



Environmental Product Declaration

Arriscraft Natural Stone Cladding



Product Name: Natural Stone Cladding

Product Group: Cladding System Products

EPD Scope: Cradle-to-Gate

Declaration Holder: Arriscraft

Program Operator: ASTM International

Declaration Number: EPD-054

Date of Issuance: December 8, 2016

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Reference PCR: Underwriters Laboratory Product Category Rule (PCR) for Preparing an Environmental Product Declaration (EPD) for Product Group Cladding System Products; Version (June 18, 2015)

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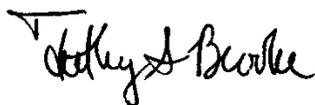
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Explanatory information about the EPD content can be obtained at (<http://www.ul.com/global/eng/pages/offering/businesses/environment/services/certification/epd/index.jsp>) or send an email to epd@ul.com

Product Description

The declared unit is 100 Square Feet of Natural Stone Cladding – as Manufactured at Arriscraft's Hope Bay and Cambridge Ontario facilities. The product system is the A1-A3 Cradle-to-Gate production of the cladding system.

The natural stone cladding product system is an average product (i.e. the product profile represents the weighted average of Arriscraft's natural stone cladding product offerings) produced at the manufacturer's two plants. All stone is quarried at the Hope Bay quarry; a portion of the quarried stone is finished at the Hope Bay facility and the remainder is finished at the Cambridge facility.

The product system includes the ancillary materials that are included in the installation of the product, mortar and masonry connectors. Arriscraft produces only the natural stone component of the cladding system. The installer purchases the mortar and masonry connectors separately.

Application:

Required properties for limestone natural stone masonry are described in ASTM C568, Standard Specification for Limestone Dimension Stone; Class III – High Density. Arriscraft limestone units meet the requirements of the Class III – High Density category of this standard.

Limestone natural stone is recognized as a suitable material for masonry construction in Canada under CSA A371, Masonry Construction for Buildings (ref. 5.1.4.1.2).

Limestone natural stone is recognized as a suitable material for masonry construction in the United States under TMS 602 / ACI 530.1 / ASCE 6, Specification for Masonry Structures (ref. 2.3 C). The International Building Code (ref. 2103.1) references Specification for Masonry Structures for suitable masonry unit materials.

Technical Information:

Table 1: Technical Information

Name	Value	Unit	Test Method
Compressive Strength	22,900	psi	ASTM C170
Abrasion Resistance	18.0		ASTM C241
Absorption	0.75	%	ASTM C97
Density	167	lb/ft ³	ASTM C97
Modulus of Rupture	2,250	psi	ASTM C99
Flexural Strength	1,600	psi	ASTM C880
Coefficient of Thermal Expansion	6.0 x 10 ⁻⁶	°F ⁻¹	ASTM C531

Market Placement/Installation Requirements:

CAN/CSA A371, Masonry Construction for Buildings governs the use of limestone natural stone units in masonry construction in Canada.

MS 402 / ACI 530 / ASCE 5, Building Code Requirements for Masonry Structures governs the use of limestone natural stone units in masonry construction in the United States.

Base Materials/Ancillary Materials:*100 Square Feet of Natural Stone Cladding Declared Unit Composition*

- 95.8 Square Feet of Natural Stone: 2,159.1 kg (4,760.0 lbs)
- 4.2 Square Feet of Mortar: 45.4 kg (100.1 lbs)
- Masonry Connectors: 5.7 kg (12.6 lbs)

Manufacturing:

Natural stone is first quarried at the Hope Bay facilities. A portion of the stone slabs are finished into a split face cladding product. A portion of the stone slabs are also shipped via truck to Arriscraft's Cambridge facility where they are similarly finished into cladding. The result of the quarrying and finishing processes is a durable stone cladding product.

Environment and Health Considerations during Manufacturing:

Under the Ministry of the Environment and Climate Change for Ontario we have an Environmental Compliance Approval that was applied under section 20.2 of Part II.1 of the Environmental Protection Act, R.S.O. 1990, c. E. 19.

Packaging:

Table 2 lists the packaging inputs that are included in the shipment of natural stone cladding to Arriscraft's customers. Some packaging materials (i.e.pallets) may be reused.

Table 2: Packaging Inputs

Input	Amount per ton bricks manufactured	Unit	Amount per 100 square feet installed	Unit
Pallets	10.21	kg	22.04	kg
Stretch Wrap	0.32	kg	0.69	kg
Bags	0.33	kg	0.70	kg
Bubblewrap	0.16	kg	0.34	kg
Styrofoam	0.38	kg	0.82	kg

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Product Installation:

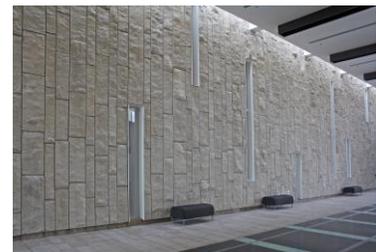
The installation of the product includes the application of mortar and masonry connectors by a skilled tradesperson. The materials used in the installation (mortar and masonry connectors) have been included in A1. Some mortar waste is generated during installation.

Environment and Health Considerations During Use:

The natural stone product is comprised of inert materials and poses no significant environmental or health considerations during the use phase.

Recycling, Energy Recovery, and Disposal:

At the end of the product's service life, it may be removed and re-installed or crushed and disposed in a manner similar to any other inert high-mass material (i.e. inert material landfill and/or used as fill material). No energy recovery possibilities exist.



Life Cycle Assessment

Declared Unit:

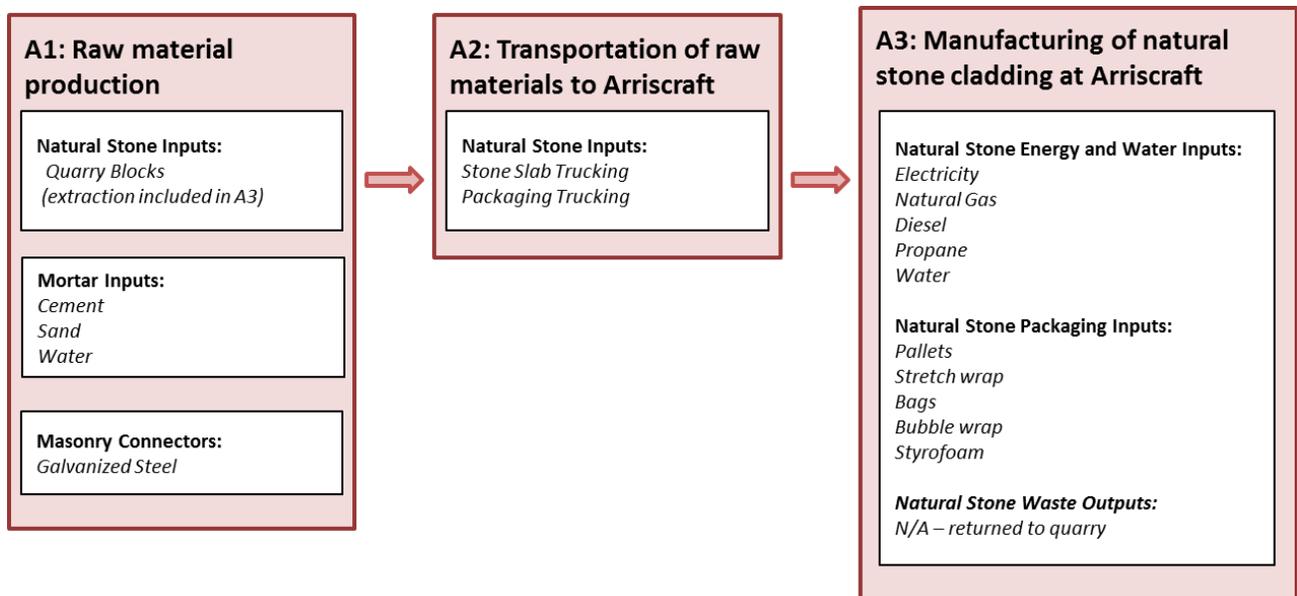
The declared unit is 100 Square Feet of Natural Stone Cladding – as Manufactured at Arriscraft’s Hope Bay and Cambridge Ontario facilities.

System Boundary:

The system boundary for this study is limited to a cradle-to-gate focus. The following three life cycle stages as per the governing PCR are included in the study scope (see Figure1):

- A1- Raw material supply (upstream processes): extraction, handling, and processing of the natural stone as well as the intermediate component products and fuels used in the production of the cladding product.
- A2- Transportation: transportation of all input materials and fuels from the supplier to the gate of the manufacturing facility.
- A3- Manufacturing (core process): the energy used to store, move, and finish the natural stone product. Also includes the operations of the manufacturing facility as well as the transportation and processing of wastes from these core processes.

Figure 1: Cradle-to-gate product system for natural stone cladding



Estimates and Assumptions:

All significant foreground data was gathered from the manufacturer based on measured values (i.e. without estimation). The weighted average product profile is assumed to be representative of the various dimensions and finish options offered by Arriscraft for their natural stone product offerings.

Allocation:

As prescribed by the UL PCR, the applied allocation procedures conform with ISO14044 clause 4.3.4. For Hope Bay Quarry, the inventory associated with the quarry stone coproduct could not be separated from the finished stone and thus the conservative assumption was made to ignore the coproducts and avoid allocation by assigning the entire inventory to the finished stone product. At the Cambridge ON facility, all the processing required (handling, curing, etc) for the various products was allocated on a mass basis to reflect the nature of the inventory flows relative to the product outputs.

Cut-off Criteria:

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO14044:2006 and section 3.3 of the governing PCR. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty are included;
- The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle flow inventory.

Background Data

All upstream material, resource and energy carrier inputs have been sourced from various industry-average datasets and literature. Care was taken to fill known data gaps as recorded in the US LCI database profiles.

Tables 3 through 5 describe each LCI data source for raw materials (A1), transportation by mode (A2) and the core manufacture process (A3). Tables 2 through 4 also include a data quality assessment for all secondary data on the basis of the technological, temporal, and geographical representativeness as per Section 2.1.7 of the UL PCR.

Table 3: A1 – Raw Material Supply

Materials	LCI Data Source
Natural Stone Inputs	
Quarry Blocks	Primary data gathered from Hope Bay Quarry and included in A3
Mortar Inputs	
Cement	Cement Association of Canada EPD of General Use Cement
Sand	ecoinvent process: "Gravel, round, at mine", ecoinvent 2.02 Modified with Ontario electricity
Masonry Connector Inputs	
Galvanized Steel	World Steel Association Data for hot dipped galvanized steel

Table 4: A2 - Transportation

Process	LCI Data Source
Rail, ocean freighter and barge*	USLCI - rail transport, diesel powered; ocean freighter, average fuel mix; barge, average fuel mix
Road	USLCI 2014 – single unit truck transport, diesel powered, short haul US avg.;

Table 5: A3 - Manufacturing

Process	LCI Data Source
Electricity	Arriscraft purchased electricity grid mix- Electricity, medium voltage, at grid, ON (ecoinvent v3.01)
Natural Gas	USLCI - Natural gas, combusted in industrial boiler/US
Diesel	USLCI - Diesel, combusted in industrial equipment/US
Non-Hazardous Solid Waste	N/A

Data Quality

Data quality requirements, as specified in the UL PCR: 2013, section 2.1.7, are applied. This LCA and resulting EPD was created using industry average data for upstream materials. Data variation can result from differences in supplier locations, manufacturing processes, efficiency and fuel types used. All LCI data (Tables 3 through 5) were assessed on the basis of the three data quality indicators listed below. Each indicator is interpreted with respect to its context and key determining data parameters.

Technical representativeness: *The degree to which the data reflects the actual technology(ies) used.* Core manufacturing process technology is derived from very recent annual data covering the specific plants at which the products are manufactured. Background data are deemed to be reflective of typical or average technologies used. Some background material and process data are European but deemed to be similar to technologies used in the US and Canada. *Overall quality: Good to very good*

Temporal representativeness: *The degree to which the data reflects the actual time (e.g. year) or age of the activity.* Core manufacturing process data is very recent (2015). All significant LCI data sources, those that exercise a large influence over the calculated results, are generally less than 10 years old. *Overall quality - Fair to very good*

Geographical representativeness: *The degree to which the data reflects the actual geographic location of the activity (e.g. country or site).* Geographical coverage of core manufacturing processes is specific to the Arriscraft facilities in Ontario. All energy profiles reflect Ontario-specific conditions for foreground processes, and North American averages for other inputs. Some material (aggregates and admixtures) and process data are based on European sources. *Overall quality - Fair to very good*

Life Cycle Impact Assessment

Life cycle impact assessment (LCIA) is the phase in which the set of results of the inventory analysis – the inventory flow table – is further processed and interpreted in terms of environmental impacts and resource use inventory metrics. As specified in the UL PCR, Table 3, the IPCC AR5 and the US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), version 2.1, 2013 impact categories were used. Table 6 below summarizes the LCA results for the cradle-to-gate (A1-A3) product system of natural stone cladding.

Table 6: LCA Results

Description of the System Boundary

(x : included in LCA; mnd: module not declared)

Product			Construction Installation		Use							End-of-life				Benefits of Loads Beyond the System Boundary		
Raw Material supply	Transport	Manufacturing	Transport	Construction/Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition	Transport	Waste processing	Disposal	Reuse	Recovery	Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	D	D
x	x	x	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd	mnd

Impact Assessment Results: A1-A3 100 Square Feet of Natural Stone Cladding

Environmental Indicator	Unit	A1-A3 Total
Global Warming Potential (climate change)	kg CO2 eq	4.4E+02
Ozone Depletion Potential	kg CFC-11 eq	8.9E-06
Acidification Potential	kg SO2 eq	4.5E+00
Eutrophication Potential	kg N eq	3.0E-01
Photochemical Ozone Creation/Smog Potential	kg O3 eq	1.0E+02
Total use of non-renewable primary energy	MJ	9.4E+03

Comparability of EPDs:

Full conformance with the PCR for North American Cladding Product Systems allows EPD comparability only when all stages of a Cladding Product System's life cycle have been considered. However, variations and deviations are possible.

Environmental declarations from different programs may not be comparable. Comparison of the environmental performance of **CLADDING PRODUCT SYSTEMS** using EPD information shall be based on the product's use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building energy use phase as instructed under this PCR.

Interpretation

Table 7 provides a contribution analysis of the impact assessment results by information module. Table 8 shows the breakdown of the impacts caused by A3, which was identified as the most significant cradle-to-gate module.

Table 7: Interpretation (A1-A3) 100 Square Feet of Natural Stone Cladding

Environmental Indicator	Unit	Total	A1	A2	A3
Global Warming Potential (climate change)	kg CO2 eq	4.4E+02	2.4E+01	5.7E+01	3.6E+02
Ozone Depletion Potential	kg CFC-11 eq	8.9E-06	1.3E-07	2.4E-09	8.7E-06
Acidification Potential	kg SO2 eq	4.5E+00	9.0E-02	6.7E-01	3.8E+00
Eutrophication Potential	kg N eq	3.0E-01	1.0E-02	4.0E-02	2.6E-01
Photochemical Ozone Creation/Smog Potential	kg O3 eq	1.0E+02	1.3E+00	1.7E+01	8.2E+01
Total use of non-renewable primary energy	MJ	9.4E+03	2.4E+02	7.9E+02	8.3E+03

Table 7 shows that the majority of the environmental burdens are generated during the core manufacturing (A3) of the natural stone cladding. The dominance of A3 is accentuated by the fact that the quarrying impacts were not able to be separated from the finishing that occurs at the Hope Bay quarry and thus are included in the A3 results.

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Table 8: Interpretation (A3) 100 Square Feet of Natural Stone Cladding

Environmental Indicator	Unit	Total	Electricity	Diesel	Other
Global Warming Potential (climate change)	kg CO2 eq	3.6E+02	1.9E+02	1.6E+02	1.5E+01
Ozone Depletion Potential	kg CFC-11 eq	8.7E-06	7.2E-06	8.6E-09	1.5E-06
Acidification Potential	kg SO2 eq	3.8E+00	1.5E+00	2.2E+00	9.0E-02
Eutrophication Potential	kg N eq	2.6E-01	1.2E-01	1.3E-01	1.0E-02
Photochemical Ozone Creation/Smog Potential	kg O3 eq	8.2E+01	1.1E+01	6.9E+01	1.6E+00
Total use of non-renewable primary energy	MJ	8.3E+03	5.8E+03	2.2E+03	3.1E+02

Table 8 shows that the electricity and diesel inputs drive the impacts in every category. These are the two dominant energy sources used at the Hope Bay quarry and Cambridge facility.

References

1. Athena Institute: 1998 - Life Cycle Analysis of Brick and Mortar Products (1998). Published by the Athena Institute.
2. Athena Institute: 2016 - A Cradle-to-Gate Life Cycle Assessment of Calcium Silicate and Natural Stone Cladding Manufactured by Arriscraft. Background LCA report to this EPD.
3. EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.
4. ISO 21930: 2007 Building construction – Sustainability in building construction – Environmental declaration of building products.
5. ISO 14025: 2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.
6. ISO 14044: 2006 Environmental management - Life cycle assessment - Requirements and guidelines.
7. ISO 14040: 2006 Environmental management - Life cycle assessment - Principles and framework.
8. National Renewable Energy Laboratory 2014. U.S. Life Cycle Inventory Database. <https://www.lcacommons.gov/nrel/search>.
9. Underwriters Laboratory: Product Category Rule (PCR) for Preparing an Environmental Product Declaration (EPD) for Product Group Cladding System Products; Version June 18, 2015.