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SINGLE FIRED WALL TILES

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GRES PANARIA PORTUGAL, S.A. – Divisão LOVE TILES (AVEIRO)



GRES PANARIA
Portugal S.A.


centroHabitat
Plataforma para a Construção Sustentável

Index

1. GENERAL INFORMATION	1
1.1. THE DAPHABITAT SYSTEM.....	1
1.2. EPD OWNER	1
1.3. INFORMATION CONCERNING THE EPD	6
1.4. DEMONSTRATION OF THE VERIFICATION	6
1.5. EPD REGISTRATION	6
1.6. PCR OF REFERENCE.....	7
1.7. INFORMATION CONCERNING THE PRODUCT/PRODUCT CLASS.....	8
2. ENVIRONMENTAL PERFORMANCE OF THE PRODUCT	11
2.1. CALCULATION RULES OF THE LCA	11
2.1.1. FLOW DIAGRAM OF INPUT AND OUTPUT OF THE PROCESSES	11
2.1.2. DESCRIPTION OF THE SYSTEM BOUNDARIES.....	14
2.2. PARAMETERS DESCRIBING ENVIRONMENTAL IMPACTS	15
2.3. PARAMETERS DESCRIBING RESOURCE	16
2.4. OTHER ENVIRONMENTAL INFORMATION DESCRIBING DIFFERENT WASTE CATEGORIES	17
2.5. OTHER ENVIRONMENTAL INFORMATION DESCRIBING OUTPUT FLOWS.....	18
3. SCENARIOS AND ADDITIONAL TECHNICAL INFORMATION.....	18
3.1. A4 TRANSPORT TO THE BUILDING SITE – CONSTRUCTION PROCESS STAGE	18
3.2. A5 INSTALLATION OF THE PRODUCT IN THE BUILDING – CONSTRUCTION PROCESS STAGE	18
3.3. B1 USE STAGE	18
3.4. B2 MAINTENANCE.....	19
3.5. B3 REPAIR.....	19
3.6. B4 REPLACEMENT	19
3.7. B5 REFURBISHMENT	19
3.8. B6 USE OF ENERGY	19
3.9. B7 USE OF WATER.....	19
3.10. [C1 – C4] END OF LIFE OF THE PRODUCT	20
3.10.b BENEFITS AND LOADS BEYOND THE PRODUCT SYSTEM BOUNDARY (D):	20
3.11. ADDITIONAL INFORMATION ON RELEASE OF DANGEROUS SUBSTANCES TO INDOOR AIR, SOIL AND WATER DURING THE USE STAGE	21
3.12. TRACI INDICATORS	22
REFERENCES	23

1. GENERAL INFORMATION

1.1. The DAPHabitat System

Program operator:	Associação Plataforma para a Construção Sustentável www.centrohabitat.net centrohabitat@centrohabitat.net	 Plataforma para a Construção Sustentável
Address:	Departamento Engenharia Civil Universidade de Aveiro 3810-193 Aveiro	
Email address:	deptecnico@centrohabitat.net	
Telephone number:	(+351) 234 401576	
Website:	www.daphabitat.pt	
Logo:		

1.2. EPD OWNER

Name of the owner:	Gres Panaria Portugal, S.A.
Production site:	Gres Panaria Portugal, S.A.- Industrial Unit Love Tiles, 3801-101 Aveiro
Address (head office):	Zona Industrial de Aveiro, Apartado 3002, 3801-101 Aveiro
Telephone:	Gres Panaria: +351 234329700 Catarina Dias: +351 961537048
E-mail:	catarina.dias@grespanaria.pt ; geral@grespanaria.pt
Website:	www.grespanaria.pt ;
Logo:	
Information concerning the applicable management Systems:	Certification scope: Design, production and marketing of ceramic tiles NP EN ISO 9001:2015- Environmental Management Systems- Certifying entity APCER, Certificate of conformity number 2005/AMB.0244 NP EN ISO 14001:2015- Quality Management- Certifying entity APCER, Certificate of conformity number 2000/CEP.1049 EMAS III- Eco-Management and Audit Scheme- Certifying entity APCER, Register number PT- 000051
Specific aspects regarding the production:	CAE _{Rev.3} n.º23312 - Manufacture of tiles, mosaics and ceramic tiles
Organization's environmental policy:	Gres Panaria Portugal S.A., aware of its environmental and social responsibilities, is committed to the principles of strategic orientation that are crucial for the continuous improvement of the Integrated Management System, as well as the sustainable development of the business and the return on invested capital.

Thus, the management of Gres Panaria Portugal assumes the following commitments:

- Satisfaction of customers and other stakeholders, seeking the internationalization of its brands and products in the various markets;
- Innovation and product development, anticipating the expectations of its customers and ensuring the sustainability of its products throughout their life cycle;
- Implementation of a culture of operational excellence that maximizes the efficiency of processes;
- Involvement and motivation of its employees as they are a decisive asset for the success of the company;
- Protection of the environment, including the prevention of pollution, contributing to the minimization of environmental impacts and opting whenever possible and economically viable for the best available technologies, to improve environmental performance;
- Prevention and minimization of risk to the health and safety of employees to contribute to their integrity and quality of life;
- Compliance with applicable compliance obligations, inherent to its activities, products and services;

It thus undertakes to implement, document, communicate, review and disclose this Sustainability Policy, as well as the other strategic assumptions, to all employees and other stakeholders from a perspective of organizational transparency, seeking to involve employees, customers, suppliers, the local community and society in general in its Management System.

THE STORY OF PANARIAGROUP

Ceramica Panaria began as an industrial company in 1973, with the purchase of the land that now houses the Finale Emilia production facilities (province of Modena).

In 1976 the company was founded, and the first two production lines were installed and tested, and in December, the first tiles were produced. Total production capacity was reached in 1977. In the late eighties, the old kilns were replaced with single-layer roller kilns, which were more efficient and had greater productivity. At the same time, the presses were renewed, with more powerful machines capable of faster production cycles.

In 1990 Panariagroup upgraded its production from red single firing to white single firing production using mixtures of the finest clays.

In 1992 the ceramics firm Lea based in Fiorano Modenese was acquired, consisting of two kilns, one for flooring and one for wall-cladding.

In 1993 the Cotto d'Este brand was launched, a company marketing product of the very highest quality, employing production methods with the very best technical and aesthetic characteristics. Initially, the products were white body single-fired, and subsequently they were also made in Porcelain Stoneware.

In 1995 work began on constructing a new production site in Fora di Cavola, in the municipality of Toano (province of Reggio Emilia), for the production of Porcelain Stoneware. Initially, two kilns were put into operation. Later (in 1999) this number would rise to three, with an atomizer and a continuous mill to grind raw materials.

In 1996 the Fiordo brand was born, a company marketing product made exclusively of Porcelain Stoneware.

In 2000, with the construction of new installations for the third atomizer and a continuous grinding mill, as well as the installation of new kilns, the production of Porcelain Stoneware also began at the Finale Emilia plant.

In 2002 the Panaria group was expanded, incorporating the Company Maronagrés, a leading Portuguese ceramics manufacturing company, the leader in the production of technical porcelain stoneware.

In 2004 Panaria Industrie Ceramiche S.p.A. changed its company name, maintaining its registered office, to Panariagroup Industrie Ceramiche S.p.A. incorporating the Cotto d'Este Companies - Antica Ceramica d'Arte S.p.A., Fiordo Industrie Ceramiche S.p.A., Ceramiche Artistiche Lea S.p.A. and GMG S.r.l. which maintained their administrative offices.

2004 is the year in which Panariagroup decided to go public, and on 19 November 2004, the Group was listed in the Star segment of the Italian Stock Exchange.

In December 2005, Panariagroup acquired 100% of Novagrès S.A., a leading Portuguese company in producing and distributing ceramic material for floors and walls.

In February 2006, Panariagroup acquired the brand and the main assets of Florida Tile Industries Inc., a well-known US company specializing in producing and distributing ceramic material for floors and walls in the US market.

In October 2007, Panariagroup acquired the company Montanari S.r.l., a retail outlet for ceramic materials and complementary products based in Crespellano (BO).

In November 2008, an important restructuring phase began at the Fiorano plant, which involved installing a production line for a technologically innovative product called "Laminated Porcelain Stoneware" consisting of slabs measuring 1000x3000 mm and with a thickness of 3 mm. The project involved the total replacement of a production line (the first installed at the plant) consisting of machines used to produce glazed porcelain stoneware.

In May 2010, a new division was created within the Group called Panariagroup Trade, which deals with business development in the Middle East, Far East, and Oceania regions, marketing the products of the Panaria, Cotto d'Este, Lea and Fiordo brands.

In May 2012, a Joint Venture Company (JVC) was set up in Ahmedabad, in the Indian state of Gujarat, a company 50% owned by Panariagroup and 50% by Asian Granito India Ltd. The JVC products are sold on the Indian market with the new "Bellissimo - STILE ITALIANO" brand owned by Panariagroup.

In May 2012, Emilia Centrale was hit by violent earthquakes with peaks on the 20th and 29th with a magnitude 5.9 and 5.8 respectively on the Richter scale, the first with its epicentre in Finale Emilia; the Panariagroup No.1 production site suffered significant damage some production lines and buildings. Immediate reparation works were organized, and after only three months, the plants returned to full production.

In January 2016, the installation of the third complete line for the production of Laminated Porcelain Stoneware was completed at the Fiorano plant.

Panariagroup currently has a structure that includes 6 production plants (3 in Italy, 2 in Portugal, 1 in the United States) and 3 logistics hubs (2 in Italy and 1 in the United States). Specialised in the production of porcelain and laminated porcelain stoneware, the Group has focused on the high-end and luxury segments of the market that it caters for by means of brands like: Panaria Ceramica, Lea Ceramiche, Cotto d'Este, Blustyle, Florida Tile, Margres, Love Tiles and Bellissimo (see figure 1.1).

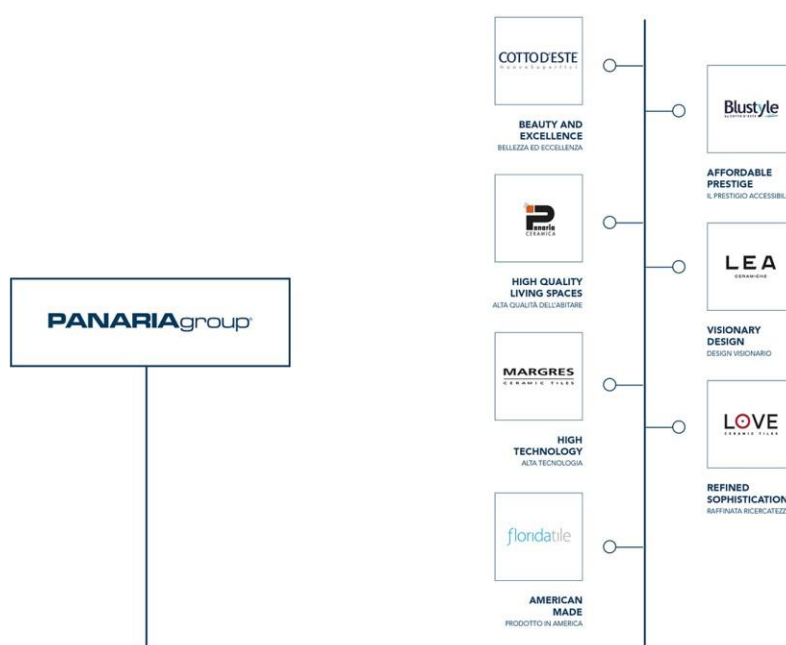


Figure 1.1- Panariagroup brands

The group employs around 1600 people and produces about 20 million m² of tiles each year (see figure 1.2).



Figure 1.2- Panariagroup around the world

LOVE TILES BRAND STORY

The Love Tiles brand was created in May 2008, replacing the Novagres brand. This new project, linked to an emotional marketing concept, intended to follow up on a communication and marketing policy that started two years earlier. The bet was to connect people affectionately to a way of being and feeling each space of their home, provided through elegant, exclusive and unrepeatable environments.

In 1990 Novagrés - Indústria de Cerâmica, S.A., started its activity so its history is recent. It started with the production of white glazed porcelain floors, and, in 1996, it also started producing single fired wall tiles (monoporous coverings).

In March 1998, it launched an innovative product characterized by the large dimensions presented, the straightening of edges and the quality in the definition of the design, thus consolidating a prominent place in the high-end market.

On November 30, 2005, Novagrés, S.A. was acquired by Panariagroup Industrie Ceramiche S.P.A. The Panaria Group is among the main Italian producers of ceramic flooring and cladding material.

On December 29, 2006, Novagres Indústria de Cerâmica S.A. merges with Maronagres Comércio e Indústria de Cerâmica, S.A., changing its corporate name to Gres Panaria Portugal, S.A. currently has the trademarks Love Tiles and Margres.

AVEIRO PRODUCTION UNIT

The production site of the Panaria Group in Aveiro is in the Industrial Zone of Aveiro, municipality of Aveiro in a global area around 141000 m².

The daily production of natural and rectified monoporosa coverings and natural and rectified stoneware flooring with formats ranging from 15x75 to 45x120 cm is around 13 000 m² / day, with a team of 380 employees.

Figure 1 presents the general view of the raw materials preparation unit.

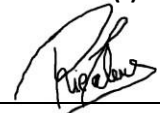


Figure 1.3 - General view of preparation unit

1.3. Information concerning the EPD

Authors:	1. Gres Panaria Portugal, S.A. 2. Centro Tecnológico da Cerâmica e do Vidro (CTCV)
Contact of the authors:	1. Gres Panaria Portugal, S.A. – Chousa Nova, 3830-133 Ílhavo- Portugal (T) +351 234329700; geral@grespanaria.pt 2. CTCV materials: habitat iParque – Parque Tecnológico de Coimbra - Lote 6 3040-540 Antanhol- Portugal (T) +351 239499200 Marisa Almeida: marisa@ctcv.pt
Issue date:	30/07/2021
Registration date:	22/09/2021
Registration number:	DAP 003:2021
Valid until:	31/12/2026
Representativity of the EPD (location, manufacturer, group of manufacturers):	DAP of single fired wall tiles, produced at the Aveiro-Portugal production unit, owned by Gres Panaria Portugal, S.A. The Panaria Group unit in Aveiro is dedicated to producing ceramic floors in white or coloured paste porcelain, white-paste glazed porcelain (single-fired) and single fired wall tiles, mainly used for floors and wall coverings. The products are distributed by the commercial divisions of the group's brands: - MARGRES - BLUSTYLE - COTTO D'ESTE - LEA CERAMICHE - PANARIA CERAMICA - LOVE TILES - FLORIDA TILE - PANARIAGROUP
Where to consult explanatory material:	www.grespanaria.pt
Type of EPD:	DAP - Cradle to Grave (A1-D)

1.4. Demonstration of the verification

External independent verification, accordingly with the standard ISO 14025:2009 and EN 15804:2012+A1:2013	
Certification Body	Verifier (s)
	
(CERTIF – Associação para a Certificação)	(Ricardo Mateus)

1.5. EPD Registration

Program Operator

(Plataforma para a Construção Sustentável)

1.6. PCR of reference

Name:	1. PCR: Basic module for construction products and services 2. PCR: Floor covering 3. PCR: Wall covering 4. EN 17160:2019 - Product category rules for ceramic tiles
Issue date:	1. November 2020 2. November 2020 3. November 2020 4. 27-Feb-2019, entry into force 15-Apr-2019
Number of registration on the data base:	1. PCR-mb001 2. RCP001:2014 3. RCP002:2014 4. --
Version:	1. Version 2.1 2. Version 1.1 3. Version 1.1 4. --
Identification and contact of the coordinator (s):	1. PCR: basic module for construction products and services • Marisa Almeida marisa@ctcv.pt • Luís Arroja arroja@ua.pt • José Silvestre ids@civil.ist.utl.pt 2. PCR: Wall coverings • Luís Arroja arroja@ua.pt • Marisa Almeida marisa@ctcv.pt 3. PCR: Floor coverings • Luís Arroja arroja@ua.pt • Marisa Almeida marisa@ctcv.pt
Identification and contact of the authors:	1. PCR: basic module for construction products and services • Marisa Almeida; Luís Arroja; José Silvestre; Fausto Freire; Cristina Rocha; Ana Paula Duarte; Ana Cláudia Dias; Helena Gervásio; Vítor Ferreira; Ricardo Mateus e António Baio Dias 2. PCR: Wall coverings • Marisa Almeida marisa@ctcv.pt • Luís Arroja arroja@ua.pt • Ana Cláudia Dias acdias@ua.pt 3. PCR: Floor coverings • Marisa Almeida marisa@ctcv.pt • Luís Arroja arroja@ua.pt • Ana Cláudia Dias acdias@ua.pt
Composition of the Sectorial Panel:	1. RCP: Wall coverings • RMC - Revestimentos de Mármore Compactos, S.A. • APICER – Associação Portuguesa da Indústria de Cerâmica • Sonae Indústria, SGPS, S.A. • Gyptec Ibérica - Gessos Técnicos, S.A. 2. RCP: Floor coverings • RMC - Revestimentos de Mármore Compactos, S.A. • Dominó – Indústrias Cerâmicas, S.A. • MAS – Manuel Amorim da Silva, Lda. • Sonae Indústria, SGPS, S.A. • APICER – Associação Portuguesa da Indústria de Cerâmica
Consultation period:	1. 18/11/2015 - 18/01/2016 2. 12/08/2013 - 30/11/2013 3. 01/08/2013 - 30/11/2013
Valid until:	1. January 2022 2. January 2022 3. January 2022 4. --

	The Panariagroup products manufactured at Aveiro have achieved the following product certifications for Quality (QB-UPEC, CERTIF), Environment (GreenGuard) and Safety (CE, CCC). The Quality/Environment and Safety Integrated Management System of this production site are certified according to ISO 9001:2015, ISO 14001:2015 and EMAS.
Description of the products application:	Single fired wall tiles for coating interior walls in the following applications: • Areas and residential buildings • Areas and public buildings • Areas and industrial buildings
Reference service life:	The service life of the tiles is generally more than 50 years (CEN,2012). In addition, according to the US Green Building Council, the service life of the tiles could have the same service life as the building itself. Therefore, 50 years can be considered as the realistic service life for the tiles.
Placing on the market / Rules of application in the market / Technical rules of the product:	EN 14411:2012 - Ceramic tiles - Definitions, classification, characteristics, evaluation of conformity and marking. EN ISO 10545 – Ceramic wall and floor (several parts) DIN 51130:2014 - Slip resistance test for flooring DIN 51097:2016 - Ramp testing BS 7976-1:2002+A1:2013 - Pendulum testers Specification Regulation (UE) n.º 305/2011 from the European Parliament and of the Council, of 9 March 2011, laying down harmonized conditions for the marketing of construction products and repealing Council Directive 89/106/EEC
Quality control:	According to the technical product standards, CERTIF and NF-UPEC.
Special delivery conditions:	Not applicable.
Components and substances to declare:	Not applicable.
History of the LCA studies:	---

The ceramic tile is subjected to a series of tests to determine the main technical characteristics of the product in conformity with the applicable standards (see figure 1.3 as an example of compressive strength).

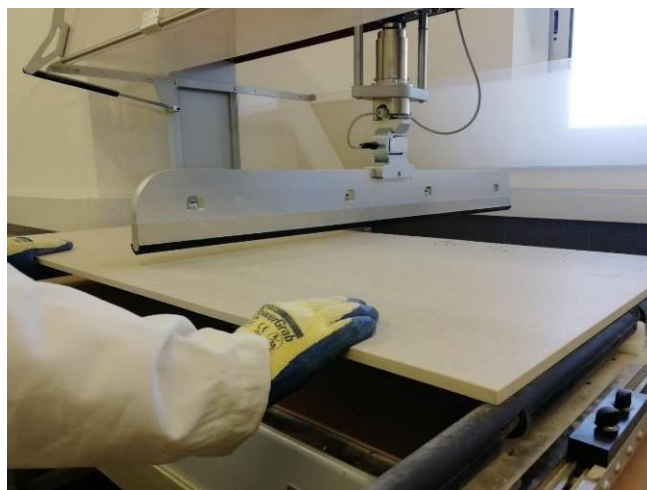


Figure 1.4 - Compressive strength

Declared unit:	--												
Functional unit:	1 m² of single fired wall tiles for wall covering (average) for wall cladding, and a 50-year reference life <table><tr><th>Name</th><th>Value</th><th>Unit of measure</th></tr><tr><td>Unit of measurement</td><td>1</td><td>m²</td></tr><tr><td>Weight</td><td>16,10</td><td>kg/m²</td></tr><tr><td>Conversion factor to 1 kg</td><td>0,0621</td><td>-</td></tr></table>	Name	Value	Unit of measure	Unit of measurement	1	m ²	Weight	16,10	kg/m ²	Conversion factor to 1 kg	0,0621	-
Name	Value	Unit of measure											
Unit of measurement	1	m ²											
Weight	16,10	kg/m ²											
Conversion factor to 1 kg	0,0621	-											
System boundaries:	EPD from cradle to grave												
Criteria for the exclusion:	According to paragraph 6.3.5 of EN 15804, the exclusion criterion for unitary processes is 1% of the total energy consumed and 1% of the total mass of the inputs, paying particular attention not to exceed 5% of energy and mass flows excluded in the product step. The following cases were not considered in this study, as they may fall under the exclusion criteria: - Environmental loads associated with the construction of industrial infrastructures and the manufacture of machinery and equipment; - Environmental loads relating to infrastructure (vehicle and road production and maintenance) for the transport of pre-products; - Long term emissions. All flows in known inputs and outputs were considered.												
Assumption and limitations:	For processes over which producers have no influence or specific information, such as the extraction of raw materials, generic data from the Ecoinvent v3.3 databases were used. The dataset used to model electricity production and natural gas was adapted to the Portuguese context. The electric mix was updated for the year 2018 through information from the National Energy Networks (REN), the Energy Services Regulatory Authority (ERSE) and the General Board of Energy and Geology (DGEG) to obtain more updated results regarding the environmental impacts generated by the electricity grid in Portugal. . According to the information provided by the DGEG Energy Report in Portugal (2018), the natural gas process was modelled regarding the countries where the importation comes from. The environmental impacts indicated in this EPD are a weighted average of all monoporosa tiles products fabricated in 2018, based on the production of the Aveiro industrial plant. The modules from A5 to C4 are scenarios based on average data, included in the PCR created by the European Federation of ceramic tile manufacturers /CET PCR 2014/ and subsequently implemented in the EN 17160 - Product category rules for ceramic tiles.												
Quality and other characteristics about the information used in the LCA:	The production data collected correspond to the year 2018 and are in accordance with the reality. The generic data used belong to the Ecoinvent database v3.3 and comply with quality criteria (age, geographical and technological, coverage, plausibility, etc.) of generic data. The validity period of the background data from the Ecoinvent database is between 2013 and 2019. Most of the information (energy and water consumption, emissions of pollutants, atomized powders and ceramic production) are measured or calculated directly at the company level and declared in the EMAS Report and in the Sustainability Report, which is specific and is checked for each plant involved in this study. Carbon dioxide emissions (related to carbonate oxidation) are collected through the ETS (Emissions Trading Scheme) declaration. Detailed data were obtained for mixtures of raw materials (collected with primary data from the company) and for dyes, frits, and other raw materials for glaze production. The overall quality of the data can be considered optimal.												
Allocation rules:	The consumption of energy and materials has been allocated to the product in question based on the mass of ceramic tiles produced annually. No further allocations were applied in the modules subsequent to the production phase. Some ceramic waste is recycled internally. Credits for energy recovery of packaging materials and end of life of the product have been considered.												
Comparability of EPD for construction products:	EPD for construction products and services may not be comparable if they are not produced following EN 15804 and EN 15942 and under comparability conditions defined by ISO 14025. For each Gres Panaria ceramic product, manufactured in the Love Tiles Industrial Unit, the environmental impacts can be determined by multiplying the results of this study by mass scale factors.												

2. ENVIRONMENTAL PERFORMANCE OF THE PRODUCT

2.1. Calculation rules of the LCA

2.1.1. Flow diagram of input and output of the processes

The production process of the ceramic tile covered by this EPD is shown below and described.

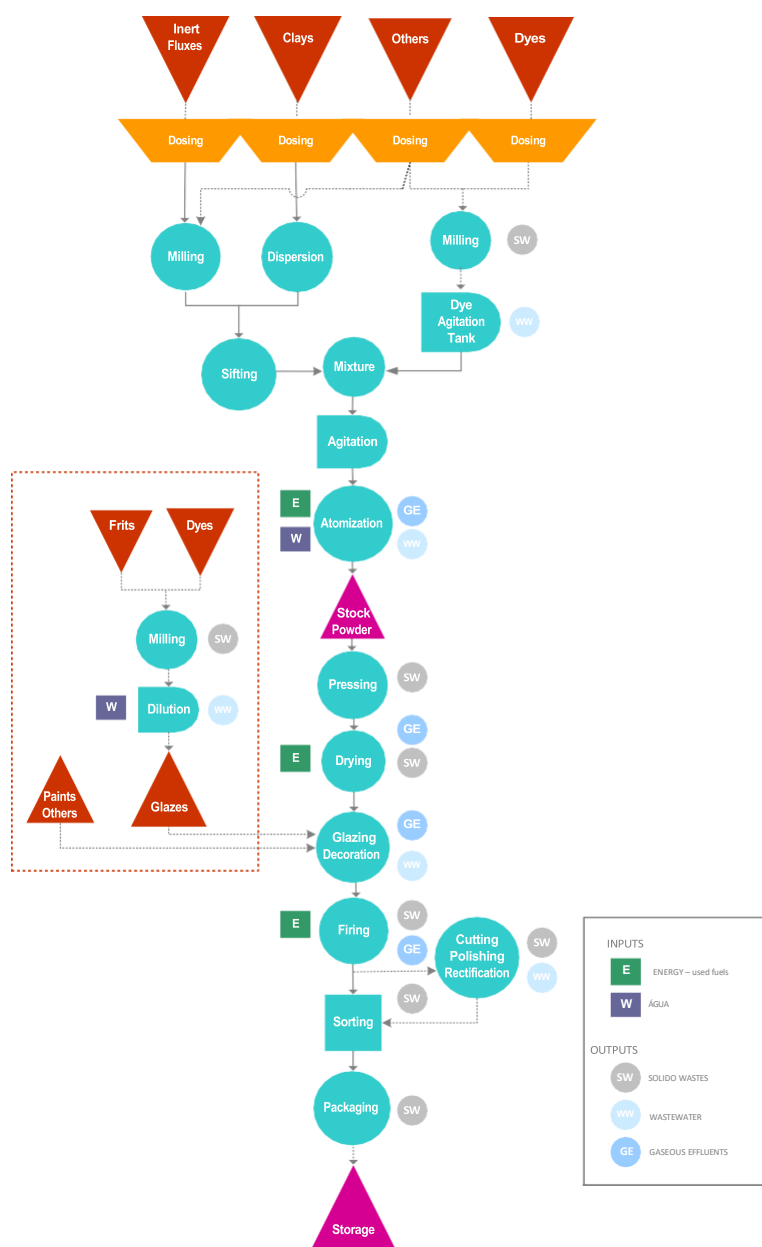


Figure 2.1- Production process of the ceramic tile covered by this EPD

The production process illustrated in the flowchart (figure 2.1) is divided into a series of operations and activities that are carried out consecutively. The individual phases of the production cycle are generally associated with a specific department, appropriately identified within the plant.



Figure 2.2- Raw materials preparation



Figure 2.3- Raw materials

Reception of raw materials:

Love Tiles produces single fired wall tiles and porcelain stoneware flooring. The raw materials used in the process are natural inorganic materials such as clays, calcite and feldspars, sands and talc. The raw materials are stored in separate bins, placed using a loader in load hoppers, and distributed separately by storage silos with weighing systems.

Paste preparation:

In discontinuous mills, the grinding of the hard materials is performed by wet-milled. The clays are diluted in turbodiluters. After grinding, the contents of the mills are added to the clays diluted in the turbodiluter, and the paste obtained is discharged into slip tanks, undergoing the first sieving, filtering, and is subjected to the action of agitators to be homogenized and kept in suspension. The slip is then transferred to the atomizer feed tank, being sieved again, now in a finer mesh.

Atomization:

Pulp atomization is carried out in an atomizer that is powered by high-pressure hydraulic pumps. The hot gas generator for drying is powered by natural gas. The atomized powder has about 5 to 6,5% moisture and is stored in silos that feed the production lines. There is a dry staining system that allows the production of coloured pasta.

Forming / pressing:

The pressing is carried out in large capacity hydraulic presses. After pressing, an operation in which the piece acquires its shape and part of the mechanical and surface characteristics, the material is transported to a dryer where the drying operation is carried out, which consists of removing almost all the moisture still existing in the atomized powder, thus giving the pieces the remaining mechanical characteristics that will allow their transport and processing in the glazing and decoration line.

Glazing / Decoration:

The company has a section for preparing glasses and ceramic paints that aims to obtain suspensions of paints and glasses that allow its application in glazing and decoration. Love Tiles has associated with each press, a line of glazing and decoration. Glazing and decoration are done by applying glaze by airbrush and glass curtain or using the screen printing or digital printing method. Love Tiles prepares serigraphic frames and scrolls used in flat and rotary screen printing. There are also several digital printers installed that allow digital printing on ceramic pieces. After this phase, the pieces go to the intermediate park until they are unloaded into one of the 4 existing roller ovens.

Firing:

Firing takes place in roller kilns fed with natural gas. The firing process is completely controlled, mainly in temperature and cycles, depending on the dimensions and technical characteristics of the final product. After leaving the kiln, the material is transported in boxes, where it awaits the next operation.

Cutting and Grinding:

Part of the product after the firing phase is sent to the cutting and rectifying section, where it is rectified and cut.

Choice and Packaging:

The choice of the final product is made piece by piece and focuses on two types of visual defects, detected by the operators and the dimensional defects, gauges and flatness, detected by automatic equipment installed in the lines of choice and packaging.

This process is followed by the automatic packaging operation in cardboard boxes and the subsequent placement of the boxes on wooden pallets, using palletizers.

Final inspections:

The Final Inspection performs an inspection of the packaged product to detect any error in the choice of material.

Warehousing and Shipping:

The final product is stored in a final product park waiting for the order to be sent to the customer.

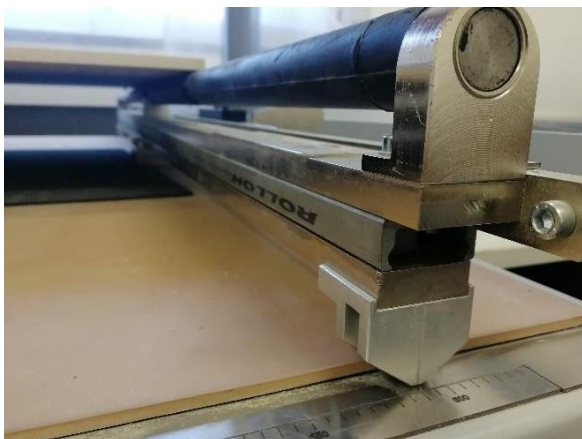


Figure 2.4- Ceramic tile testing



Figure 2.5- Glazing applications

BASE MATERIALS / ANCILLARY MATERIALS

The ceramic tile is mainly composed of ceramic raw materials and also glaze materials. The main raw materials for ceramic tile are clay (20-40%), Kaolin (0-12%), feldspar (20-40 %), carbonates (10-20%) sand (0-30 %) and pigments (0-4 %). The main glaze components are clay powder, quartz, alumina, pigments, frits and feldspars. The main auxiliary additives consist of dispersant, binder and fluidifying agents.

INSTALLATION/LAYING

The tiles are fixed to the surfaces of walls using specific materials and in different quantities, for example, dispersion adhesives, cementitious adhesives and mortar, sealants or applied liquid membranes. No emissions are generated during installation, and ceramic tile installations do not cause health or environmental hazards.

2.1.2. Description of the system boundaries

(✓ = included; ✗ = module not declared)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
Raw material supply	Transport	Manufacturing	Transport	Construction installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-constructions, demolition	Transport	Waste processing	Disposal	Re-use, recovery, recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The entire life cycle of the product (type of EPD: « **cradle-to-grave** ») and the Modules described below are considered:

Modules **A1-A3** include those processes that provide energy and material input for the system (A1), transport up to the factory gate of the plant (A2), manufacturing processes as well as waste processing (A3).

Module **A4** includes the transport from the production site to the customer or to the point of installation of the tiles. Three scenarios were considered : 300 km, 1350 km and 6520 km according to EN 17160.

Module **A5** considers all tile installation steps (like adhesives consumption) also packaging waste processing (recycling, incineration, disposal). Credits from energy substitution are declared in module D.

Module **B1** considers the use of tiles. During the use of ceramic tiles, no hazardous indoor emissions are expected to occur.

Module **B2** includes the cleaning of the tiles. Provision of water, cleaning agent for the cleaning of the tiles, incl. wastewater treatment, are considered.

Modules **B3-B4-B5** are related to the repair, replacement and refurbishment of the tiles. If the tiles are properly

installed, no repair, replacement or refurbishment processes are necessary. For this reason, Modules B3-B4-B5 are not considered.

Modules **B6-B7** consider energy use for operating building-integrated technical systems (B6) and operational water use for technical building-related systems. No operational energy or water use are considered. Cleaning water is declared under B2.

Module **C1** refers to the demolition and deconstruction process of the tiles from the building.

Module **C2** considers transportation of the discarded tile to a recycling or disposal process.

Module **C3** considers every process (collection, crushing process etc.) properly for recycling the tiles.

Module **C4** includes all the landfill disposal processes, including pre-treatment and management of the disposal site.

Module **D** includes benefits from all net flows in the end-of-life stage that leave the product boundary system after passing the end-of-waste stage.

2.2. Parameters describing environmental impacts

		Global warming potential; GWP kg CO ₂ equiv.	Depletion potential of the stratospheric ozone layer; ODP kg CFC 11 equiv.	Acidification potential of soil and water, AP kg SO ₂ equiv.	Eutrophication potential, EP kg (PO ₄) ³⁻ equiv.	Formation potential of tropospheric ozone, POCP kg C ₂ H ₄ equiv.	Abiotic depletion potential for non-fossil resources kg Sb equiv.	Abiotic depletion potential for fossil resources MJ, P.C.I.
Raw material supply	A1	-	-	-	-	-	-	-
Transport	A2	-	-	-	-	-	-	-
Manufacturing	A3	-	-	-	-	-	-	-
Total	Total	1,16E+01	1,67E-06	4,72E-02	4,23E-03	2,30E-03	5,19E-06	1,65E+02
Transport ¹	A4-300	1,12E+00	2,07E-07	2,99E-03	5,08E-04	1,43E-04	2,31E-09	1,71E+01
	A4-1390	3,12E+00	5,76E-07	8,32E-03	1,41E-03	3,98E-04	6,42E-09	4,75E+01
	A4-6520 boat	9,45E-01	1,76E-07	2,38E-02	2,02E-03	7,48E-04	1,76E-09	1,45E+01
Construction installation process	A5	1,41E+00	1,24E-07	4,93E-03	5,29E-04	2,21E-04	2,11E-07	1,34E+01
Use	B1	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Maintenance	B2	4,34E-02	5,52E-09	2,82E-04	2,11E-05	1,58E-05	4,45E-08	1,57E+00
Repair/Replacement/Refurbishment	B3 – B5	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Operational energy/water use	B6 – B7	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
De-construction and demolition	C1	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Transport	C2	4,49E-02	8,28E-09	1,20E-04	2,03E-05	5,73E-06	9,23E-11	6,83E-01
Waste processing	C3	4,49E-02	8,43E-09	3,45E-04	7,48E-05	8,27E-06	8,74E-11	6,95E-01
Disposal	C4	4,86E-02	8,79E-09	3,38E-04	7,07E-05	1,07E-05	1,06E-10	7,39E-01
Re-use, recovery, recycling potential	D	-3,49E-02	-1,25E-08	-1,78E-04	-3,44E-05	-6,57E-06	-3,55E-08	-5,10E-01

N.R. – not relevant according to EN 17160 - Product category rules for ceramic tiles

LEGEND:

	Product stage
	Construction process stage
	Use stage
	End - of - life stage
	Benefits and loads beyond the system boundary

NOTES: P.C.I. – Net calorific value
Units expressed by functional unit (1 m²).

¹ Three scenarios are presented for transport in A4 to the construction site:

- National: 300 km - Truck with a capacity of 25 tons;
- Europe: 1390 km - Truck with a capacity of 25 tons;
- International (outside Europe): 6520 km - Transoceanic cargo ship.

2.3. Parameters describing resource use

		Primary energy						Secondary materials and fuels, and use of water			
		EPR	RR	TRR	EPNR	RNR	TRNR	MS	CSR	CSNR	Net use of fresh water
		MJ, P.C.I.	MJ, P.C.I.	MJ, P.C.I.	MJ, P.C.I.	MJ, P.C.I.	MJ, P.C.I.	kg	MJ, P.C.I.	MJ, P.C.I.	m³
Raw material supply	A1	-	-	-	-	-	-	-	-	-	-
Transport	A2	-	-	-	-	-	-	-	-	-	-
Manufacturing	A3	-	-	-	-	-	-	-	-	-	-
Total	Total	3,72+01	1,55E+00	3,88E+01	1,70E+02	0,00E+00	1,70E+02	0,00E+00	0,00E+00	0,00E+00	1,39E-02
Transport	A4-300	4,20E-02	0,00E+00	4,20E-02	1,72E+01	0,00E+00	1,72E+01	0,00E+00	0,00E+00	0,00E+00	2,89E-04
	A4-1390	1,17E-01	0,00E+00	1,17E-01	4,78E+01	0,00E+00	4,78E+01	0,00E+00	0,00E+00	0,00E+00	8,02E-04
	A4-6520 boat	2,77E-02	0,00E+00	2,77E-02	1,46E+01	0,00E+00	1,46E+01	0,00E+00	0,00E+00	0,00E+00	2,42E-04
Construction installation process	A5	7,86E-01	0,00E+00	7,86E-01	7,18E+00	0,00E+00	7,18E+00	0,00E+00	0,00E+00	0,00E+00	8,33E-05
Use	B1	-	-	-	-	-	-	-	-	-	-
Maintenance	B2	2,32E-02	0,00E+00	2,32E-02	1,60E+00	0,00E+00	1,60E+00	0,00E+00	0,00E+00	0,00E+00	8,91E-06
Repair/Replace ment/Refurbish ment	B3 – B5	-	-	-	-	-	-	-	-	-	-
Operational energy/water use	B6 – B7	-	-	-	-	-	-	-	-	-	-
De-construction and demolition	C1	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Transport	C2	1,68E-03	0,00E+00	1,68E-03	6,87E-01	0,00E+00	6,87E-01	0,00E+00	0,00E+00	0,00E+00	1,15E-05
Waste processing	C3	1,25E-03	0,00E+00	1,25E-03	6,98E-01	0,00E+00	6,98E-01	0,00E+00	0,00E+00	0,00E+00	1,16E-05
Disposal	C4	3,13E-03	0,00E+00	3,13E-03	7,45E-01	0,00E+00	7,45E-01	0,00E+00	0,00E+00	0,00E+00	1,22E-05
Re-use, recovery, recycling potential	D	-1,72E-01	0,00E+00	-1,72E-01	-1,30E+00	0,00E+00	-1,30E+00	0,00E+00	0,00E+00	0,00E+00	-6,68E-05

LEGEND:

- Product stage
- Construction stage
- Use stage
- End – of - life stage
- Benefits and loads beyond the system boundary

EPR = use of renewable primary energy excluding renewable primary energy resources used as raw materials;

RR = use of renewable primary energy resources used as raw materials;

TRR = total use of renewable primary energy resources (EPR + RR);

EPNR = use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials;

RNR = use of non-renewable primary energy resources used as raw materials;

TRNR = total use of non-renewable primary energy resources (EPNR + RNR);

MS = use of secondary material;

CSR = use of renewable secondary fuels;

CSNR = use of non-renewable secondary fuels.

NOTE: Units expressed by functional unit (1 m²).

P.C.I. – Net calorific value

N.R.– not relevant according to EN 17160 - Product category rules for ceramic tiles

2.4. Other environmental information describing different waste categories

		Hazardous waste disposed kg	Non-hazardous waste disposed kg	Radioactive waste disposed ** kg
Raw material supply	A1	-	-	-
Transport	A2	-	-	-
Manufacturing	A3	-	-	-
Total	Total	1,35E-03	7,48E-01	2,06E-04
Transport	A4-300	2,82E-06	1,37E-04	1,17E-04
	A4-1390	7,85E-06	3,80E-04	3,26E-04
	A4-6520 boat	2,54E-06	1,13E-04	9,94E-05
Construction installation process	A5	2,71E-06	9,15E-03	3,29E-05
Use	B1	0,00E+00	0,00E+00	0,00E+00
Maintenance	B2	6,87E-07	6,91E-04	1,31E-06
Repair/Replacement/Refurbishment	B3 – B5	0,00E+00	0,00E+00	0,00E+00
Operational energy/water use	B6 – B7	0,00E+00	0,00E+00	0,00E+00
De-construction and demolition	C1	0,00E+00	0,00E+00	0,00E+00
Transport	C2	1,13E-07	5,46E-06	4,69E-06
Waste processing	C3	1,15E-07	1,12E-05	4,76E-06
Disposal	C4	1,32E-07	5,87E+00	4,98E-06
Re-use, recovery, recycling potential	D	-1,85E-06	-2,94E-01	-1,49E-05

Values expressed by functional unit (1 m²)

LEGEND:

	Product stage
	Construction stage
	Use stage
	End – of - life stage
	Benefits and loads beyond the system boundary

N.R. – not relevant according to EN 17160 - Product category rules for ceramic tiles

** The radioactive waste component does not come from the activity (A3). It is a component derived from the upstream activities (A1 and A2), namely from electricity production.

2.5. Other environmental information describing output flows

Parameters	Units*	Results
Components for re-use	kg	N/A
Materials for recycling	kg	1,24E+01
Materials for energy recovery	kg	1,49E-01
Exported energy	MJ by energy carrier	N/A
* expressed by functional unit (1 m ²)		

3. SCENARIOS AND ADDITIONAL TECHNICAL INFORMATION

3.1. A4 Transport to the building site – Construction process stage

The scenarios for A4 transport to the building site were according to EN 17160 regarding Product category rules for ceramic tiles.

Destination	Type of transport	Average distance (km)
National	Truck with a capacity of 25 tons	300
Europe	Truck with a capacity of 25 tons	1 390
International (Outside Europe)	Transoceanic freight ship	6 520

3.2. A5 Installation of the product in the building – Construction process stage

For the installation stage, the scenario was also according to the options defined in EN17160 and Almeida, 2019. The option chosen was 3,5 kg of cementitious adhesive for each m² of ceramic tile. The ceramic material loss considered was 3%.

Option 3 (medium size tiles)	Value	Unit of measure
Cementitious adhesive	3,5	kg

3.3. B1 Use stage

According to the specific PCR for Product category rules for ceramic tiles - EN 17160, the environmental impacts generated during the use phase are very low and therefore can be neglected. Ceramic tiles are robust and have a hard, abrasion-resistant surface.

There are no impacts on the environment during the use stage.

3.4. B2 Maintenance

Ceramic covering products shall be cleaned regularly, depending on the type of building: residential, commercial, healthcare. Thus, the consumption of water and cleaning agents has been considered. The values declared in this stage refer to a time period of 50 years. The scenario for maintaining ceramic floor and wall tiles was conservative and according to EN 17160. The scenario used for maintaining ceramic floor tiles was for residential use, using 0,134 ml detergent and 0,1 l water to wash 1 m² of ceramic wall tiles once every three months.

Name	Value	Unit of measure
Water consumption	0,1	l
Detergent	0,134	ml
Wall tile maintenance cycle	200	Number per RSL

3.5. B3 Repair

In general, the service life of ceramic tiles is the same as the building lifetime. Repair, replacement and refurbishment are not required for ceramic tiles.

Thus, according to EN 17160, ceramic tiles require no repairing during the use phase, and therefore no impacts should be declared in the repair phase.

3.6. B4 Replacement

In general, the service life of ceramic tiles is the same as the building lifetime. Repair, replacement and refurbishment are not required for ceramic tiles.

3.7. B5 Refurbishment

In general, the service life of ceramic tiles is the same as the building lifetime. Repair, replacement and refurbishment are not required for ceramic tiles.

Thus, according to EN 17160, ceramic tiles require no repairing during the use phase, and therefore no impacts should be declared in the refurbishment phase.

3.8. B6 Use of energy

These modules are not relevant for ceramic tiles, according to EN 17160.

3.9. B7 Use of water

These modules are not relevant for ceramic tiles, according to EN 17160.

3.10. [C1 – C4] End of life of the product

C1: This module, according to the PCR developed in EN 17160, is not relevant for ceramic tiles.

C2: The ceramic tile demolition waste is transported from the building site to a container or treatment plant by truck. An average distance of 20 km is considered, according to the default scenario of EN17160.

C3-C4: the end-of-life scenario is described in the following table:

Name	Value	Unit of measure
Recycling percentage (C3)	70	%
Landfill percentage (C4)	30	%

3.10.b BENEFITS AND LOADS BEYOND THE PRODUCT SYSTEM BOUNDARY (D):

Module D includes credits from materials recycling of tiles and packaging, energy credits from the thermal recovery of the packaging.

According to EN 17160, after the demolition/deconstruction stage, ceramic tiles can be crushed and then used in a range of different applications:

- road construction in filled embankment;
- concrete aggregates;
- when ceramic tiles are crushed, it forms recycled ceramic aggregates, which can be integrated as a partial substitute of natural aggregate in hot-mix asphalt [8];
- recycled ceramic aggregates can be used in the construction of landfills [8];
- recycled ceramic aggregates can be utilized in the construction of sub-based courses on secondary roads [8].

In this case, according to the Portuguese Environmental Agency (APA, 2020), in Portugal, the valorization rate of ceramic materials in construction and demolition waste is approx. 75%.

3.11. Additional information on the release of dangerous substances to indoor air, soil and water during the use stage

Love Tiles products have achieved the GREENGUARD Certification by a third-party, which is related to indoor air pollution and the risk of chemical exposure.

Identified Volatile Organic Compounds at 24 elapsed Exposure Hours		
CAS Number	Compound	Emission Factor ($\mu\text{g}/\text{m}^2\cdot\text{hr}$)
22531-20-0	Naphthalene, 6-ethyl-1,2,3,4-tetrahydro-*	3,3
42775-75-7	Naphthalene, 5-ethyl-1,2,3,4-tetrahydro-*	3,1

* indicates NIST/EPA/NIH best library match only based on retention time and mass spectral characteristics.

Target List Aldehydes at 24 Elapsed Exposure Hours		
CAS Number	Compound	Emission Factor ($\mu\text{g}/\text{m}^2\cdot\text{hr}$)
4170-30-3	2-Butenal	BQL
75-07-0	Acetaldehyde	BQL
100-52-7	Benzaldehyde	BQL
5779-94-2	Benzaldehyde, 2,5-dimethyl	BQL
529-20-4	Benzaldehyde, 2-methyl	BQL
620-23-5 / 104-87-0	Benzaldehyde, 3- and/or 4-methyl	BQL
123-72-8	Butanal	BQL
590-86-3	Butanal, 3-methyl	BQL
50-00-0	Formaldehyde	BQL
66-25-1	Hexanal	BQL
110-62-3	Pentanal	BQL
123-38-6	Propanal	BQL

Analyses based on EPA Compendium Method TO-17 and ASTM D 6196 for VOCs by thermal desorption followed by gas chromatography/mass spectrometry (TD/GC/MS), and EPA Method TO-11A and ASTM D 5197 for selected aldehydes by high-performance liquid chromatography (HPLC).

BQL corresponds to a value below the quantifiable threshold of 0,04 μg , based on a standard 18 liters air collection volume for TVOC and individual VOCs, and 0,1 μg based on a standard 45 liters air collection volume for formaldehyde and total aldehydes.

3.12. TRACI INDICATORS

TRACI indicators (version 2.1), from EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts, <http://www.epa.gov/nmel/std/traci.html>, are listed below.

TRACI INDICATORS of 1m ² of single fired wall tiles (16,10 kg/m ²)											
Parameter	Unit	A1-A3	A4-300	A4-1390	A4-6520-boat	A5	B2	C2	C3	C4	D
Global Warming Air	kg CO ₂ eq	1,16E+00	1,12E+00	3,12E+00	9,45E-01	1,07E+00	4,34E-02	4,49E-02	4,49E-02	4,86E-02	-3,49E-02
Ozone Depletion Air	kg CFC11 eq	2,13E-06	2,76E-07	7,67E-07	2,35E-07	7,19E-08	6,30E-09	1,10E-08	1,12E-08	1,17E-08	-1,44E-08
Acidification Air	kg SO ₂ eq	4,65E-02	3,40E-03	9,45E-03	2,40E-02	3,54E-03	2,72E-04	1,36E-04	4,43E-04	4,27E-04	-2,09E-04
Eutrophication	kg N eq	4,12E-03	4,86E-04	1,35E-03	9,58E-04	3,05E-04	2,44E-05	1,94E-05	3,84E-05	3,81E-05	-2,71E-05
Smog Air	kg O ₃ eq	5,58E-01	7,85E-02	2,18E-01	3,64E-01	5,96E-02	2,80E-03	3,14E-03	1,36E-02	1,27E-02	-5,25E-03

The stages B1, B3, B4, B5, B6, B7 and C1 are not relevant according to EN 17160 - Product category rules for ceramic tiles, and for that reason are not presented in the table above.

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