**NORTH AMERICAN PRODUCT CATEGORY RULES (PCR) FOR
ISO 14025 TYPE III ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)
and/or
GHG PROTOCOL CONFORMANT PRODUCT 'CARBON FOOTPRINT' of**

CONCRETE

Meeting the requirements of one of the following:
ASTM C 94
ASTM C90
CSA A23.1-09/A23.2-09
UNSPSC code 30111500

EPDs created by this PCR are appropriate to be used to evaluate the environmental impact of concrete.

Provided this data is integrated into a comprehensive product LCA, the EPD results can be used to evaluate the **concrete** component of products such as:

Cast in Place Concrete (e.g. CSI/CSC 2004 Master Format 03 3X XX)
Precast Concrete (e.g. CSI/CSC 2004 Master Format 03 4X XX)
Mass Concrete (e.g. CSI/CSC 2004 Master Format 03 70 00)
Concrete Masonry Units (e.g. CSI/CSC 2004 Master Format 04 22 00)

ADOPTED NOVEMBER 30, 2012

This PCR has been reviewed by the World Resources Institute for conformance with the GHG Protocol Product Life Cycle Standard.

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And

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And

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And

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And

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And

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And

World Resource Institute Reviewer: Cynthia Cummis.

PCR DEVELOPMENT AND STAKEHOLDER CONSULTATION

This PCR was initiated in May of 2011 by the Carbon Leadership Forum (CLF) at the University of Washington in response to a request by CLF sponsors. The first draft for stakeholder comments was published on Feb 14, 2012 and was open for a review period of 45 days. Over 200 comments were received and integrated into a revised version. A second version of the PCR was posted for public comment on August 15, 2012 and was open for a review period of 20 days. 370 comments were received and integrated into this revised version. A summary of comments and the CLF responses to all of the received comments has been posted on the CLF website (www.carbonleadershipforum.org). A summary of issues that deserve consideration when developing the next iteration of this PCR, as well as the ISO reviewer comments not adopted are included at the end of these notes.

PCR HARMONOZATION NOTES

CSI 'GLOBAL' PCR FOR CONCRETE

After the CLF PCR development was underway, the Cement Sustainability Initiative (CSI) and the World Business Council for Sustainable Development (WBCSD) initiated the development of a 'global' PCR for Concrete. The CLF leadership has been in conversation with the CSI research team since late 2011 via email and conference calls. Through these conversations, regional process and government policy differences were confirmed and the need to develop regionally specific PCRs/EPDs was recognized. Specific issues include: the need to develop US specific baseline numbers to ensure comparability of product carbon footprints; the need to clarify options permitted within the CSI PCR and the fact that the CSI PCR has not yet been finalized; and the US market demand for a verified PCR.

The CSI PCR was recorded at the International EPD System and was posted for stakeholder comment in September and October of 2012. As the concrete PCR is developed over future iterations, the CLF will continue to work toward developing a unified global PCR with options for regional variation.

Compared to the current draft CSI/WBCSD PCR dated 30 August, 2012 the following differences are noted:

1. The CLF product category is defined as 'concrete' rather than 'unreinforced concrete'.
2. The CSI PCR provides guidance on reporting construction stage impacts; the CLF committee does not feel the methods are sufficiently developed at this time to include reporting in the EPD.
3. The CSI PCR provides guidance on additional declared units used in unreinforced concrete products. The CLF PCR only identifies cubic meters of concrete as the appropriate declared unit as this PCR does not apply to concrete products.
4. The CSI PCR has more complex requirements for allocation of impacts from supplementary cementitious materials generally considered as waste in the US. The CLF PCR recognizes US EPA designations of waste products. See CLF PCR section 3.7. EU LCA legislation requires other allocation methods not appropriate in US context.
5. The CSI PCR has an explicit treatment of biogenic carbon (sequestered carbon) that differs from the CLF. The CLF requires reporting of all emissions from bio-fuels products without considering carbon uptake through growth. The CLF PCR permits optional reporting of biogenic carbon as an extra inventory item per the WRI/WBCSD's GHG Protocol Product Life Cycle Accounting and Reporting Standard.

6. The CSI PCR has more prescriptive requirements for reporting water use. The CLF PCR recognizes limitations in the current practice of reporting water footprints for upstream materials and has focused on reporting the company-controlled water use in mixing concrete and plant operations.
7. The CSI PCR outlines a comprehensive reporting of impacts and resource use. The CLF PCR provides a stepped approach aimed to encourage adoption of PCR by providing options for both 'climate declarations' and EPDs of increasing comprehensiveness.
8. The CSI PCR permits the reporting of different environmental impact categories and uses different characterization factors. The CLF PCR specifies the use of EPA TRACI methodology.

The CLF PCR requires the following additional items not included in the CSI PCR:

1. The CLF PCR provides additional clarification about how to model transportation impacts.
2. The CLF PCR provides additional clarification on quantification of manufacturing phase (A3 per CEN, 2011 see Fig 2.1): plant operations.
3. The CLF PCR provides additional clarification on assumptions regarding production waste and washing of vehicles.
4. The CLF EPD reports water use in washing vehicles in manufacturing stage (A3 per CEN, 2011 see Fig 2.1). This water use is reported in construction stage (A4/A5 per CEN, 2011 see Fig 2.1) in the CSI EPD.

INTERNATIONAL EPD PCR FOR CEMENT

A PCR for cement exists through International EPD System, PCR 2010:09 Version 1.0 as prepared by CE.Si.S.P. (Centre for the Development of Product Sustainability) in co-operation with AITEC and Buzzi Unicem. Of note, the International EPD PCR for cement includes the following statements:

'All energy consumption is considered for all process phases, both thermal and electrical for all types of use (production and services). All alternative fuels (recycled waste) must be counted.' And:

'*Direct emissions of carbon dioxide resulting from decarbonation and combustion in pyroprocessing phase (clinker production) are recommended to be counted in compliance with "CO2 Emissions Monitoring and Reporting Protocol for Cement Industry", prepared in March 2005 by Working Group Cement of World Business Council for Sustainable Development.'*

EPDs produced in accordance with the International EPD PCR would be considered to be compatible with this PCR with the following additional clarifications:

1. If a manufacturer produces an EPD for multiple facilities, a weighted average based on volume of production shall be used to represent actual conditions and the between-plant variability of the data must be published to match the requirements outlined in the CLF PCR (see section 3.6);
2. Transportation backhaul shall be considered; and
3. Water use calculation methodology shall be documented in the LCA and water use shall be reported as an inventory item.

PCA PCR FOR CEMENT

The Portland Cement Association (PCA) initiated the development of a US PCR for cement in early 2012. Based on our review of the draft cement PCR dated August 17, 2012 EPDs produced to the PCA PCR would be considered to be compatible with this PCR with the following additional clarifications:

1. Clarification of the need for regional specificity and documentation of harmonization efforts with the International EPD system;
2. If a manufacturer or industry produces an EPD based on multiple facilities' data, a weighted average based on volume of production shall be used to represent actual conditions and the between-plant variability of the data must be published to match the requirements outlined in the CLF PCR;
3. Transportation backhaul shall be considered;
4. Decarbonization and pyroprocessing shall be modeled per the World Business Council for Sustainable Development procedures outlined in the International EPD cement PCR; and
5. Water use calculation methodology shall be documented and water use shall be reported as an inventory item.
6. Ensure that the emissions related to extraction and processing of fuels and electrical power generation are included.

KEY OUTSTANDING METHODOLOGICAL ISSUES

A complete list of the stakeholder comments and the CLF committee response to those comments are posted on the CLF website. A summary of key issues that deserve consideration when developing the next iteration of this PCR include:

1. Allocation: The allocation procedures used should be verified with those used in other industries to ensure that consistent accounting of environmental impacts across industry sectors is being achieved.
2. Variability: Better data on the variability of upstream material LCI is required. The default variability data for climate change impacts alone is a rough estimate of variability and should be updated with better data when provided by industry. In future iterations of the PCR variability of all environmental impacts should be included.
3. Reporting of environmental impacts: While ISO requires reporting 'all' environmental impacts in an LCA, there are a variety of interpretations of what methods to use and what data to report in order to capture 'all' impacts. EPDs developed in conformance with this PCR shall report, at a minimum, the cradle-to-gate impacts outlined in section 3.2. Future iterations of the PCR should carefully review new and emerging methods to characterize environmental impacts and explore methods to report a more comprehensive suite of environmental impacts. Tracking and reporting of additional inventory items such as full supply chain water footprint and/or mercury emissions should be considered when developing the next version of the PCR.
4. Harmonization: The next iteration of this PCR should endeavor to be unified with the WBCSD Concrete PCR and harmonized with PCRs for the upstream materials and emerging building industry standards.
5. Limitations of LCA/EPDs: This PCR requires reporting the inventory's limitations as part of the official EPD to help inform users of the limitations of LCAs and EPDs. The scope of and need for these statements should be reviewed.
6. Concrete products: This PCR is only for the **concrete material** used in concrete products. PCRs should be developed to build upon this component to enable use by a broader spectrum of concrete products.

7. Reporting of chemicals of concern: The alignment with developing efforts to report material contents through listing of chemicals of concern or 'health product declarations' should be considered.
8. Guidance for construction phase impacts: Guidance for reporting construction phase impacts should be developed for the different concrete products.

COMMENTS FROM ISO REVIEW NOT INCORPORATED INTO THIS PCR

1. Material Safety Data Sheets: One reviewer recommended including the reporting of the material safety data sheets if there is a chance that this EPD will be used for business-to-consumer uses. The stated use of the EPD is business-to-business and other mechanisms for distributing the material safety data sheet exist.
2. Functional Unit: Some reviewers requested that we state the functional unit rather than the declared unit. A note to clarify why a functional unit is not appropriate was added to the PCR.
3. Transportation Backhaul: A reviewer asked to review the significance of requiring the inclusion of transportation backhaul. This is beyond the scope of the current project and appropriate for future study.
4. The calculation procedures and concrete specific data quality requirements should be specified in more detail. Will be reviewed after PCR implemented and more specific recommendations added for the next iteration of the PCR.
5. One reviewer suggested to provide a summary of all PCR requirement language in an appendix (all shall statements) so users can ensure as a final check they have met all the requirements prior to submitting the project report to verification. While we believe this is a good idea, we do not have the resources at this time to complete this effort. We recommend developing these as guidelines for use by the EPD program operators who are issuing EPDs.

CONTENTS

APPENDIX

1. Introduction

This product category rule (PCR) covers the product 'concrete' and enables the quantification and reporting of the environmental impacts associated with the production of that product from cradle-to-gate.

This PCR was developed specifically for use in North America. Care should be used if adapting for use in other regions, as policies regarding energy use and waste allocation are not globally consistent.

This PCR can be used to model the environmental impacts of the **concrete** component of products that use concrete including, but not limited to, cast in place concrete, precast concrete, concrete masonry units and concrete pavements, provided that the life cycle impacts of all additional materials and processes are accounted for and the information is integrated into a comprehensive LCA.

This PCR provides reporting criteria for developing an EPD in varying levels of detail:

Product 'Carbon Footprint'/GHG Inventory

Additional guidelines to be provided by EPD Program Operator

ISO Compliant Type III EPD

Report a comprehensive spectrum of environmental impacts in compliance with ISO 14025 (ISO, 2006a) and the CEN 15804 'Core Rules for the product category of construction products' (CEN 2011). This PCR outlines both mandatory and optional impact categories that may be included.

A general summary of the materials and processes covered by this PCR is summarized in Figure 1.0. Additional detailed information regarding the system boundary and processes to include is found in sections 3 and 4 of this PCR. A cradle-to-gate system boundary is appropriate as concrete mixtures are supplied to a variety of different products and the function of the final product is not determined.

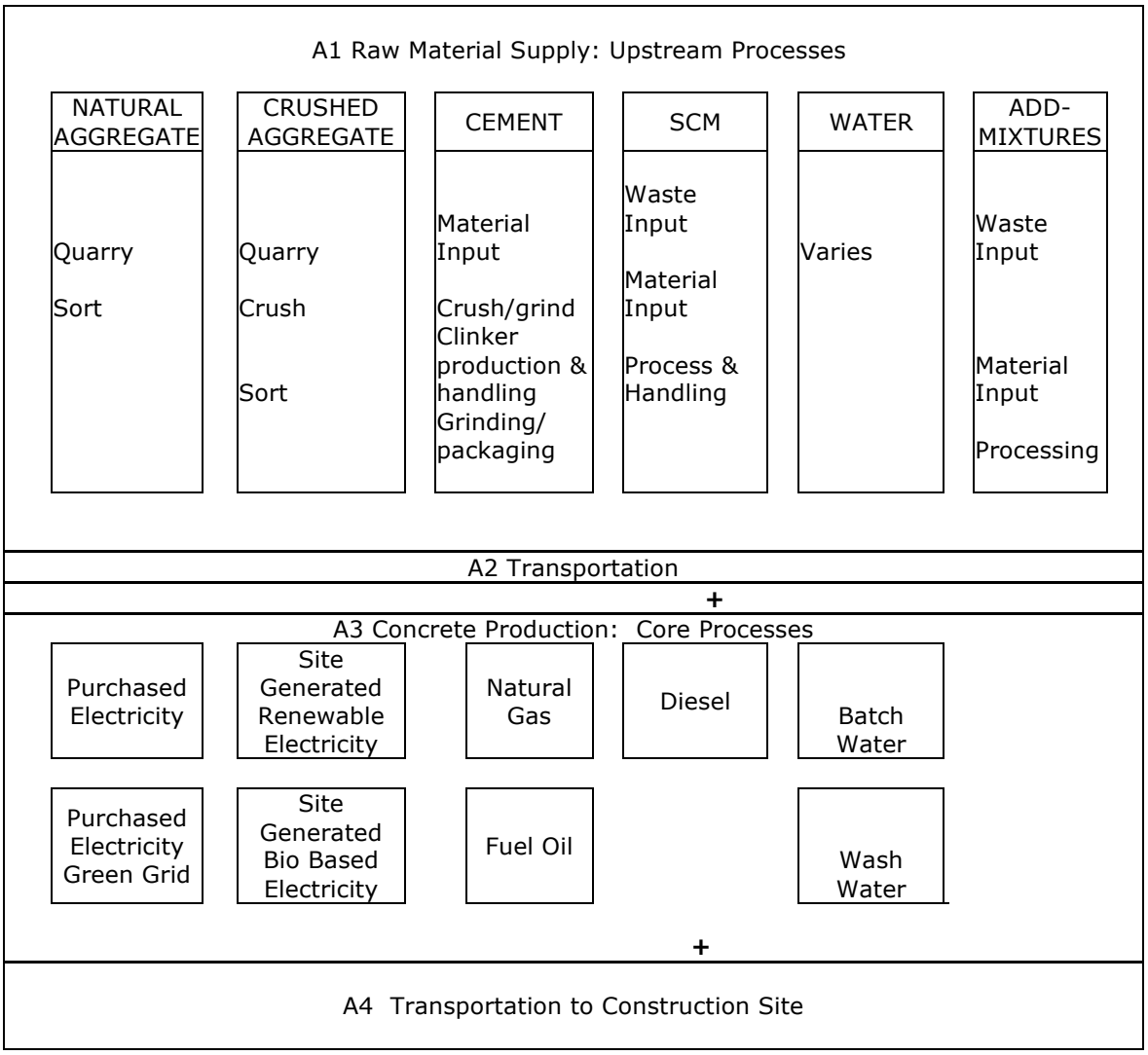

Fig. 1.0: Diagram of key processes within system boundary. See section 4 for more detail

1.1. Goal

The goal of this PCR (defined as 'business goals' by WRI/WBCSD) is to encourage concrete producers to quantify, report, better understand and reduce the environmental impacts of concrete production and to enable the creation of mixture-specific EPDs. The rules are designed to provide meaningful and applicable standards that enable concrete producers and specifiers to:

A. Quantify the environmental impacts of specific concrete mixture designs;
B. Encourage the reporting of supply chain-specific EPDs for upstream constituent materials;
C. Enable concrete producers to track and reduce the environmental impact of their operations and products;
D. Enable environmental impacts to be used as additional performance metrics for concrete.

1.2. PCR Development

This PCR was developed over the period of May 2011 through October 2012 with a committee identified in Appendix A. This PCR was published for stakeholder review and comment in February 2012 for a 45-day period and subsequently revised in July of 2012. The updated PCR draft was published August 15, 2012 for a 20-day period. Stakeholder comments were reviewed and either incorporated into this document or responded to individually.

See description of harmonization process and status on the first page of this PCR.

1.3. Period of Validity

This PCR is valid for 5 years from its initial adoption and may be updated earlier if new standards, data, processes, materials or analysis methods are developed. See details included in the Carbon Leadership Forum's program operator rules: www.carbonleadershipforum.org.

1.4. Background LCI/PCR

The PCR development was based on the LCI of concrete prepared for the Portland Cement Association by CTLGroup (Marceau, 2007) along with other published LCI reports (CSI, 2006, Marceau, 2010, Flower & Sanjayan, 2007).

This PCR expands upon an out of date PCR for Concrete developed through the (Swedish-based) International EPD program: PCR 2005:7. In addition to providing more detail than the existing PCR, this document modifies/clarifies the following conditions:

A. Terminology is consistent with North American practices, standards and specifications;
B. Allocation rules for waste materials and waste- and bio-based fuels are clarified;
C. Acceptable data sources and methodology are clarified;
D. Impact assessment methodology is clarified and expanded;
E. Conforms with the European Standard *CEN 15804 Product Category Rules: Core rules for product category of construction product* (CEN, 2011a); and
F. Provides clarification on how to report known variability.

1.5. Definitions & Abbreviations

allocation:	Partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems (ISO 14044). Note that there are different allocation methods described within ISO standards.
ancillary input:	Material input that is used by the unit process producing the product, but does not constitute part of the product (ISO 14044).
average data:	Data averaged across a number of product, material or process data points. Should be weighted by percent of production of a product, material or process when data represents products that are provided by more than one supplier or that represents a range of products provided by one supplier.

carbon footprint:	Shorthand for a measure of the climate change impact (global warming potential) reporting the greenhouse gas (GHG) emissions as carbon dioxide equivalents (CO_2e) using established global warming potential (GWP) characterization factors.
characterization factor:	Factor derived from a characterization model which is applied to convert an assigned life cycle inventory analysis result to the common unit of the category indicator. NOTE: The common unit allows calculation of the category indicator result (ISO 14044).
comparative assertion:	Environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function (ISO 14044).
cradle-to-gate :	The partial life cycle assessment of a product from extraction of resources, "cradle", to the "gate" (see below). Transportation to end user, use and end of life impacts are not considered.
declared unit:	Quantity of a building product for use as a reference unit in an environmental product declaration (EPD) based on life cycle assessment (LCA), for the expression of environmental information needed in information modules. NOTE: The declared unit is used where the function and the reference scenario for the whole life cycle, on the building level, cannot be stated (ISO 21930). A declared unit does not necessarily represent all performance criteria of a material or product nor does the EPD based on a declared unit represent impacts from all life cycle phases.
environmental product declaration:	Claim which indicates the environmental aspects of a product or service. NOTE: An environmental label or declaration may take the form of a statement, symbol or graphic on a product or package label, in product literature, in technical bulletins, in advertising or in publicity, amongst other things (ISO 14020).
gate:	Point at which the building product or material leaves the factory before it becomes an input into another manufacturing process or before it goes to the distributor, a factory or building construction site (ISO 21930).
impact category:	Class representing environmental issues of concern to which life cycle inventory analysis results may be assigned (ISO 14040).
information module:	Compilation of data to be used as a basis for a type III environmental declaration, covering a unit process or combination of unit processes that are part of the life cycle of a product (ISO 21930).

input:	Product, material or energy flow that enters a unit process (ISO 14040).
life-cycle assessment (LCA):	Compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle (ISO 14040).
life cycle impact assessment (LCIA):	Phase of the life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product (ISO 14040).
life cycle inventory (LCI):	Phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle (ISO 14040).
primary data	Data from specific processes in the studied product's life cycle. (per GHG Protocol)
product category:	Group of products that can fulfill equivalent functions.(ISO 14025).
product category rules (PCRs):	Set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories (ISO 14025).
program operator:	Body or bodies that conduct a Type III environmental product declaration program (ISO 14025).
range:	Either the 'highest probable' and 'lowest probable' when determined data provided by EPD program operator or the 10^{th} and 90^{th} percentile determined using statistical analysis.
renewable energy:	Energy generated from photovoltaic, solar-thermal, geothermal or wind sources. Note that any non-renewable energy used to generate, process, or transport the energy is not included as renewable.
sequestered carbon:	The result of a process in which concrete or concrete products have undergone a carbonation treatment during formation such that carbon dioxide is permanently sequestered into the concrete matrix as solid calcium carbonate. This 'active' sequestering is distinct from 'passive' sequestration of concrete that occurs over time during the natural absorption of $C0_2$ by concrete that occurs over time. Any 'passive' sequestration would occur during the use phase or end-of-life phases, which are not included in this PCR.
system boundary:	Set of criteria specifying which unit processes are part of a product system (ISO 14040).
third party:	Person or body that is recognized as being independent of the parties involved, as concerns the issues in question. NOTE: "Parties involved" are usually supplier ("first party") and purchaser ("second party") interests (ISO 14025).

type III environmental declaration:	Environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information. NOTE 1: The predetermined parameters are based on the ISO 14040 series of standards, which is made up of ISO 14040 and ISO 14044. NOTE 2: The additional environmental information may be quantitative or qualitative (ISO 14025).
uncertainty	Uncertainty is a measure of the quality of LCA data. Uncertainty should be evaluated as a part of the LCA prepared to create an EPD based on this PCR.
upstream processes:	In this PCR upstream processes applies to the sourcing and production of materials used in formulating concrete that are typically (although not always) outside the direct control of the facility that batches the concrete.
variability:	In this document variability refers to fluctuations in data due to process and material differences such as different manufacturing plants, crushed vs. natural aggregate or different transportation distances (see section 3.6).

Abbreviations

CEN	European Committee for Standardization
CLF	Carbon Leadership Forum
CML	Institute of Environmental Sciences at Leiden University
CSI	Cement Sustainability Initiative
eq	Equivalent
EPA	Environmental Protection Agency (US)
EPD	Environmental Product Declaration
GGBFS	Ground Granulated Blast Furnace Slag
GWP	Global Warming Potential
ISO	International Standards Organization
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
NREL	National Renewable Energy Laboratory (US)
PCA	Portland Cement Association
PCR	Product Category Rule
SCM	Supplementary Cementious Material
UNSPSC	United Nations Standard Products and Services Code

WBCSD World Business Council for Sustainable Development

WRI World Resource Institute

1.6. Relevant Standards

ISO 14025:2006(E): Environmental labels and declarations – Type III environmental declarations – Principles and procedures.

ISO 14040:2006(E): Environmental management – Life cycle assessment – Principles and framework.

ISO 14044:2006(E): Environmental management –Life cycle assessment – Requirements and guidelines

ISO 21930: 2007(E): Sustainability in building construction – Environmental declaration of building products.

CEN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products

Greenhouse Gas Protocol Product Life Cycle Accounting and Reporting Standard (2011): Published by the World Resource Institute and the World Business Council for Sustainable Development

1.7. Ownership/responsibility/liability of EPD

The concrete producer or a group of concrete producers who develop an EPD following this PCR maintain sole ownership and have responsibility and liability for their EPD.

1.8. Conversion Factors

Provide both US and metric units using the following conversion factors.

Convert from:	**Convert to:**	**Multiply by:**
Cubic yard (yd^3)	Cubic meter (m^3)	7.654 549 E-01
Square Foot (ft^2)	Square meter (m^2)	9.290 304 E-02
Foot (ft)	Meter (m)	3.048 E-01
British Thermal Unit (BTU)	Mega Joule (MJ)	1.055 056 E-03
Pound (lb)	Kilogram (kg)	4.535 924 E-01

Source: NIST: http://physics.nist.gov/Pubs/SP811/appenB9.html

2. Definition of the Product

This PCR defines the rules for the product 'concrete.' EPDs created with this PCR can be used to compare mixtures used in the same product, that is, those with the same function and application.

As adapted from the definition by Mather and Ozyildriim: Concrete is a composite materials that consists of a binding medium (cement paste, hydraulic cement and water, and possibly one or more admixtures) embedded with fine aggregate (typically sand) and coarse aggregate (typically gravel) to form a hard solid mass. While the most widely used hydraulic cement is Portland cement, other hydraulic cements include blended cements and ground granulated blast furnace slag (GGBFS). Pozzolans, both natural and artificial (e.g. fly ash and silica fume) are often used as a cementitious ingredient of concrete.

See section 2.3 for more information regarding comparability.

2.1. Product Description & Declared Unit

See the section 1 for the general description of 'concrete'

The declared unit shall be defined as 1 m^3 of concrete. Outputs shall be presented in SI units. They may additionally be presented per cubic yard of concrete.

> ***NOTE:*** *The declared unit is used to characterize a reference flow of material quantity instead of a 'functional unit' as this PCR does not address the use or end of life phase for concrete. Users of EPD data can integrate the performance-based conditions of concrete application into their own LCA for a defined functional unit analysis of the full life cycle of buildings, roadways or other structures. Concrete is considered an 'intermediate product' since it cannot serve a specific function without further processing.*

The EPD shall include the following description of the product:

A. Specified compressive strength at specified age in days. Examples: 20MPa (3,000psi) at 28 days 30MPa (4,000psi) at 90days, or between 20MPa (3,000psi) and 30MPa (4,000psi) at 28 days. Note that compressive strength can be presented in either SI or US units or both as appropriate for the application.

Additionally, the EPD may include other specified characteristics such as:

A. Specified environmental exposure class (per ACI 318 or other specified or accepted standard), Example: Exposure Class F1, S0, P0, C1 or F0-F3, S0, P0-P1, C0-C2;

B. Design slump or slump flow. Example: 4-6 in (10-15 cm); and

C. Any other specified characteristic that affects concrete performance (e.g. air entrainment, unit weight, high early strength requirements, etc).

Alternately one can provide ranges of product descriptions such as: compressive strength between 4,000 and 5,000psi; multiple exposure classes; a range of slump or slump flow values; and a range of additional characteristics for EPDs that represent a range of concrete mixture designs.

2.2. Life Cycle Stages: Modularity

This PCR is developed to capture the product stages A1-A3 (cradle-to-gate) and optionally plus integrated with A4 (gate-to-construction site) as defined in EN15804 (CEN, 2011a) (see FIG. 2.1 below) and does not address the use or end of life stages of concrete and thus provides information appropriate for use as a module in preparing a full cradle-to-grave life cycle assessment. Concrete is considered an intermediate product as defined by the GHG Protocol Product Standard and thus a cradle-to-gate inventory shall be completed.

EPDs based on this PCR are appropriate for use in business-to-business applications. Impacts from construction related activities such as formwork, curing or reinforcement are not captured within this PCR.

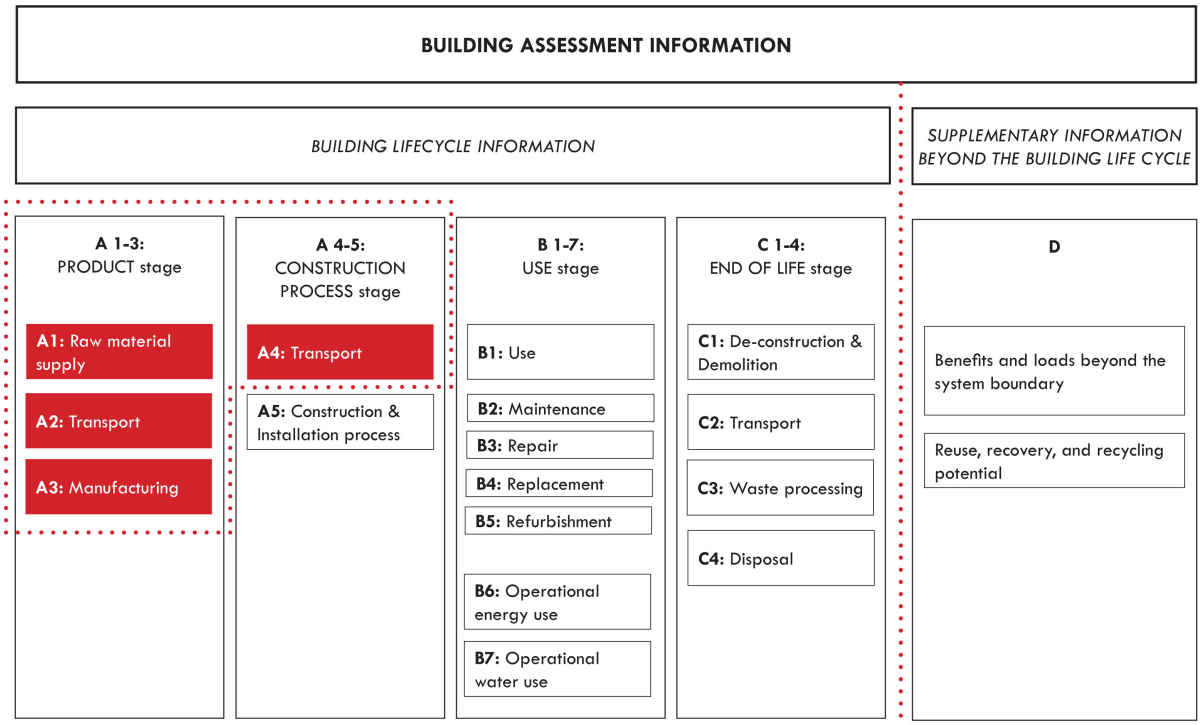

Fig. 2.1 Diagram of designations of modular information used for different stages of building assessment. Adapted from Figure 6 of CEN 15978:2011

Data from stages A1, A2 & A3 may be declared as one aggregated module, A1-3, or separated into three separate modules.

2.3. Use and Comparability

Application of this PCR can enable the comparison of the environmental impacts of different concrete mixture designs used in similar applications. In order for the resulting data to be used to compare between manufacturers and/or to achieve product labeling or rating, the EPDs must be developed in accordance with this PCR.

As EPDs covered by this PCR only cover the cradle-to-gate impacts of concrete, the results cannot be used to compare construction products nor can the results be used to compare between mixtures used

in different construction products. Given that different products (most notably precast and concrete masonry units) include manufacturing processes and impacts from forming and curing attributed to different life cycle phases of ready mixed concrete, the results from this EPD must be integrated into a comprehensive LCA in order to compare between different products.

EPD data created based on this PCR may be able to assist in comparisons as the EPD provides comparable data for the concrete that can be used as input for a more comprehensive LCA. Comparisons between different products should not be performed using EPDs created with this PCR. For example, comparing a cubic meter of ready mixed concrete to a cubic meter of precast concrete cannot be done since this PCR does not address the differences in processes, transportation, construction and use. For example, electrical use at precast and CMU plants will likely include the energy related to placing and curing of the concrete-impacts not included in a ready-mixed concrete EPD. Similarly a cubic meter of concrete cannot be compared to a cubic meter of steel, as the function and application of each product are not the same.

Note: Direct cradle-to-gate system comparison of precast products with cast-in-place concrete would not be relevant using data generated based on this PCR unless this data was combined with LCA data to include all construction related impacts noted above.

3. Life Cycle Inventory

The scope included in EPDs developed in accordance with this PCR shall conform to the following system boundary assumptions and identify impacts and report data quality and variability as noted.

3.1. System Boundaries (core and upstream processes)

The PCR system boundaries follow the two principles below (as outlined in section 6.3.4.1 of CEN 15804:2011):

A. The "modularity principle": Where processes influence the product's environmental performance during its life cycle, they shall be assigned to the module of the life cycle where they occur; all environmental aspects and impacts are declared in the life cycle stage where they occur.

B. The "polluter pays principle": The process of waste processing shall be assigned to the product system that generates the waste until the end-of-waste state is reached.

A diagram of the system boundary is provided in Figure 2.2 below. The system boundary with nature is set to include those processes that provide the material and energy inputs into the system and the following manufacturing, and transport processes up to the factory gate as well as the emissions to air, soil and water and the processing of any waste arising from those processes. The time period over which inputs to and outputs from the system shall be accounted for is 100 years from the year for which the data set is deemed representative (most relevant for evaluating impacts from landfilled waste, not a critical issue for this PCR). All attributional processes accorded to the GHG Protocol Product Standard shall be included.

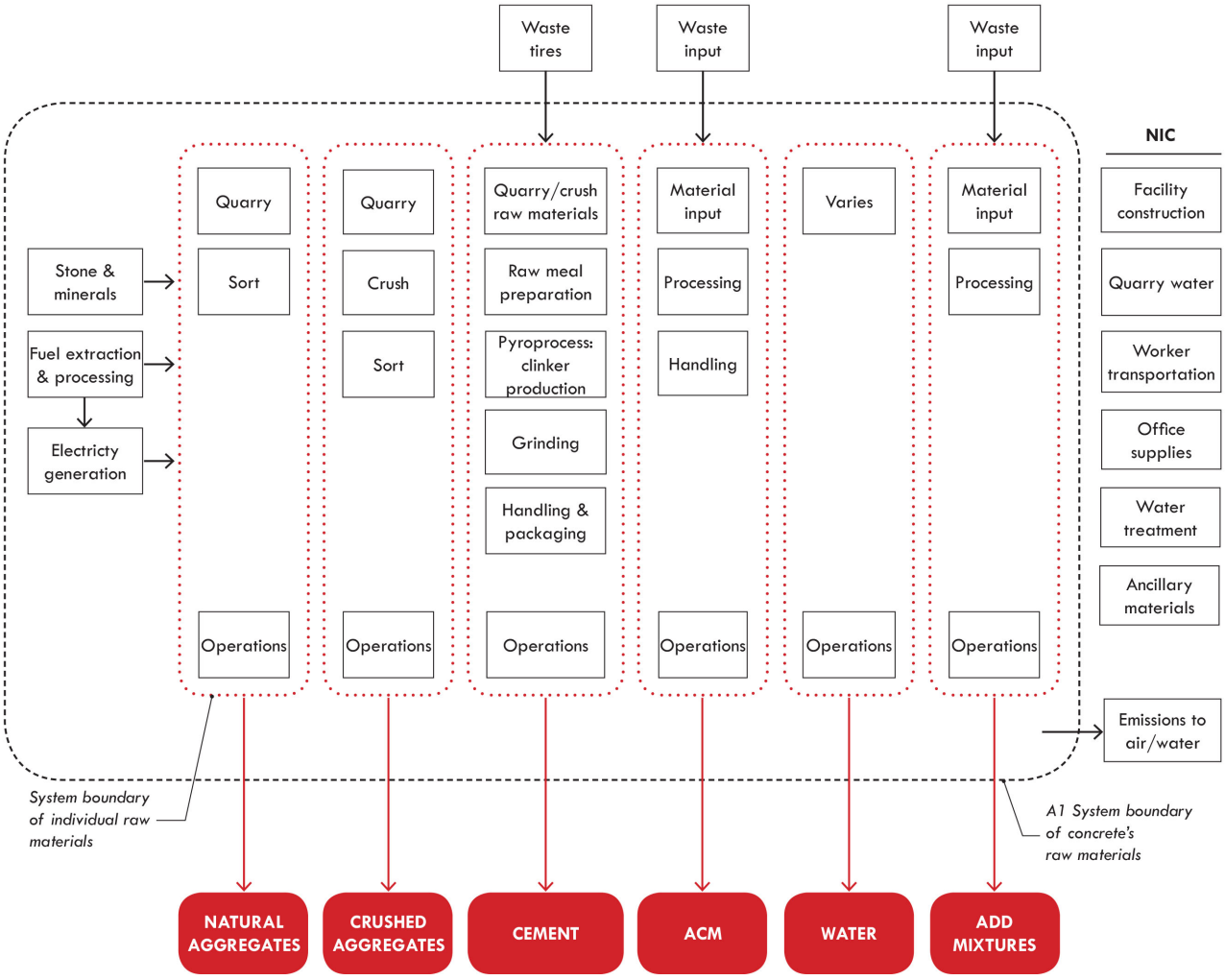

Figure 2.2: Diagram of the system boundary for concrete used in this PCR

3.1.1. System Boundaries General Requirements

The following items shall be included in EPDs developed from this PCR are as follows:

A1 Raw Material Supply (upstream processes): Extraction, handling and processing of the materials (including fuels) used in the production of concrete.

A2 Transportation: Transportation of these materials from the supplier to the 'gate' of the concrete producer.

A3 Manufacturing (core processes): The core processes result from the energy used to store, move, batch and mix the concrete and operate the facility (concrete plant).

A4 Construction Transportation (optional): Transport of the concrete from the producer's 'gate' to the construction site.

Excluded from System Boundary: A summary of items that may be excluded in the primary product stages include:

A. Production, manufacture and construction of buildings' capital goods and infrastructure with an expected lifespan of over 5 years.

B. Production and manufacture of concrete production equipment, concrete delivery vehicles, earthmoving equipment, and laboratory equipment with expected lifespan of over 5 years.

C. Personnel-related activities (travel, furniture, office supplies).

D. Energy and water use related to company management and sales activities ('corporate overhead' per GHG Protocol Product Standard) which may be located either within the factory site or at another location.

3.1.2. Product Stage A1: Raw Material Supply (upstream processes)

The following items shall be included in the system boundaries of the A1 life cycle phase:

A. Extraction and processing of fuels and raw materials (e.g. mining processes);

B. Production and manufacture of additives and other materials used in the production of the materials used in concrete;

C. Processing of any waste or recovered or recycled materials as required for use as secondary materials (e.g. re-processing, handling and sorting such as drying, grinding and transport of ground granulated blast furnace slag (GGBFS) or crushing and sorting of recycled aggregate);

D. Generation of any electricity, steam or heat used in the product manufacturing processes;

E. Energy recovery from secondary and/or waste fuels that are used as input for manufacturing, not including the impacts related to the creation of the previous product or waste prior to the product being declared a waste (see section 3.7A).

F. Waste disposal directly related to the manufacturing process; and

G. Any transportation required from the upstream supply chain.

In addition to items outlined above, the following criteria shall apply to the typical upstream processes of material production of concrete:

Material	Description	Notes
Aggregate	Density, size, ASTM specification (C33 normal weight or C330 light weight), site location, type (natural or crushed)	• Facility/factory annual emissions shall be allocated by mass to product class. • Include impacts from consumable equipment used in production. • Recycled aggregate must include impacts related to transportation and processing after primary demolition of source aggregate is completed.
Cement	ASTM C 150	• Identify and use data for actual plant production type

	ASTM C595 ASTM C1157	(wet, dry etc.) • Include emissions from calcination
Fly Ash	ASTM C618	• See section 3.7 • Any process energy/impacts required to make appropriate for use as SCM. • Include transport from waste site • Include drying energy.
Ground Granulated Blast Furnace Slag (GGBFS)	ASTM C989	• See section 3.7 • Include transport from waste site. • Include grinding and drying energy. • Any other process energy/impacts required to transform to SCM.
Silica Fume	ASTM C 1240	• See section 3.7 • Include transport from waste site. • Include drying energy. • Any other process energy/impacts required transform to SCM.
Other SCM		• Describe status of source material per section 3.7. • If non-waste source include all upstream energy and material flows. • Any process energy/impacts required to make appropriate for use as SCM. • Explain rational in report to EPD verifier.
Water	ASTM C 1602	• See guidance provided by program operator. • Better water footprint data needed for all upstream material processes
Admixtures	ASTM C494	• See notes regarding cut-off criteria in section 3.3. • EU LCI data published on chemical admixtures
Other Materials		• Document methodology in LCA report and publically posted for users of the EPD.

3.1.3. Product Stage A2: Transportation

The following items shall be included in the system boundaries of the A2 transportation life cycle phase:

A. The actual distance and mode traveled by the raw materials to the manufacturing site where the concrete is batched and emission factors for transportation.

B. The transportation of all materials from origin of extraction or upstream production to manufacturing site.

C. The transportation to interim distribution centers. If multiple suppliers are used, a weighted average based on volume or mass can be used.

D. The backhaul of trucks assuming empty return unless documented otherwise.

3.1.4. Product Stage A3: Manufacturing (core processes)

The following items shall be included in the system boundaries of the A3 life cycle phase:

A. Plant operating energy consumption:

B. Report impacts per average cubic meter produced on an annual basis. This includes energy throughout the production process, heating and lighting for manufacturing facility and management office support.

C. Fuel Consumption: Include fuel used for on-site transportation, operation of equipment and heating/cooling. Report impacts per cubic meter from total fuel purchased averaged over a 12 month period divided by the production volume for the same year.

D. Factor to account for material losses and overproduction.

E. Assume 5% losses or use actual recorded losses (Loss = Volume returned or disposed of divided by total volume produced at plant per year.)

F. Impacts from disposal of wastes and final residues (including packaging) not leaving the factory gate and excess produced concrete not recycled into other uses. Report impacts per average cubic meter on an annual basis.

G. Washing of vehicles and equipment.

3.1.5. Product Stage A4: Transportation to Construction Site (optional)

The following items shall be included in the system boundaries of the A4 life cycle phase:

A. The transportation shall account for the fuel and truck type.

B. The in-use average miles per gallon (liters per kilometer) of gasoline/diesel or kilometers per m^3 (miles per ft^3) for natural gas for trucks shall be used.

C. The total annual distance traveled for each type of truck used at a specific site shall be used.

D. The average impact per cubic meter (cubic yard) shall be estimated by dividing the total impact of transportation fuel used by the total cubic meter (cubic yard) of concrete produced per year.

E. Alternatively, the EPD may declare typical emission factors for each tonne-km (ton-mile) to enable the user to develop product specific data.

F. The impacts from the truck 'backhaul' (return trip of the truck to the plant) shall be included. Use actual fuel usage or assume truck returns 5% of delivered concrete unless documented otherwise.

3.2. Impact categories

The following impact categories, derived from life cycle stages identified in the EPD, shall be separated and reported. Use the characterization factor(s) noted.

Notes:

1. *See Appendix B for detailed information on calculating and reporting GWP to be in conformance with GHG Protocol Product Life Cycle Accounting and Reporting Standard.*
2. *For Product 'Carbon Footprints'/Climate Declarations only the climate change impact of greenhouse gas emissions (CO_2e) shall be reported. The full complement of GHGs included in TRACI shall be included-(more than the minimum 6 Kyoto gases specified by the GHG Protocol).*
3. *Any inventory items or impact categories from the ISO compliant Type III EPD or Optional Additional Information listed below may be included in a 'Carbon Footprint'/ GHG Inventory at the manufacturers discretion.*
4. *Characterization factors from TRACI version 2.1 2012 09 27 (and optionally, additionally CML 2010) shall be used.*
5. *Where methodologies to compute and report impacts are not established, EPDs that report these impacts shall document the methodology used to generate the data and make this methodology publically available.*
6. *If active sequestration of carbon is documented, this shall be reported as a separate negative line item as noted in the Optional Additional Information below and not subtracted from the climate change/'Carbon Footprint' as reported.*
7. *Alternatively eutrophication can be reported as a single inventory 'Eutrophication to Air and Water' equal to a sum of the values for Eutrophication Air and Eutrophication Water, expressed in the same units.*

LIFE CYCLE ASSESSMENT DATA TO BE INCLUDED IN EPD

Product 'Carbon Footprint'/GHG Inventory

Impact Category Indicators		
Climate Change/'Carbon Footprint'	kg CO_2e	TRACI (CML)

ISO Compliant Type III EPD

Life Cycle Inventory Data		
Total primary energy consumption	MJ (BTU)	
Concrete Water Use (batch)	m^3 (gal)	Per EPD program
Concrete Water Use (wash)	m^3 (gal)	operator

Impact Category Indicators		
Climate Change/'Carbon Footprint'	kg CO_2e	TRACI (CML)
Ozone Depletion	kg CFC 11 eq	TRACI (CML)
Acidification Air	kg SO_2 eq	TRACI
Eutrophication Air	kg N eq ($kgPO_4$)	TRACI (CML)
Eutrophication Water	kg N eq	TRACI
Photochemical Ozone Creation/Smog	kg O_3 eq	TRACI

OPTIONAL ADDITIONAL INFORMATION

Inventory Items

Energy from waste recovery	MJ (BTU)	
Total Water Use	m^3 (gal)	Document Methodology
Total waste disposed	kg (lb)	Document Methodology
Total waste recycled	kg (lb)	Document Methodology
Total waste Used	kg (lb)	Document Methodology
Non-renewable energy consumption	MJ (BTU)	Document Methodology
Renewable energy consumption	MJ (BTU)	Document methodology
Bio-mass energy consumption	MJ (BTU)	Document Methodology
Content Declaration/Chemicals of Concern	list	Document Methodology
Hazardous waste disposed	kg (lb)	Document Methodology
Sequestered Carbon	kg CO2e	Document Methodology
Particulate matter emissions	kgPM10eq	

Impact Category Indicators

Ecotoxicity water, chronic kg	kg	TRACI (CML)
Ecotoxicity water, acute	kg	TRACI (CML)
Ecotoxicity soil, chronic	kg	TRACI (CML)
Human Toxicity, air	kg	TRACI (CML)
Human Toxicity, water	kg	TRACI (CML)
Human Toxicity, soil	kg	TRACI (CML)
Depletion of abiotic resources (elements)		CML
Depletion of abiotic resources (fossil)		CML

3.3. Criteria for the exclusion of inputs and outputs

The cut-off criteria for flows to be considered within each system boundary shall conform to CEN 15804:2011section 6.3.5, summarized as follows:

A. All inputs and outputs, for which data are available shall be included in the calculation;

B. Data may be neglected for insignificant inputs and outputs **where data is not available.** A estimated/anticipated values for energy, mass or climate change impact of more than 1% of the total shall be considered as significant. The total of the estimated neglected input flows shall be a maximum of 5% of the energy, mass or climate change impact.

C. Provide documentation in LCA report to confirm all neglected input flows meet the cut off criteria. This should include verification that no relevant data is available, calculations to confirm insignificance, and justification that no similar LCI data is appropriate to be customized as a proxy for this flow.

D. Particular care should be taken for flows known to cause significant impact or data uncertainty-most notably chemical admixtures.

E. The above cut-off rules do not apply to hazardous and toxic materials, all of which shall be included in the inventory.

3.4. Selection of Data

Primary data shall be used for processes under the ownership or control of the company completing the inventory.

Data should be selected per CEN 15804:2011, summarized and expanded as follows:

A. An EPD describing an average product shall be calculated using representative average data for all the products declared in the EPD.

B. Data shall use the highest quality and most representative data available. Data sources shall be identified within the LCA and reviewed by the EPD verifier. The concrete producer shall request primary data in the form of a product EPD from all of its suppliers. Only after confirmation that no EPD exists or is not forthcoming, may the default values provided by the EPD operator or other sources of data provided below be used.

C. Choice of data shall be prioritized as follows and data selections justified in the LCA report:

   a. Plant-specific EPD results.

   b. Company-weighted average EPD results.

   c. Regional-weighted average EPD results.

   d. ISO compliant and reviewed LCI for used supplier.

   e. Current industry average data supported by a published ISO compliant LCA.

   f. CO_2e: Use defaults provided by EPD program operator.

   g. Life Cycle Inventory of Portland Cement Concrete, Marceau et al., 2007. This is only applicable to U.S. manufactured concrete and should not be used for imported materials. Shall add emissions related to extraction and processing of fuels and electricity emissions.

h. Life Cycle Inventory of Chemical Admixtures (presented as 'EPD' data although not an ISO-compliant EPD) as presented by the European Federation of Concrete Admixtures Associations http://www.efca.info/publications.html.

i. The following default sources:

Transportation	US Life Cycle Inventory Database (NREL) and US Environmental Protection Agency (EPA 2003)
Electricity Generation	US EPA Emissions & Generation Resource Integrated Database (eGRID) North American Electric Reliability Council (NERC) regions as the source for energy data and grid variation. Shall add emissions related to extraction and processing of fuels.
Electricity Emissions	US LCI Database. Emissions for any energy source without data available in the US LCI database shall be modeled substituting LCI data from alternate LCI databases or with appropriate proxies. Document assumptions in LCA report.
Site Generated Energy	US LCI Database with 'dummies' substituted with appropriate proxies from other LCI databases.

j. US LCI Database (NREL)

k. Other LCI sources (including but not limited to proprietary dataset, published research and economic input output data). Must match technology and energy source mix or be modified to reflect the in use conditions.

3.5. Data Quality

Data collection shall be per ISO 14044. Data collection for upstream constituent materials as well as data for transportation and manufacturing shall follow the guidance provided in ISO 14044:2006, 4.3.2 and CEN 15804:2011. Data shall be as current as possible. Data used in calculations shall have been updated within the last 5 years for industry average data and within the last 3 years for site-specific data;

A. Data sets shall be based on 1 year averaged data; deviations shall be justified;
B. The technology shall reflect the physical reality of the material and/or product;
C. Industry average data shall be checked by the verifier to confirm that the data collected accurately represents the production methods of the industry and region represented by the average; and
D. Data sets shall be complete according to the criteria of inclusion of inputs and outputs of this PCR.

Data shall be assessed on the following five data quality indicators (Per GHG Product Standard):

A. Technical representativeness: (The degree to which the data reflects the actual technology(ies) used.
B. Temporal representativeness: The degree to which the data reflects the actual time (e.g., year) or age of the activity.
C. Geographical representativeness: The degree to which the data reflects the actual geographic location of the activity (e.g., country or site).
D. Completeness: The degree to which the data are statistically representative of the relevant activity. Completeness includes the percentage of locations for which data is available and used

out of the total number that relate to a specific activity. Completeness also addresses seasonal and other normal fluctuations in data.

E. Reliability: The degree to which the sources, data collection methods and verification procedures used to obtain the data are dependable.

3.6. Data Variability

LCAs can contain two main types of data variability:

1. Variability within the underlying LCI data (e.g. variability in actual emissions from coal fired power plants); and
2. Variability known due to process and material differences (e.g. different manufacturing plants, crushed vs. natural aggregate, different transportation distances).

Although both types of variability are important, at this time the methods and data to permit reporting of the LCI data variability and uncertainty are not adequately developed to be reasonably included. However, the known variability can be computed and should be reported. Additional requirements of this PCR include the following:

A. EPD covering more than one product:

In cases where several similar products are produced by a site or company, the PCR offers the possibility for similar products to be grouped as an average product in the same EPD provided that the difference between their environmental impacts is less than 5% for each environmental impact category. In cases where the difference is greater than 5%, it is still possible to include average products in the same EPD (e.g. in separate columns in a table). In case a single value is chosen for each impact category for all products, the value reported should be the worst performance within the range of variation. It is also permissible to show arithmetically weighted 'averaged data' in an EPD as supplementary information if found relevant.

B. 'Sector' EPD/'Industry Wide EPD'

It is possible to create a so-called Sector EPD, which enables the possibility to present average data for a whole industrial branch in a well-defined geographical area. Where a group of manufacturers are declaring performance using a single sector EPD, then a mass weighted average of production should be used to calculate the average for the product or product group. Where the average for the product group is provided, information on the range of variation should be provided such as +XX% or - YY%. .

If industry average data is used for upstream constituent materials, variability of the underlying data should be included. If no published data is available, use default assumptions in data variability provided by the EPD program operator.

3.7. Allocation Assumptions

Allocation shall be made per ISO 14044 (summarized here):

Step1: Wherever possible, allocation should be avoided by

1) dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes, or

2) expanding the product system to include the additional functions related to the co-products

Step 2: Where allocation cannot be avoided, the inputs should be partitioned based on physical relationships.

Step 3: Where physical relationship alone cannot be established or used as the basis for allocation, allocation may be made based on other relationship such as by economic value.

See Appendix D for expanded justification of the source specific allocation recommendations found below which assign only impacts related treatment and transportation of waste inputs.

A. Emissions from incineration of waste fuels (e.g tires) shall be included in the EPD. Emissions from original production prior to end-of-life state may be omitted (allocated to primary use) however transportation of waste from end-of-life state to production facility must be included.

B. Impacts from transportation and transformation of the wastes to useable fuel shall be included.

C. Emissions from the generation of coal power and production of steel or ferro-silica metal production need not be allocated to the waste products used as source materials when producing supplementary cementitious materials (SCMs). All processing and transportation required to transform these waste products to SCMs and to transform any other waste products used in producing concrete must be included.

4. Reporting: Product 'Carbon Footprint'/GHG Inventory

The following items shall be declared in the Product 'Carbon Footprint'

1. The name and address of the manufacturer(s);
2. The description of the construction product's use and the declared unit of the construction product to which the data relates;
3. Construction product identification by name (including UNSPSC product code and CSI Specification Section) and ideally a simple visual representation to which the data relates;
4. Name of the EPD program used and the program operator's name, address and, if relevant, logo and website;
5. The following table shall be completed and reproduced in the Product Carbon Footprint:

The Carbon Leadership Forum PCR: *North America Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) and GHG Protocol Compliant Product 'Carbon Footprint' of Concrete*, Version 1.0 dated 11/30/2012 serves as the PCR for this Product Carbon Footprint www.carbonleadershipforum.org
Independent verification of the declaration, according to ISO 14025:2006 □ internal □ external
Independent Verifier <Name and Organization of the Independent verifier>

6. The date the declaration was issued and the 5 year period of validity;
7. Life Cycle Assessment information including the following statements:

'A summary of life cycle stages included in the EPD is as follows:

1. Raw Material Supply (upstream processes): Extraction, handling and processing of the raw materials used in the production of concrete: cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures and other materials or chemicals used in concrete mixtures.
2. Transportation: Transportation of these materials from the supplier to the 'gate' of the concrete producer.
3. Manufacturing (core processes): The core processes result from the energy used to store, batch, mix and distribute the concrete and operate the facility (concrete plant)
4. Water use in mixing and distributing concrete.

A summary of life cycle stages excluded from the EPD is as follows:

1. Production, manufacture and construction of buildings capital goods and infrastructure with an expected lifespan of over 5 years.
2. Production and manufacture of concrete production equipment, concrete delivery vehicles, earthmoving equipment, and laboratory equipment with an expected lifespan of over 5 years.
3. Personnel-related activities (travel, furniture, office supplies).
4. Energy use related to company management and sales activities.
5. Water use in upstream manufacturing processes and in placement and curing of concrete. Better data and methodology is required to track and report these numbers.

A summary of the limitations of Product 'Carbon Footprint'/GHG Inventory include:

1. A Product 'Carbon Footprint'/GHG Inventory reports only one environmental impact. Per ISO 14025 & 14044 no comparative assertions may be made based on single impact LCA. Of particular note, one cannot use this data to compare between construction products or concrete mixtures used in different concrete products unless the data is integrated into a comprehensive LCA. For example, precast concrete, concrete masonry units and site cast concrete all have different manufacturing processes whose impacts are attributed to different LCA stages. This precludes direct comparison between mixtures used in these different products until all life cycle phases are included.'
2. One of the following statements:
    a. 'This Product 'Carbon Footprint'/GHG Inventory presents a single environmental impact tracked through a comprehensive LCA. The complete LCA results are presented here: (*provide freely accessible link to attain comprehensive LCA data if exists*)'.
    b. 'This Product 'Carbon Footprint' was generated through a single impact LCA study and no additional environmental impacts were tracked or reported at this time.'
3. 'The product manufacturer has the option of declaring additional information about their product including conformance with any other sustainability certification programs, which often have performance and prescriptive requirements that aim to capture environmental best practices that cannot be captured by LCA.
4. Life Cycle Impact Assessment results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.'

8. In the case where a Product 'Carbon Footprint'/GHG Inventory is declared as an average environmental performance for a number of products, a statement to that effect shall be included in the declaration together with a description of the range and variability.

9. A statement regarding data quality and variability: Options include one of the following:.
   A. 'This Product 'Carbon Footprint'/GHG Inventory was created using industry average data for upstream materials. Variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel type used. Climate change impacts could range between $XXCO_2e$ and $YYCO_2e$ per cubic meter. (insert actual range predicted per appendix B)

   B. This Product 'Carbon Footprint'/GHG Inventory was created using plant-specific data for upstream materials. Potential variations due to supplier locations, manufacturing processes and efficiencies and fuel use are thus accounted for in this Product 'Carbon Footprint'/GHG Inventory.

10. In the case where a Product 'Carbon Footprint'/GHG Inventory is declared as an average environmental performance for a number of products, a statement to that effect shall be included in the declaration together with a description of the range/variability of the LCA results;
11. The location(s), manufacturer or group of manufacturers or those representing them for whom the Product 'Carbon Footprint'/GHG Inventory is representative;
12. Other information relating to environmental performance such as third party certifications or labels awarded to the manufacturer or product.

5. Reporting: Content of the EPD

The following general items shall be declared in the EPD (per CEN 15804:2011):

1. The name and address of the manufacturer(s);
2. The description of the construction product's use and the declared unit of the construction product to which the data relates;
3. Construction product identification by name (including UNSPSC product code and CSI Specification Section);
4. Name of the EPD program used and the program operators name and address and, if relevant, logo and website;
5. The following table shall be completed and reproduced in the EPD:

The Carbon Leadership Forum PCR: *North America Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) and GHG Protocol Compliant Product 'Carbon Footprint' of Concrete,* Version 1.0 dated 11/30/2012,serves as the PCR for this EPD. www.carbonleadershipforum.org
Independent verification of the declaration, according to ISO 14025:2006 □ internal □ external
Independent Verifier <Name, Organization and contact information of the Independent verifier>

6. The date the declaration was issued and the 5 year period of validity;

7. Life Cycle Assessment information including the following statements:

'A summary of life cycle stages included in the EPD is as follows:

1. Raw Material Supply (upstream processes): Extraction, handling and processing of the raw materials used in production of concrete: cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures and other materials or chemicals used in concrete mixtures.
2. Transportation: Transportation of these materials from supplier to the 'gate' of the concrete producer.
3. Manufacturing (core processes): The core processes result from the energy used to store, batch, mix and distribute the concrete and operate the facility (concrete plant)
4. Water use in mixing and distributing concrete.

A summary of life cycle stages excluded from the EPD is as follows:

1. Production, manufacture and construction of buildings capital goods and infrastructure with an expected lifespan of over 5 years.
2. Production and manufacture of concrete production equipment, concrete delivery vehicles, earthmoving equipment and laboratory equipment with an expected lifespan of over 5 years.
3. Personnel-related activities (travel, furniture, office supplies).
4. Energy and water use related to company management and sales activities.
5. Water use in upstream manufacturing processes and in placement and curing of concrete. Better data and methodology is required to track and report these numbers.

A summary of the limitations of this EPD include:

1. This EPD does not report all of the environmental impacts due to manufacturing of the product, but rather reports the environmental impacts for those categories with established life cycle assessment based methods to track and report. Unreported environmental impacts include (but are not limited to) factors attributable to human health, land use change, water use in the upstream manufacturing process and habitat destruction.
2. This EPD reports the results of an LCA for 'cradle-to-gate' analysis. Thus, declarations are not comparative assertions, defined as an environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function. An EPD does not make any statements that the product covered by the EPD is better or worse than any other product.
3. In order to assess the local impacts of product manufacturing, additional analysis is required.
4. The product manufacturer has the option of declaring additional information about their product including conformance with any other sustainability certification programs that often have performance and prescriptive requirements that aim to illustrate environmental best practices that cannot be captured by LCA.
5. Life Cycle Impact Assessment results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.'

8. In the case where an EPD is declared as an average environmental performance for a number of products, a statement to that effect shall be included in the declaration together with a description of the range and variability.

9. A statement regarding data quality and variability: Options include one of the following:
   A. This EPD was created using industry average data for upstream materials. Variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel type used. Climate change impacts could range between XXCO2e and YYCO2e per cubic meter. Other environmental impact values will have a different range.

   B. This EPD was created using plant specific data for upstream materials. Potential variations due to supplier locations, manufacturing processes and efficiencies and fuel use are thus accounted for in this EPD.

10. A table outlining the primary sources of data used to compute the upstream material LCI such as:

	Data used for cradle to gate impacts of the primary materials			
Component	CO_2e	LCI	Date	Notes
Portland Cement	Plant specific EPD	Plant specific EPD	TBD	Specific supplier identified and data provided-V. high quality data.
Slag cement	CLF Defaults Version 1.0	LCI Slag Cement Manufacturing	2003	CTL Group report to Slag Cement Association
Fly ash	none	none	N/A	No impacts for manufacturing.
Silica Fume	none	none	N/A	No impacts for manufacturing.
Fine and Coarse Aggregate	CLF Defaults Version 1.0	Gabi Ecoinvent database	2012	Modified per US energy mix
Admixtures	CLF Defaults Version 1.0	EU 'EPD' Data	2006	Modified per US energy mix
Water	NONE	NONE	N/A	Not including impacts of water treatment and transport

11. A statement that: 'EPDs of concrete mixtures may not be comparable if they do not comply with this standard and data from this EPD. While EPDs can be used to compare concrete mixtures, the data cannot be used to compare between construction products or concrete mixtures used in different concrete products unless the data is integrated into a comprehensive LCA. For example, precast concrete, concrete masonry units and site cast concrete all have different manufacturing processes whose impacts are attributed to different LCA stages. This precludes direct comparison between mixtures used in these different products unless all life cycle phases are included.'

12. In the case where an EPD is declared as an average environmental performance for a number of products, a statement to that effect shall be included in the declaration together with a description of the range/variability of the LCA results;

13. The locations(s), manufacturer or group of manufacturers or those representing them for whom the EPD is representative;
14. The life cycle inventory and impact measures outlined in section 3.2.
15. Other information relating to environmental performance such as third party certifications or labels awarded to the manufacturer or product.

NOTE: *See appendix C for an example EPD format/content.*

6. Project Report

6.1. General

The project report is the systematic and comprehensive summary of the project documentation supporting the verification of an EPD. The project report shall record that the LCA-based information and the additional information as declared in the EPD meet CEN 15804. It shall be made available to the verifier with the requirements on confidentiality stated in ISO 14025.

The project report is not part of the public communication.

The project report should contain any data and information of importance for the data published in the EPD and as specified by CEN 15804. Special care is necessary to demonstrate in a transparent way how the data and information declared in the EPD results from the LCA study.

NOTE In this context 'project' means the LCA study on the declared product.

6.2. LCA-related elements of the project report

The results, data, methods, assumptions, limitations and conclusions of the LCA shall be completely and accurately reported without bias. They shall be transparent and presented in sufficient detail to allow independent verification and to permit an understanding of the complexities and trade-offs inherent in the LCA. The report should also allow the results and interpretation to be used in support of the data and additional information made available in the respective EPD.

The project report shall give the following - (taken directly from CEN 15804 changes italicized):

A. General aspects:
   1. Commissioner of the LCA study, internal or external practitioner of the LCA study;
   2. Date of report;
   3. Statement that the study has been conducted according to the requirements of this PCR;

B. Goal of the study:
   1. Reasons for carrying out the study and its intended application and audience, i.e. providing information and data for an EPD for business-to-business and/or business-to-consumer communication;

C. Scope of the study:
   1. Declared unit/reference flow, including:
      i. Definition, including relevant technical specification(s);
      ii. Calculation rule for averaging data e.g. when the declared/functional unit is defined for:
         1. A group of similar products produced by different suppliers (*Sector EPD per 3.6B)* or
         2. The same product produced at different production sites *(Average EPD per 3.6A);*
   2. System boundary according to the modular approach as outlined in Figure 2.1, including:
      i. Omissions of life cycle stages, processes or data needs and justifications for exclusions;
      ii. Quantification of energy and material inputs and outputs, taking into account how plant-level data is allocated to the declared products; and

iii. Assumptions about electricity production and other relevant background data;

3. Cut-off criteria for initial inclusion of inputs and outputs, including:
   i. Description of the application of cut-off criteria and assumptions;
   ii. List of excluded processes;

D. Life cycle inventory analysis:
1. Qualitative/quantitative description of the unit processes necessary to model the life cycle stages of the declared unit, taking into account the provisions of EN ISO 14025 regarding data confidentiality;
2. Sources of generic data or literature used to conduct the LCA;
3. Date and creation of the dataset;
4. Justification of the use of specific dataset if more than one dataset for the same product/process exists;
5. Justification of how approximate proxy datasets were identified;
6. Validation of data, including:
   i. Data quality assessment (date, source); and
   ii. Treatment of missing data including justification of how approximate proxy datasets were identified;
7. Allocation principles and procedures, including:
   i. Documentation and justification of allocation procedures; and
   ii. Uniform application of allocation procedures;

E. Life cycle impact assessment:
1. The LCIA procedures, calculations and results of the study;
2. The relationship of the LCIA results to the LCI results;
3. Reference to all characterization models, characterization factors and methods used.
4. A statement that the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks;

F. Life cycle interpretation:
1. The results;
2. Assumptions and limitations associated with the interpretation of results, both methodology and data related, as declared in the EPD;
3. The variance from the means of LCIA results should be described if generic data are declared from several sources or for a range of similar products;
4. Data quality assessment;
5. Full transparency in terms of value-choices, rationales and expert judgments.

6.3. Documentation on additional information

The project report shall include any documentation on additional environmental information declared in the EPD as specified by this standard. Such documentation on additional environmental information may include, (as copies or references):

- laboratory results/measurements for the content declaration;
- laboratory results/measurement of functional/technical performance;

- documentation on declared technical information on life cycle stages that have not been considered in the LCA (e.g. transport distances, energy consumption during use, cleaning cycles, etc.);
- laboratory results/measurements for the declaration of emissions to indoor air, soil and water during the product's use stage *(if available or appropriate).*

6.4. Data availability for verification

To facilitate verification, the following information shall be made available to the EPD verifier, taking into account data confidentiality according to ISO 21930:2007, 7.4 and 9.1:

- analysis of material and energy flows to justify their inclusion or exclusion *based on cut off criteria*;
- quantitative description of unit processes that are defined to model processes and life cycle stages of the declared unit;
- attribution of process and life cycle data to datasets of an LCA-software (if used); LCIA results per modules of unit processes, e.g. structured according to life cycle stages; LCIA results per production plant/product if generic data is declared from several plants or for a range of similar products;
- documentation that substantiates the percentages or figures used for the calculations in the end-of-life scenario *(if available or appropriate).*;
- documentation that substantiates the percentages and figures (number of cycles, prices, etc.) used for the calculations in the allocation procedure, if it differs from the PCR.

7. Verification and Validity of an EPD/GHG Inventory

Externally verified EPDs/GHG Inventories shall be used to compare between suppliers. Internally verified EPDs/GHG Inventories may be used for comparison of products produced by a single supplier.

After verification, an EPD is valid for a 5-year period from the date of issue, after which it must be updated. The supplier must affirm that technology or other circumstances that could alter the content and accuracy of the declaration have not changed. An EPD for a specific product does not have to be recalculated after 5 years if the underlying data has not changed by more than +/-10% for any one of the declared impacts of the EPD. Industry or company average EPDs must be recalculated every 5 years using updated production values.

EPDs for unique concrete mixtures can be generated by a software system that has been verified by an EPD operator provided that a systematic method of review of the unique EPDs is in place and the mixture specific EPD uses only materials previously verified by the EPD operator. The EPD operator should develop a protocol for verification of EPDs and EPD software.

The process for verification and establishing the validity of an EPD shall be in accordance with EN ISO 14025 and ISO 21930.

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APPENDIX A: Committee Composition

The development of this PCR was sponsored by the Carbon Leadership Forum and the College of Built Environments at the University of Washington. The committee was led by Kathrina Simonen who was the primary author of this document.

Name	Affiliation
Jeff Davis	Central Concrete
Francesca DesMarais	Architecture 2030 (observer)
Chris Erickson	Climate Earth
Dean Frank	Precast/Pre-stressed Concrete Institute
Loretta Tam	UL Environment
Won Lee	Independent Engineer
Lionel Lemay	National Ready Mixed Concrete Association
Greg McKinnon	Stoneway Concrete
Helena Meryman	Consultant
John Ochsendorf	Massachusetts Institute of Technology
Kathrina Simonen	University of Washington (chair and primary author)
Carlo Strazza	University of Genoa
Mark Webster	Simpson Gumpertz & Heger

APPENDIX B: GHG PROTOCOL REQUIREMENTS

The following general items shall be reported in the EPD in addition to the requirements noted in the PCR. These are

A. Report a qualitative assessment of the data uncertainty of significant processes using the 5 data quality indicators outlined in the PCR section 3.3.

B. Report variability per PCR section 3.6.

C. Quantify the percentage of primary data in the final inventory: divide CO_2e determined via EPD or core processes by total product CO_2e.

D. The following statement: 'The GHG inventory includes reported emissions from all GHG included within the US TRACI characterization factors, more than the minimum required by the GHG Protocol'.

E. Assurance type (Third party, self-assurance or critical review). If internal assurance providers are used, the following information shall be disclosed in the product GHG inventory report or assurance statement:

    F. their relative competencies;

    G. the reason for selecting them as the assurance providers; and

    H. how any potential conflict of interest was avoided.

I. The following statement shall be added to all declarations with only first-party verification:

    'The reported data has not been assured by a third party and thus is only appropriate for use in comparing between mixtures within a single company and is not appropriate for use in purchasing decisions, GHG labeling programs or comparative assertions'

J. The following statement shall be added to all declarations with third-party assurance:

    'The reported data has been assured by a third party and thus is appropriate for use in comparing between mixture designs and GHG labeling programs. This data should not be used for comparative assertions unless a LCA in conformance with ISO 14044, assessing all environmental impacts is performed.'

APPENDIX C: SAMPLE EPD

[NOTE: This SAMPLE Environmental Product Declaration (EPD) provides the basic information that should be included in an EPD. The values presented here are for demonstration purposes only and do not represent actual environmental impacts associated with concrete. No LCA was conducted to obtain these values. Note, items in RED UNDERLINE are to be developed by the concrete producer when preparing the EPD. Items in black are standard to all EPDs. The graphic format of the EPD can be developed and changed by the producer and EPD program operator]

CONCRETE Environmental Product Declaration (SAMPLE)

For concrete produced by Rock Hard Concrete Company, Plant 99 West, 99 West Street, Middleton, KS, USA with the following product names:

1. STR040
2. STR050
3. STR080
4. EXT050

Company

Rock Hard Concrete Company is a privately held ready mixed concrete producer based in Kansas City, KS, and operates 11 concrete production facilities in Kansas and Missouri. This environmental product declaration was created for concrete produced at Plant 99 West located in Middleton, KS.

Headquarters:
Rock Hard Concrete Company
101 Main Street
Kansas City, KS 55555
555-555-5555

Plant:
Rock Hard Concrete Company, Plant 99 West
99 West Street
Middelton, KS, 99999
999-999-9999

EPD Program	LCA Verification
The EPD Program Operator verifying/registering this EPD is: Green Environmental Sustainability, Inc. 1000 Heavenly Way Seattle, WA 88888 www.GESwebsite.net	The Life Cycle Assessment was independently verified by: Go Get Em Environmental: 2000 Cradle Lane Cradle, CA 77777 www.GOgetEMEnvironmental.com

Date of Issue & Period of Validity

Issued January 1, 2099 and valid for 5 years until January 1, 2104

The Carbon Leadership Forum PCR Version 1.0 dated 11/30/2012 serves as the PCR for this EPD www.carbonleadershipforum.org
Independent verification of the declaration, according to ISO 14025:2006 ☐ internal ☐X external
Independent Verifier Jane Precision, j.precision@lcaexpert.com

Product Description

This EPD reports the impacts for the product "concrete". (ASTM C94/UNSPSC code 30111500) and covers the life cycle phases A1-A3 Cradle-to-Gate. Life cycle stages **NOT** included in this EPD:

A4: Transportation to the construction site
A5: Construction (reinforcement, forming, placing, curing etc)
B1-7: Building use and maintenance.
C1-4: End of life

This information can be used to model the environmental impacts of the **concrete** component of products that use concrete including, but not limited to, cast in place concrete, precast concrete, concrete masonry units mass concrete and concrete pavements, provided the life cycle impacts of all additional materials and processes are accounted for and the information is integrated into a comprehensive LCA.

While EPDs can be used to compare concrete mixtures, the data cannot be used to compare between construction products or concrete mixtures used in different concrete products unless the data is integrated into a comprehensive LCA. For example, precast concrete, concrete masonry units and site cast concrete all have different manufacturing processes whose impacts are attributed to different LCA stages. This precludes direct comparison between mixtures used in these different products until all life cycle phases are included.

Life Cycle Assessment

A summary of life cycle processes included in the EPD are as follows:

1. Raw Material Supply (upstream processes): Extraction, handling and processing of the raw materials used in production of concrete: cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures and other materials or chemicals used in concrete mixtures.
2. Transportation: Transportation of these materials from supplier to the 'gate' of the concrete producer.
3. Manufacturing (core processes): The core processes result from the energy used to store, batch, mix and distribute the concrete and operate the facility (concrete plant)
4. Water use in mixing and distributing concrete.

A summary of life cycle processes excluded from the EPD:

1. Production, manufacture and construction of buildings capital goods and infrastructure with an expected lifespan of over 5 years.
2. Production and manufacture of concrete production equipment, concrete delivery vehicles, earthmoving equipment, laboratory equipment with expected lifespan of over 5 years.
3. Personnel-related activities (travel, furniture, office supplies).
4. Energy and water use related to company management and sales activities.
5. Water use in upstream manufacturing processes and in placement and curing of concrete. Better data and methodology is required to track and report these numbers.

A summary of the limitations of this EPD include:

1. This EPD does not report all of the environmental impacts due to manufacturing of the product, but rather environmental impacts for categories with established life cycle assessment based methods to track and report. Unreported environmental impacts include

(but are not limited to) factors attributable to human health, land use change, water use in the upstream manufacturing process and habitat destruction.

2. This EPD reports the results of an LCA for 'cradle-to-gate' analysis and thus declarations are not comparative assertions. A comparative assertion is an environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function. An EPD does not make any statements that the product covered by the EPD is better or worse than any other product.
3. In order to assess the local impacts of the product manufacturing, additional analysis is required.
4. The product manufacturer has the option of declaring additional information about their product including conformance with any other sustainability certification programs that often have performance and prescriptive requirements that aim to capture environmental best practices that cannot be captured by LCA.
5. Life cycle Impact Assessment results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Data Quality and Variability

This EPD was created using industry average data for upstream materials. Variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel type used. LCA data used to prepare this EPD is between 1-12 years old.
Climate change impacts could range between 230 CO_2e and 300 CO_2e per cubic meter. Other environmental impact values will have a different range. Better upstream data is required to refine variability evaluation for all environmental impacts. The following sources of data were used in developing this EPD

	Data used for cradle-gate impacts of the primary components (note transportation data quality and type not reported within the EPD)			
Component	CO_2e	LCI	Date	Notes
Portland Cement	Plant specific EPD	Plant specific EPD	TBD	Specific supplier identified and data provided-V. high quality data.
Slag cement	CLF Defaults Version 1.0	LCI Slag Cement Manufacturing	2003	CTL Group report to Slag Cement Association
Fly ash	none	none	N/A	No impacts for manufacturing.
Silica Fume	none	none	N/A	No impacts for manufacturing.
Fine and Coarse Aggregate	CLF Defaults Version 1.0	Gabi Ecoinvent database	2012	Modified per US energy mix
Admixtures	CLF Defaults Version 1.0	EU 'EPD' Data	2006	Modified per US energy mix
Water	NONE	NONE	N/A	Not including impacts of water treatment and transport

Declared Unit: The declared unit is 1 cubic meter of concrete for each of the identified products.

Products Included in this EPD:

Product name	STR040	STR050	STR080	EXT050
Specified Compressive Strength	4000 psi (28 MPa) at 28 days	5000 psi (35 MPa) at 28 days	8000 psi (55 MPa) at 56 days	5000 psi (35 MPa) at 28 days
Specified Environmental Exposure Class (ACI 318)	F0, S1, P0, C0	F0, S0, P0, C0	F0, S0, P0, C0	F3, S0, P0, C2
Design Slump	6 in. +/- 1.5 in. (152 mm +/- 38 mm)	6 in. +/- 1.5 in. (152 mm +/- 38 mm)	24 in. +/- 3 in. (610 mm +/- 76 mm)	6 in. +/- 1.5 in. (152 mm +/- 38 mm)
Unit Weight	Normalweight	Normalweight	Normalweight	Lightweight
Primary Applications	Grade with moderate sulfate exposure	Structural beams, girders and slabs with no exposure	Structural columns with no exposure	Parking deck slabs, beams and columns

Product Components

	STR040	**STR050**	**STR080**	**EXT050**
Component	**Meeting the Following Standard**			
Portland Cement	ASTM C 150 Type II	ASTM C 150 Type I	ASTM C 150 Type I	ASTM C 150 Type I
Slag cement	ASTM C 989	None	ASTM C 989	None
Fly ash	ASTM C 618	ASTM C 618	ASTM C 618	ASTM C 618
Silica Fume	None	None	None	ASTM C 1240
Fine and Coarse Aggregate	ASTM C 33	ASTM C 33	ASTM C 33	ASTM C 33
Admixtures	ASTM C494	ASTM C494	ASTM C494	ASTM C494
Water	ASTM C 1602	ASTM C 1602	ASTM C 1602	ASTM C 1602

Environmental Impacts per Cubic Meter of Concrete

	STR040	STR050	STR080	EXT050
Inventory Item				
Total Primary Energy	2957 MJ/m^3	3235 MJ/m^3	3512 MJ/m^3	2957 MJ/m^3
Batch Water	127 kg/m^3	133 kg/m^3	145 kg/m^3	127 kg/m^3
Wash Water	18 kg/m^3	18 kg/m^3	18 kg/m^3	18 kg/m^3
Total Waste Disposed	24 kg/m^3	25 kg/m^3	26 kg/m^3	24 kg/m^3
Impact Category				
Climate Change	334 kg CO_2e/m^3	361 kg CO_2e/m^3	387 kg CO_2e/m^3	334 kg CO_2e/m^3
Ozone Depletion	0.00 kg CFC11 eq/m^3	0.00 kg CFC11 eq/m^3	0.00 kg CFC11 eq/m^3	0.00 kg CFC11 eq/m^3
Acidification Air	0.78 kg SO2 eq/m^3	0.78 kg SO2 eq/m^3	0.78 kg SO2 eq/m^3	0.78 kg SO2 eq/m^3
Eutrophication Air	0.00 kg N eq/m^3	0.00 kg N eq/m^3	0.00 kg N eq/m^3	0.00 kg N eq/m^3
Eutrophication Water	0.09 kg N eq/m^3	0.09 kg N eq/m^3	0.09 kg N eq/m^3	0.09 kg N eq/m^3
Photochemical Ozone Creation/Smog	0.06 kg C2H6 eq/m^3	0.06 kg C2H6 eq/m^3	0.06 kg C2H6 eq/m^3	0.06 kg C2H6 eq/m^3

Additional Environmental Information:

Rock Hard Concrete Company is dedicated to continuous environmental improvements through product and process innovation. It demonstrates its dedication to sustainable development through the following certifications:

1. NRMCA Certified Concrete Production Facility
2. NRMCA Green-Star Certification
3. NRMCA Sustainable Concrete Plant Certification – Silver Level

References:

1. Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) of Concrete, Carbon Leadership Forum, Seattle, WA, 2012.

2. ISO 14025: Environmental labels and declarations – Type III environmental declarations – principles and procedures, ISO, Switzerland, 2006.
3. Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), US Environmental Protection Agency, Washington, DC.
4. Life Cycle Inventory of Portland Cement Concrete, Medgar L. Marceau, Michael A. Nisbet, and Martha G. VanGeem, Portland Cement Association, Skokie, IL, 2007.

APPENDIX D: ALLOCATION

The allocation rules for emissions from three multi-functional processes (tire production and blast furnace slag and fly ash generation) have been specified in the body of the PCR. Within the draft International EPD PCR for concrete, the complexities of the allocation issue are acknowledged and options to permit regional variation of allocation methodology are provided.

This PCR uses allocation methods in common practice in the US: treating fly ash, slag and tires as waste products with zero impact allocated from the initial manufacturing process and impacts related to the treatment and transportation of these waste products assigned to the new product system.

METHODOLOGY
The following is an expanded justification of the chosen methodologies for this PCR.

Per ISO 14044:2006, Clause 4.3.4.2:

'Step 1: Whenever possible, allocation should be avoided by:

a) dividing the unit processes into two or more sub-processes and collecting the input and output related to those processes. or

> ***NOTE:*** *There is no clear method do divide the input and output related to the production of tires for use in cars and cement kilns, steel and slag production or electricity and fly ash generated by a coal power plant. Thus, the step 1 method is not appropriate.*

b) expanding the product system to include the additional functions related to the co-products, taking into account the requirements of 4.2.3.3.

> ***NOTE:*** *System expansion appears to be the most appropriate method to use and is the second ranked option as outlined by ISO. However discussion of the challenges related to economic or mass allocation is provided at the end of the document.*

Step 2: Where allocation cannot be avoided, the inputs should be partitioned based on physical relationships.

Step 3: Where physical relationship alone cannot be established or used as the basis for allocation, allocation may be made based on other relationship such as by economic value.

> ***NOTE:*** *physical or economic allocation is to be used when allocation cannot be avoided. See discussion at end of this section for additional commentary on the challenges inherent in these methods.*

ALTERNATE ALLOCATION METHODS:

As demonstrated in the published LCA of Gypsum Wallboard (GWB) (Bushi & Meil, 2011), physical allocation between the product (electricity, steel, tire use) and the co-product (fly ash, slag and waste tires) is not appropriate. Using fly ash as an example, the ratio between electricity generated and the fly ash produced cannot be varied. The amount of fly ash produced is a direct result of decisions made regarding energy production and the demand for fly ash is not resulting in the plant generating extra electricity (see example 1.4, Appendix A of the GWB LCA). We concur with the GWB LCA that economic allocation of fly ash is also not practical for the following reasons:

1. Without access to LCA data for US coal-fired power plants we do not have access to the data needed to study;
2. Price fluctuations makes economic allocation inconsistent to apply; and most importantly;
3. US statistics show that not all fly ash is used and the EPA has designated it a waste product (EPA, 1990).

Similar logic can be applied to the slag and tire processes. (EPA, 2012 & 1997)

DISCUSSION

Different allocation assumptions can be justified by sound logic and still satisfy ISO LCA standards. Thus the final conclusions regarding appropriate allocation assumptions for this LCA have been made based upon a consideration of the primary goals of the PCR.

Given that the goal of this PCR is focused on reducing the impact of concrete and motivating improvement within the concrete industry, the simplified/conservative system expansion methodology is appropriate. This PCR supports US policy treating the 'W' products as waste and provides incentives to use these products and promote the development of other SCMs.

REFERENCE

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