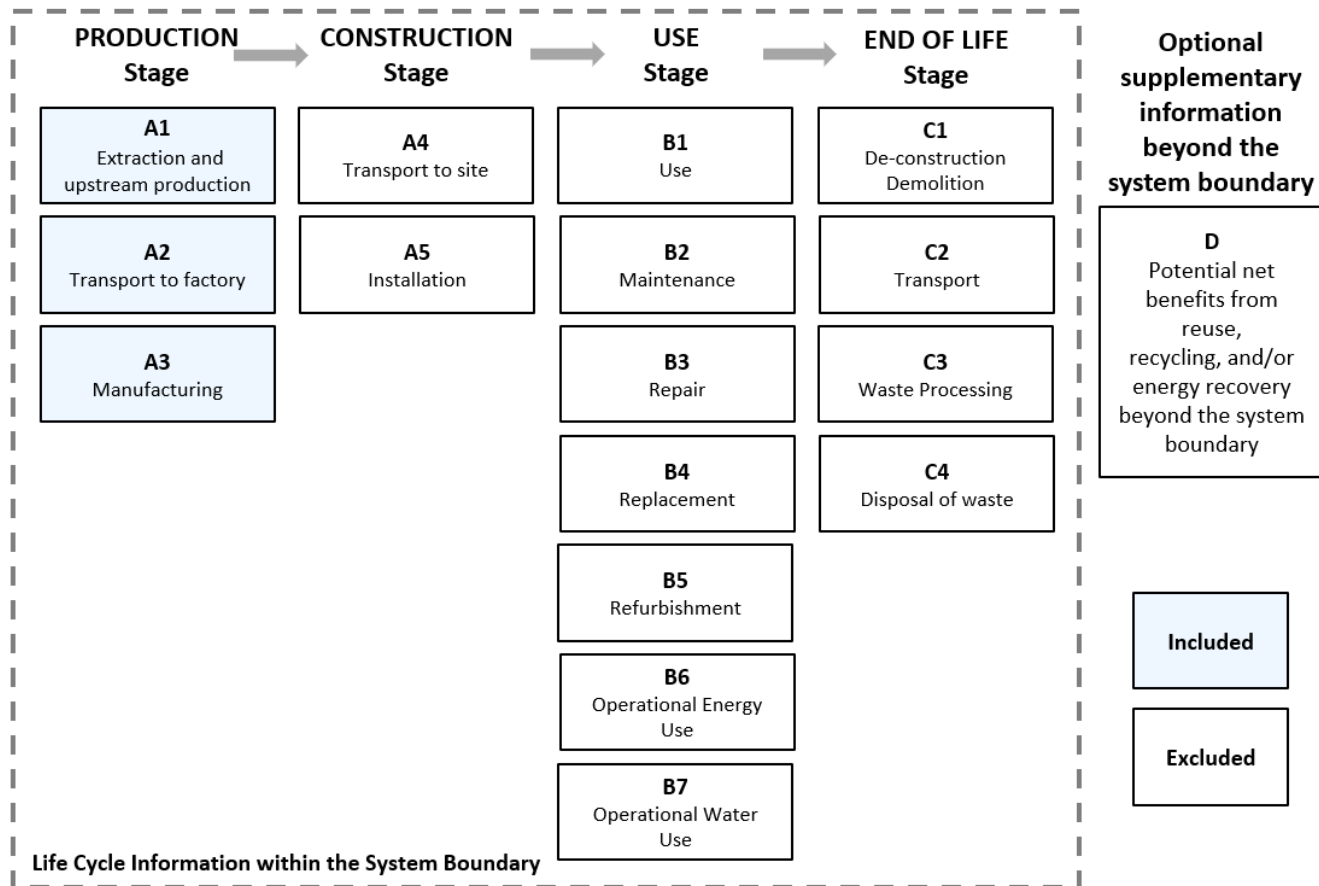
ASTM C150 / C150M – 20 Standard Specification for Portland Cement
ASTM C595 / C595M – 20 Standard Specification for Blended Hydraulic Cement
ASTM C91 / C91M – 18 Standard Specification for Masonry Cement
ASTM C1157 / C1157M – 20 Standard Performance Specification for Hydraulic Cements
AASHTO M 85-20 Standard Specification for Portland Cement (ASTM Designation: C150 / C150M - 20)

DECLARED UNIT

The declared unit is one metric ton of cement.

SYSTEM BOUNDARY

This EPD is a cradle-to-gate EPD covering the production stage (A1-A3) as depicted in the figure below. The production stage includes extraction of raw materials (cradle) through the manufacture of cements ready for shipment (gate). The Theodore, AL cement plant sources its limestone supply from an adjacent quarry. The plant also grinds slag granules sourced offshore for inclusion in its Blended Type IS cement.



Items excluded from the system boundary include:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment
- Personnel-related activities (travel, furniture, and office supplies)
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location

Cut-off Criteria

The cut-off criteria as per NSF PCR, Section 7.1.8 [2] and ISO 21930, 7.1.8 [3] were followed. Per ISO 21930, 7.1.8 [3], all input/output data required were collected and included in the LCI modelling. No substances with hazardous and toxic properties that pose a concern for human health and/or the environment were identified in the framework of this EPD. Any plant specific data gaps for the reference year 2019 e.g., amounts of lubricants and refractory were filled in with industry data (secondary data).

Data Collection

Gate-to-gate input/output flow data were collected for the following processes for the reference year 2019:

- Limestone quarry, clinker production and cement manufacture – Theodore, AL.

ALLOCATION RULES

Allocation follows the requirements and guidance of ISO 14044 Clause 4.3.4 [5], NSF PCR [2], and ISO 21930 section 7.2 [3]. Recycling and recycled content are modeled using the cut-off rule. The sub-category PCR recognizes fly ash, furnace bottom ash, bypass dust, mill scale, polluted soils, spent catalyst, aluminum oxide waste, silica fume, granulated blast furnace slag, iron rich waste, cement kiln dust (CKD), flue gas desulfurization (FGD) gypsum, and calcium fluoride rich waste as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a cement material input. Further, used tires, plastics, solvents, used oil and oily waste, coal/carbon waste, roofing asphalt, household refuse-derived waste and non-hazardous liquid waste are considered non-renewable and/or renewable secondary fuels. Only the materials, water, energy, emissions, and other elemental flows associated with reprocessing, handling, sorting and transportation from the point of the generating industrial process to their use in the production process are considered. All emissions from combustion at the point of use are considered.

DATA QUALITY REQUIREMENTS AND ASSESSMENT

Data Quality Requirements	Description
Technology Coverage	<p>Data represents the prevailing technology in use at the Theodore, AL facility. Whenever available, for all upstream and core material and processes, North American typical or average industry LCI datasets were utilized.</p> <p>The Theodore, AL plant utilizes <i>a dry with preheater kiln technology</i>.</p> <p><i>Technological representativeness is characterized as "high".</i></p>
Geographic Coverage	<p>The geographic region considered is U.S.</p> <p><i>Geographical representativeness is characterized as "high".</i></p>
Time Coverage	<p>Activity (primary) data are representative of 2019 calendar year (12 months).</p> <ul style="list-style-type: none"> - Theodore limestone extraction, - Theodore clinker production, - Theodore cement manufacturing, - In-bound/out-bound transportation data - primary data collected for Theodore quarry site and cement manufacturing plant. - Generic data: the most appropriate LCI datasets were used as found in the ecoinvent v3.6 database for US and global, December 2019 and US LCI Database. <p><i>Electricity resource mix for SERC region includes (eGRID 2018): 29.6% coal, 36.5% natural gas, 3.6% hydro, 25.9% nuclear, 0.6% wind, 0.9% solar, 2.1% geothermal, 2.1% biomass and 0.9% oil [14], [10].</i></p> <p><i>Temporal representativeness is characterized as "high".</i></p>

	All relevant, specific processes, including inputs (raw materials, energy and ancillary materials) and outputs (emissions and production volume) were considered and modeled to complete production profile for cement products.
Completeness	The relevant background materials and processes were taken from the US LCI Database (adjusted for known data placeholders), ecoinvent v3.6 LCI database for US, and modeled in SimaPro software v.9.1.1.1, September 2020. The completeness of the cradle-to-gate process chain in terms of process steps is rigorously assessed for all cement product systems
Consistency	To ensure consistency, the LCI modeling of the production input and output LCI data for the Theodore cement products of interest used the same LCI modeling structure, which consisted of input material and intermediate products, ancillary and packaging materials (if applicable), energy flows, water resource inputs, product outputs, co-products, by-products, emissions to air, water and soil, and solid and liquid waste disposal. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the facility level and selected process levels to maintain a high level of consistency.
Reproducibility	Internal reproducibility is possible since the data and the models are stored and available in <i>Amrize_Theodore Athena LCI database</i> developed in SimaPro, 2020. A high level of transparency is provided throughout the report as the LCI profile is presented for each of the declared products as well as major upstream inputs. Key primary (manufacturer specific) and secondary (generic) LCI data sources are also summarized in the background report. External reproducibility is not possible as the background report is confidential.
Transparency	Activity and LCI datasets are disclosed in the project report, including all data sources.
Uncertainty	A <i>sensitivity check</i> was conducted to assess the reliability of the EPD results and conclusions by determining how they are affected by uncertainties in the data or assumptions on calculation of LCIA and energy indicator results.

LIFE CYCLE IMPACT ASSESSMENT RESULTS: THEODORE, AL CEMENTS

This section summarizes the production stage life cycle impact assessment (LCIA) results including resource use and waste generated metrics based on the cradle-to-gate life cycle inventory inputs and outputs analysis. The results are calculated based on 1 metric ton of each cement type as produced at the Theodore, AL plant. *It should be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks [4], [5]. Further, a number of LCA impact categories and inventory items are still emerging or under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting results for these categories – identified with an “*” [2].*

Only EPDs prepared from cradle-to-grave life-cycle results and based on the same function, quantified by the same functional unit, and taking account of replacement based on the product reference service life (RSL) relative to an assumed building service life, can be used to assist purchasers and users in making informed comparisons between products [2]. Environmental declarations from different programs may not be comparable [7]. EPDs are comparable only if they comply with ISO 21930, use the same, sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works [3].

Production stage EPD Result: Theodore, AL – per Metric Ton

Impact category and inventory indicators	Unit	Portland Type I/II ASTM C150	Portland Type III ASTM C150	Blended Type IL ASTM C595	Blended Type IS(22) ASTM C595
Global warming potential, GWP 100 ¹⁾ , AR5	kg CO ₂ eq	875	891	818	712
Ozone depletion potential, ODP ²⁾	kg CFC-11 eq	5.0E-05	5.1E-05	4.8E-05	4.4E-05
Smog formation potential, SFP ²⁾	kg O ₃ eq	72.8	72.9	67.4	64.8
Acidification potential, AP ²⁾	kg SO ₂ eq	2.5	2.5	2.3	2.4
Eutrophication potential, EP ²⁾	kg N eq	1.02	1.08	1.03	0.92
Abiotic depletion potential for non-fossil mineral resources, ADP elements ³⁾ *	kg Sb eq	9.3E-05	1.1E-04	1.1E-04	1.0E-04
Abiotic depletion potential for fossil resources, ADP fossil ³⁾	MJ LHV	4,652	4,799	4,490	4,046
Renewable primary resources used as an energy carrier (fuel), RPR _E ⁺	MJ LHV	61	72	74	69
Renewable primary resources with energy content used as material, RPR _M ⁴⁾ *	MJ LHV	0	0	0	0
Non-renewable primary resources used as an energy carrier (fuel), NRPR _E ⁺	MJ LHV	5,026	5,244	4,951	4,469
Non-renewable primary resources with energy content used as material, NRPR _M ⁴⁾ *	MJ LHV	0	0	0	0
Secondary materials, SM ⁴⁾ *	kg	108	139	113	322
Renewable secondary fuels, RSF ⁴⁾ *	MJ LHV	0	0	0	0
Non-renewable secondary fuels, NRSF ⁴⁾ *	MJ LHV	1,015	1,022	924	782
Recovered energy, RE ⁴⁾ *	MJ LHV	0	0	0	0
Consumption of freshwater, FW ⁴⁾	m ³	0.9	0.9	0.8	0.8
Hazardous waste disposed, HWD ⁴⁾ *	kg	2.8E-04	0	0	0
Non-hazardous waste disposed, NHWD ⁴⁾ *	kg	3.8E-03	3.7E-03	3.3E-03	1.3E-02
High-level radioactive waste, conditioned, to final repository, HLRW ⁴⁾ *	m ³	2.0E-07	2.3E-07	2.4E-07	8.1E-08
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW ⁴⁾ *	m ³	1.3E-05	1.4E-05	1.3E-05	8.7E-06
Components for re-use, CRU ⁴⁾ *	kg	0	0	0	0
Materials for recycling, MR ⁴⁾ *	kg	0	0	0	0
Materials for energy recovery, MER ⁴⁾ *	kg	0	0	0	0
Recovered energy exported from the product system, EE ⁴⁾ *	MJ LHV	0	0	0	0
Additional Inventory Parameters for Transparency					
Emissions from calcination ⁵⁾	kg CO ₂ eq	485	488	441	373

Production stage EPD Result: Theodore, AL – per Metric Ton

Impact category and inventory indicators	Unit	Masonry Type N ASTM C91	Masonry Type S ASTM C91
Global warming potential, GWP 100 ¹⁾ , AR5	kg CO ₂ eq	516	675
Ozone depletion potential, ODP ²⁾	kg CFC-11 eq	3.4E-05	4.2E-05
Smog formation potential, SFP ²⁾	kg O ₃ eq	44.9	56.5
Acidification potential, AP ²⁾	kg SO ₂ eq	1.6	2.0
Eutrophication potential, EP ²⁾	kg N eq	0.74	0.91
Abiotic depletion potential for non-fossil mineral resources, ADP elements ³⁾ *	kg Sb eq	1.2E-04	1.2E-04
Abiotic depletion potential for fossil resources, ADP fossil ³⁾	MJ LHV	3,082	3,859
Renewable primary resources used as an energy carrier (fuel), RPR _E [*]	MJ LHV	82	82
Renewable primary resources with energy content used as material, RPR _M ⁴⁾ *	MJ LHV	0	0
Non-renewable primary resources used as an energy carrier (fuel), NRPR _E [*]	MJ LHV	3,502	4,334
Non-renewable primary resources with energy content used as material, NRPR _M ⁴⁾ *	MJ LHV	0	0
Secondary materials, SM ⁴⁾ *	kg	79	87
Renewable secondary fuels, RSF ⁴⁾ *	MJ LHV	0	0
Non-renewable secondary fuels, NRSF ⁴⁾ *	MJ LHV	541	736
Recovered energy, RE ⁴⁾ *	MJ LHV	0	0
Consumption of freshwater, FW ⁴⁾	m ³	0.7	0.8
Hazardous waste disposed, HWD ⁴⁾ *	kg	0	0
Non-hazardous waste disposed, NHWD ⁴⁾ *	kg	2.0E-03	2.0E-03
High-level radioactive waste, conditioned, to final repository, HLRW ⁴⁾ *	m ³	2.2E-07	2.5E-07
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW ⁴⁾ *	m ³	8.7E-06	1.1E-05
Components for re-use, CRU ⁴⁾ *	kg	0	0
Materials for recycling, MR ⁴⁾ *	kg	0	0
Materials for energy recovery, MER ⁴⁾ *	kg	0	0
Recovered energy exported from the product system, EE ⁴⁾ *	MJ LHV	0	0
Additional Inventory Parameters for Transparency			
Emissions from calcination ⁵⁾	kg CO ₂ eq	258	351

Table Notes:

- ¹⁾ Calculated as per U.S EPA TRACI v2.1, with IPCC 2013 (AR 5), SimaPro v 9.1.1.1 [10]. GWP 100, excludes biogenic CO₂ removals and emissions associated with biobased products; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5), TRACI v2.1 with AR5, v1.05 [10].
- ²⁾ Calculated as per U.S EPA TRACI v2.1, SimaPro v 9.1.1.1 [10].
- ³⁾ ADP elements: Clay, bentonite, limestone, gravel, silica, sand added to model per Table A4 in the 2019 NSF PCR for Concrete [6]. ADP fossil is calculated as per CML-IA Baseline v3.05, SimaPro v 9.1.1.1 [10]. ADP LHV, CML is required in LEED V4.1 MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations [13].
- ⁴⁾ Calculated as per ACLCA ISO 21930 Guidance [11].
- ⁵⁾ Total CO₂ facility combustion emissions are measured data from CO₂ Continuous Emission Monitoring System (CEMS) as reported in 2019 GHG Report submitted to US EPA. Calcination emissions are based on the Cement CO₂ and Energy Protocol detailed output method (B1) published by the World Business Council for Sustainable Development (WBCSD) Cement Sustainability Initiative (CSI) [15].

LCA INTERPRETATION

The Manufacturing module (A3) drives most of the potential environmental impacts. Manufacturing impacts are primarily driven by energy use (electricity and thermal fuels) used during the pyroprocessing of limestone in the production of clinker. Clinker content in cement similarly defines the relative environmental profile of the final cement product. Raw material extraction (A1) is the second largest contributor to the Production stage EPD results, followed by the transportation (A2).

ADDITIONAL ENVIRONMENTAL INFORMATION

Committed to sustainability, the Theodore plant co-processes waste by recovering energy from *recovered plastics, used tires and used oil* to replace some of the fossil fuels and mineral resources used in cement processing.

Environmental Protection and Equipment

Amrize Cement manufacturing facilities comply with the U.S. environmental protection agency (EPA) regulations, monitor and report the emissions to air during the manufacturing process as per the following:

- EPCRA Section 313 Toxic Release Inventory reporting (U.S) <https://www.epa.gov/toxics-release-inventory-tri-program>, accessed 12-2020.

Air pollution abatement equipment used at Amrize Cement's Theodore plant consist of high and low temperature baghouses, cartridge filters, and bin vents.

LIMITATIONS AND DISCLAIMER

Environmental declarations from different programs (ISO 14025) may not be comparable. Comparison of the environmental performance of products using EPD or ED information shall be based on the product's use and impacts at the building or construction works level, and therefore EPDs and EDs may not be used for comparability purposes when not considering the whole building life cycle. EPD and ED comparability is only possible 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 in results upstream or downstream of the life cycle stages declared.

The environmental impact results of products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted.

Amrize Cement Inc. believes the information contained in, and used in the creation of, this EPD is accurate, however Amrize Cement Inc. makes no guarantees with respect to such accuracy and assumes no liability in connection with the use of the information contained herein, which is not intended to be and should not be construed as legal advice

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REFERENCES

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4. ISO 14040:2006/Amd1:2020 Environmental management - Life cycle assessment - Principles and framework.
5. ISO 14044:2006/Amd1:2017/Amd2:2020 Environmental management - Life cycle assessment - Requirements and guidelines.
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