## Environmental Product Declaration

# Calla® Ceiling Panels

MINERAL FIBER
Prelude® XL®, Suprafine® XL, Silhouette® XL, Interlude® XL Suspension Systems
Steel

Calla ceilings panels with Suprafine XL Suspension System – Pepsi Co. – RF Granoff Architects, Purchase New York

Armstrong® CEILING SOLUTIONS

**Committed to Sustainability.**

Armstrong is committed to delivering solutions that reduce the environmental impact of the buildings you create…from product design and raw material selection, to how our products are produced and delivered.

Now we provide Environmental Product Declarations (EPD's) to document the sustainability of our products. Inside this UL Environment certified ISO compliant EPD you will find:

- Performance features like acoustics, light reflectance, and durability
- Product application and use
- Product ingredients and their sources
- Information on how a ceiling system is produced
- Life Cycle Assessment (LCA) results including global warming potential and primary energy usage
- Total impacts over the life cycle of the product

Calla delivers a superior combination of performance attributes – excellent sound absorption, a refined look, and a reduced environmental footprint – making it a great product for commercial applications.

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

# ENVIRONMENTAL PRODUCT DECLARATION

Armstrong CEILING SOLUTIONS

**CALLA® CEILING PANELS**
MINERAL FIBER

**According to ISO 14025**

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.

| | |
|---|---|
| PROGRAM OPERATOR | UL Environment |
| DECLARATION HOLDER | Armstrong |
| DECLARATION NUMBER | 4786828541.110.1 |
| DECLARED PRODUCT | **Calla Ceiling Panels** – Mineral Fiber |
| REFERENCE PCR | PCR Guidance for Building Related Products and Services, From the range of Environmental Product Declarations of UL Environment: "Part B: Non-Metal Ceiling Panel EPD Requirements", October 2015v1. |
| DATE OF ISSUE | March 31, 2016 |
| PERIOD OF VALIDITY | 5 Years |
| CONTENTS OF THE DECLARATION | Product definition and information about building physics<br>Information about basic material and the material's origin<br>Description of the product's manufacture<br>Indication of product processing<br>Information about the in-use conditions<br>Life cycle assessment results<br>Testing results and verifications |
| The PCR review was conducted by: | Review Panel<br>Dr. Lindita Bushi<br>epd@ul.com |
| This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories<br>☐ INTERNAL<br>☒ EXTERNAL | Wade Stout, UL Environment |
| This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by: | Thomas Gloria, Industrial Ecology Consultants |

# 2. Product System Documentation

## 2.1 Product Description

Armstrong® Calla Ceiling Panels are wet-formed mineral fiber acoustical ceiling panels, featuring a fine-textured, non-directional visual. Calla ceiling panels are manufactured by Armstrong World Industries in Pensacola, Florida (32505).

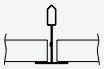
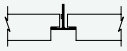
## 2.2 Application

Commercial Interior Finish. Acoustical, Suspended Ceiling System. The ceiling system must be installed in accordance with Armstrong installation guidelines. Our ceiling system installation brochure, “Installing Suspended Ceilings”, is a general application overview, covering essential steps of a basic suspended ceiling installation. You can reference this document at armstrongceilings.com/installationinstructions

## 2.3 Technical Data

There are different levels of performance associated with mineral fiber ceiling panels. Performance information is included in this EPD to provide a total understanding of this product and its performance attributes.

**Performance of Calla Ceiling Panels[1]**

| Items Included in this EPD | Attributes |
|---|---|
| Calla Square Lay-in Panels for 15/16" Suspension System<br>  2820, 2821 | **NRC 085**<br>NRC is measured according to ASTM C423<br><br>**CAC 35**<br><br>**AC 170**<br>AC is measured according to ASTM E1110 and E1111<br><br>**Fire Rating: Class A**<br>Flame Spred Index (FSI)/Smoke Developed Index (SDI) ASTM E84; UL 723; CAN/ULC – S102M<br><br>**Light Reflectance 0.86**<br><br>**Sag-resistant (HumiGuard® Plus)**<br><br>**Anti-Microbial (BioBlock® Coating)**<br><br>**Recyclable** |
| Calla Square Tegular Panels for 9/16" Suspension System<br>  2828, 2825 | |
| Calla Angled Tegular Panels for 15/16" Suspension System<br>  2822, 2823 | |

## 2. Product System Documentation (continued)

### 2.4 Placing On the Market/Application Rules

The respective standard is listed in the table in Section 2.3 above for each attribute of the declared product.

EN ISO 14025:2006, Environmental labels and declarations – Type III – environmental declarations - Principles and procedures

EN 14040 ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework

EN 14044 ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines

ASTM E1264-08e1 Standard Classification for Acoustic Ceiling Products

ASTM E84-12 Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM C518-10 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM C636 / C636M-08 Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels

ASTM C423-09a Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

2010 Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers – Version 1.1 – California

ASTM E1414 / E1414M-11a Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum

### 2.5 Delivery Status

Armstrong ceiling panels are well packaged in a variety of recyclable corrugated sleeves and box styles. Wooden pallets are used to protect unit loads during shipping.

## 2. Product System Documentation (continued)

### 2.6 Material Content

- **Back Coating** – A coating applied to the back of the product
- **Mineral Fiber Core** – Consists of fibers, perlite, recycled newspaper, and corn starch
- **Scrim** – A non-woven facing attached to the mineral fiber core with a latex adhesive
- **Face Coating** – Durable, highly light-reflectant finish paint coating applied to the scrim
- **Hot Dipped Galvanized Steel** – Steel with zinc corrosion protection
- **Painted Finish** – Painted steel capping

**Figure 1. Composition of an Calla Ceiling Panel**

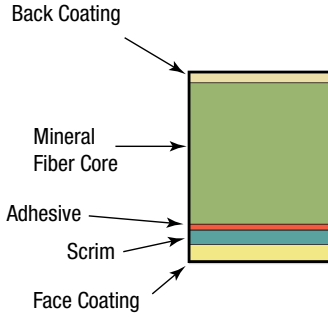
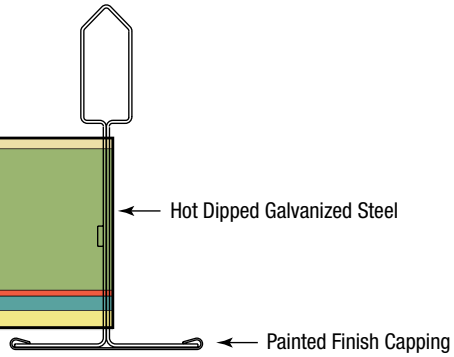



**Figure 2. Composition of Prelude XL Suspension Systems**



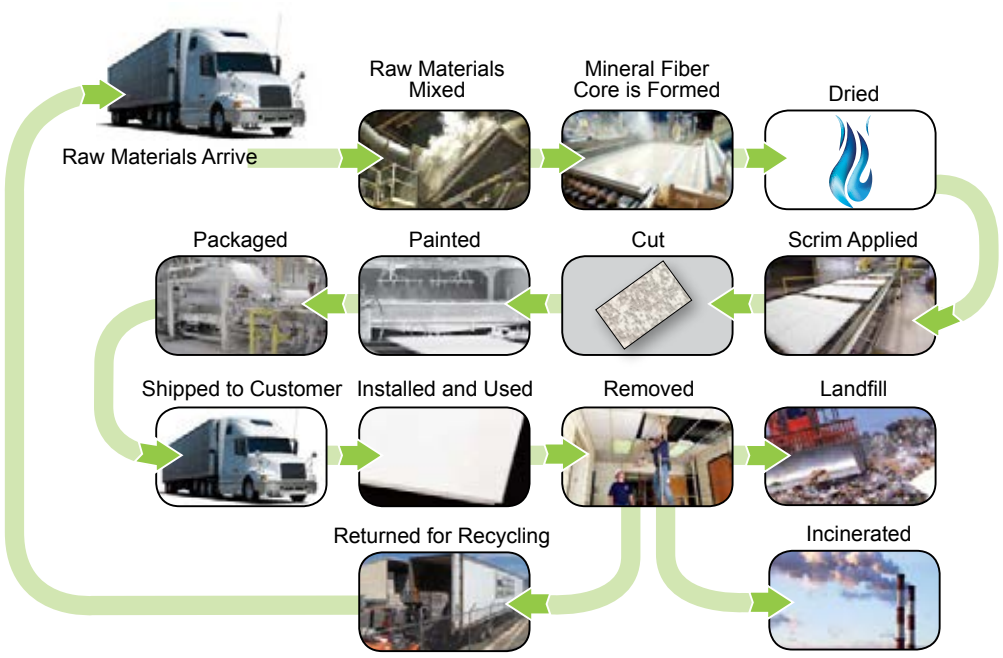

**Material Content of Calla Ceiling Panels**

| Mineral Fiber Core | FUNCTION | QUANTITY (PERCENT BY WEIGHT) | RECYCLED MINERAL RESOURCE | MINERAL RESOURCE | NON-RENEW-ABLE | RENEW-ABLE | ABUNDANT | RECYCLED MATERIAL | ORIGIN | TRANS-PORTATION MODE | TRANS-PORTATION MILES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fibers | Acoustics | 40-50% | ■ | ■ | ■ | | ■ | ■ | Global | Truck/Rail | 750-1400 |
| Perlite | Filler | 20-30% | | ■ | ■ | | ■ | | Global | Truck/Ship | 8000-9000 |
| Starch | Binder | 1-10% | | | | ■ | ■ | | U.S. | Truck | 1200-1300 |
| Recycled Ceiling Panels | Filler | 5-10% | | | | | | ■ | U.S. | Truck | 500-700 |
| Recycled Paper | Filler | 1-10% | | | | ■ | ■ | ■ | U.S. | Truck | 100-200 |
| Coating | Finish | 10-20% | | ■ | ■ | | | | U.S. | Truck/Rail | 400-4000 |
| Scrim | Finish | 1-5% | ■ | ■ | ■ | | ■ | | Global | Truck/Ship | 6000-7000 |
| Adhesive | Finish | 0.05-1.5% | | | ■ | | | | U.S. | Truck | <500 |

## 2. Product System Documentation (continued)

### 2.7 Manufacture

**Figure 3: Process for Manufacturing Calla Ceiling Panels**




Calla mineral fiber ceiling panels are manufactured using a wet-formed process. After arriving at the Armstrong facility, the raw materials are mixed, water is added, and the mixture is formed into panels which are then dried. The panels are finished by application of back and prime coats, punching, lamination of scrim, final painting, cutting to size, and addition of edge detail. After packaging, the material is shipped and installed. At the end of its useful life, the ceiling panel can then be recycled, sent to a landfill, or incinerated. Recycled ceilings can be returned to Armstrong as part of our closed loop recycling process as a raw material for new ceiling panels.

### 2.8 Health, Safety, and Environmental Aspects During Manufacturing

Armstrong has a comprehensive environmental, health, and safety management program. Risk reduction begins in the product design process. All products go through a safety, health, and environmental review prior to sale. Armstrong also has a long standing commitment to the safety and health of all our employees. The company's safety management program is considered to be World Class. Our OSHA recordable incident rate is below 1.0, meaning that there is less than one injury per 100 employees per year. All employees view safety as a key responsibility of their jobs. In 2010, Armstrong was named one of "America's Safest Companies" by EHS Today.

Armstrong is equally committed to reducing our environmental impact. As with safety goals, each manufacturing facility has environmental initiatives focused on responsible use of energy and water, and on waste reduction.

### 2.9 Installation of Ceiling Systems

The ceiling system must be installed in accordance with Armstrong installation guidelines. Our ceiling system installation brochure, "Installing Suspended Ceilings", is a general application overview, covering essential steps of a basic suspended ceiling installation. You can reference this document at armstrongceilings.com/installation.

## 2. Product System Documentation (continued)

Calla ceiling panels are HumiGuard® Plus – offering superior resistance to sagging in high humidity conditions up to, but not including, standing water and outdoor applications.

### 2.10 Packaging

Armstrong ceiling panels are well packaged in a variety of recyclable corrugated sleeves and box styles. Wooden pallets are used to protect unit loads during shipping.

### 2.11 Condition of Use

Cleaning instructions for Calla ceilings can be found at armstrongceilings.com/installation.

### 2.12 Health, Safety, and Environmental Aspects During Installation

There are no recognized systemic hazards associated with installing ceiling panels. Armstrong recommends that installers handle materials in a manner to minimize airborne dust. Installers should wear appropriate personal protective equipment, such as gloves and safety glasses, to minimize exposure to dust and the potential for skin irritation.

### 2.13 Reference Service of Life

The system is warranted for 30 years of use; however, ceiling panels can last as long as the building's useful life if properly installed and maintained. The useful life indicated in the PCR for ceiling panels is 75 years. Warranty details can be found at www.armstrongceilings.com/warranty.

### 2.14 Extraordinary Effects

- **Fire Performance**

  ASTM E84 and CAN/ULC S102 surface burning characteristics. Flame Spread Index 25 or less. Smoke Developed Index 50 or less. (UL labeled)

- **Water/Sag Resistance**

  HumiGuard® Plus offers superior resistance to sagging in high humidity conditions up to, but not including, standing water and outdoor applications and carries a 30-year limited system warranty.

- **Insulation Value**

  ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Flow Meter Apparatus

  R Factor – 2.9 (BTU units)

  R Factor – 0.445 (Watts units)

- **Seismic Performance**

  Seismic Categories C, D, E, and F

  ICC-ES ESR 1308 – see armstrongceilings.com/seismicRX

- **Acoustical Panel Classification**

  ASTM E1264 - Standard Classification for Acoustical Ceiling Products

  Type III, Form 1, Pattern E I, Fire Class A

## 2. Product System Documentation (continued)

### 2.15 Re-Use Phase

The preferred reuse method for a ceiling panel is to be recycled through the Armstrong Ceiling Recycling Program. Contact our Recycling Center at 1 877 276 7876 (press option 1, then 4), or visit www.armstrongceilings.com/ceilingrecycling. Armstrong started reclaiming and recycling ceiling panels in 1997. To date, Armstrong has recycled over 180 million square feet of used ceilings into new ceiling products.

### 2.16 Disposal

Disposal in municipal landfill or commercial incineration facilities is permissible and should be done in accordance with local, state, and federal regulations.

## 3. Life Cycle Assessment

This study provides life cycle inventory and environmental impacts relevant to Armstrong suspended ceiling systems. This LCA was conducted to 1) better understand the environmental impacts of the life cycle of suspended ceiling systems; 2) learn how the impacts of raw material selection, product formulation, and manufacturing process influence the life cycle impacts of suspended ceiling systems, and 3) use innovation to drive reduction in the product platform.

The methods for conducting the life cycle assessments used for this project were consistent with ISO 14040 and 14044. This report is intended to fulfill the reporting requirements in Section 5 of ISO 14044 and Part 2 of the Product Category Rules for Ceiling Panels for Suspended Ceiling Systems.

### 3.1 Declared and Functional Unit

The declared unit for this EPD is 1 $M^2$ of Calla ceiling panel for use over 75 years.

Armstrong has chosen to also report for 1 $ft^2$.

| Calla | Value |
|---|---|
| Declared Unit | $ft^2$ |
| DeclaredThickness (inches) | 0.625 |
| Surface Weight (lb/ft2) | 1.000 |
| Declared Unit | $m^2$ |
| DeclaredThickness (cm) | 1.588 |
| Surface Weight (kg/m2) | 4.892 |

## 3. Life Cycle Assessment (continued)

### 3.2 System Boundaries:

The system boundaries studied as part of this life cycle assessment include extraction of primary materials, raw materials manufacture, ceiling panel production, installation, and end of life.

The phases below outline a “cradle-to-grave” life cycle assessment for ceiling panels.

**Ceiling Panels:**


**The Cradle-to-Grave Assessment Includes:**

– Raw materials production including substrate, coating, and packaging materials for ceiling panels
– Transportation of raw materials to Armstrong manufacturing facility
– Manufacturing of the ceiling panels at an Armstrong manufacturing facility
– Packaging of finished products including energy to operate packaging equipment
– Transportation from manufacturing facility to distribution centers, retailers, and job site (assumed to be 500 miles by truck)
– Use phase covers a useful life of 75 years as suggested in the PCR and includes the transportation and installation of the system
– End of life includes landfill disposal of ceiling panels with assumed 50 miles truck transport from job site to landfill

**The Cradle-to-Grave Assessment Excludes:**

– Overhead energy usage (heating, lighting) of manufacturing facilities
– Maintenance and operation of support equipment

### 3.3 Assumptions:

There are no specific assumptions to list that are not dealt with in the appropriate section. When an assumption is made it will be described within the specific stage of the report. As an example a 7% waste factor was utilized for the waste generated during the installation of the product. This is described in more detail within the installation section of the report.

### 3.4 Cut-off Criteria:

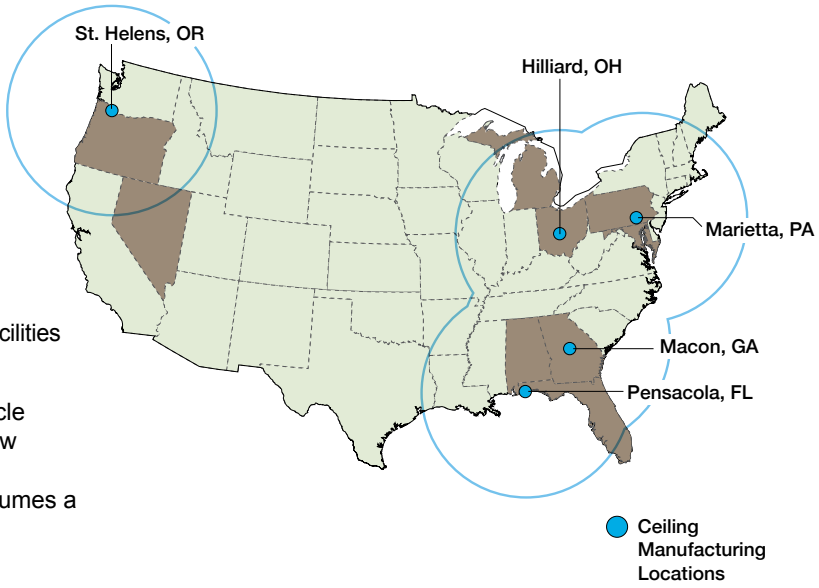
– Mass – If a flow is less than 1% of the cumulative mass of the model, it is excluded, providing its environmental relevance is not a concern.
– Energy – If a flow is less than 1% of the cumulative energy of the model, it is excluded, providing its environmental relevance is not a concern.
– Environmental relevance – If a flow meets the above criteria for exclusion, yet is believed to potentially have a significant environmental impact, it is included.

## 3.Life Cycle Assessment (continued)

### 3.5 Background Data:

All data is reported as a North American weighted average across our ceiling and suspension system plant locations. The majority of Armstrong ceiling products are distributed within 500 miles of the respective manufacturing plants. The same distribution trucks that take material to distribution centers backhaul post-consumer recycled ceiling panels to the manufacturing plants as part of our closed loop reclamation program. If product is not recycled, disposal transportation at end of life is assumed to be 50 miles.

This map shows the location of Armstrong manufacturing facilities with a circle denoting a 500-mile radius from each location.




Transportation emissions and fuels throughout the life cycle phases are included. All transportation associated with raw materials reflects the actual modes of transportation and mileage with the exception of recycled ceilings which assumes a transportation distance of 500 miles by truck.

### 3.6 Data Quality:

Data for the scrim was provided by the supplier. This data is believed to be of high quality and is consistent with industry data for fiberglass.

The LCA model was created using the GaBi Software system for life cycle engineering, developed by Think Step. The GaBi database provides the life cycle inventory data for several of the raw and process materials obtained from the background system. The data quality is considered to be good to high quality. With the exception of supplier specific data, all other relevant background data was taken from the GaBi database software.

All gate-to-gate, primary foreground data was collected for the ceiling panels manufacturing process. Background data was collected from suppliers or generic data was used. When generic data was used, it was verified and triangulated against several sources.

### 3.7 Period Under Review

2014 LCA data was used in the compilation of this EPD.

## 3.Life Cycle Assessment (continued)

### 3.8 Allocation:

No allocation was performed within the modeling of Armstrong unit processes for Calla mineral fiber ceiling panels. Allocation occurred at the end of life phase for ceiling panels as they were partitioned based on 1% overall ceiling panel recycling rate. Credits for electricity and heat gained from thermal recycling of waste and packaging in a solid waste incinerator and/or landfill were not taken in this study.

## 4. LCA: Scenarios and Additional Technical Information

The following information is necessary for the declared modules and optional for non-declared modules. Modules for which no information is declared can be deleted; additional information can also be listed if necessary. Irrelevant or non-applicable module rows may be excluded in the EPD.

– **Ceiling Panel Impacts**

  As shown in Table 6 on page 13, the majority of the environmental impacts for this product occur during the extraction and processing of raw materials detailed in the Production Stage. For most ceiling panels, the opportunity for reduction is in the manufacturing process as well as reductions associated with raw materials. Recycled ceiling panels used in the production process reduce raw material impacts by using less virgin raw materials..

– **Use Stage:**

  Although Armstrong provides a 30-year ceiling system warranty, the use stage is defined in the PCR at 75 years and this is what was used in the LCA. The assumption is that the ceiling system requires no cleaning or maintenance so the impact is very small.

– **End of Life Impacts:**

  End of Life impacts associated with landfilling and/or incineration of Calla ceiling panels range from .5% to 29% of all impact categories. For example, End of Life represented approximately 18% of the overall Global Warming Potential impacts for an Calla ceiling tile.

**Transport To The Building Site (A4)**

| | Unit | Calla |
|---|---|---|
| Liters of fuel | l/100km | 3412.556 |
| Transport distance | km | 805 |
| Capacity utilization (including empty runs) | % | 67 |
| Gross density of products transported | $kg/m^3$ | 1.334 |
| Capacity utilization volume factor | – | 1 |

## 4. LCA: Scenarios and Additional Technical Information (continued)

**Installation Into The Building (A5)**

| Parameter | Unit | 1 M² | 1 ft² |
|---|---|---|---|
| Auxiliary | kg | 0 | 0 |
| Water Consumption | m3 | 0 | 0 |
| Other Resources | kg | 0 | 0 |
| Electricity Consumption | kWh | 0 | 0 |
| Other Energy Carriers | MJ | 0 | 0 |
| Material Loss | kg | 0.3424 | 0.0318 |
| Ceililing Panel Mounting System (CPMS) | kg | 1.1230 | 0.1043 |
| Ceililing Panel Mounting System (CPMS) | % | 19% | 19% |
| Output substances following waste treatment on site | kg | 0.0000 | 0.0000 |
| Dust in air | kg | negligible | negligible |
| VOC in Air | kg | negligible | negligible |

### Installation Into the Building

There is no energy or water use required for the ceiling system installation. For suspended ceiling systems, a 7% waste factor was assumed on site during construction. This value is based on historic internal studies which have documented the quantity of scrap that are generated at the job site due to needed cuts (to allow for the installation of sprinkler heads, for example) or mistakes. While this material can be and is recycled from some jobs, it is assumed that all of the on-site scrap material will be sent to a landfill located within 50 miles of the jobsite. The Prelude suspension was considered as part of the ceiling panel mounting system (CPMS).

The values in the table are based on a Prelude system used to install 2' x 2' square tiles at a typical depth of 4 feet from the deck. Hanger wires are every 4 feet and assumed that 6 foot long 12 gauge wire was utilized.

### End of Life

End of life impacts include disposal of ceiling panels, scrap and packaging at the end of installation.

The end of life process within the LCA model assumed that 88% of the waste was landfilled and 12% of the waste was incinerated.

Armstrong offers our ceiling recycling program as a closed loop end of life solution instead of landfill or other alternative disposal methods.

The end of life phase for the ceiling tiles was included in the study. End of life impacts include disposal of ceiling panels, scap, and packaging at the end of installation. Armstrong offers our ceiling recycling program as a closed loop end of life solution instead of landfill or alternative disposal methods. Although the ceiling recycling is a successful program, the volume does vary from year to year so a conservative approach was taken within the study to not include the recycle program but to rather consider that all tiles are landfilled or incinerated. The study was also conservative in the fact that it did not take credit for any energy that was recovered in the incineration of landfill process.

## 4. LCA: Scenarios and Additional Technical Information (continued)

### Reuse, Recovery And/Or Recycling Potentials (D), Relevant Scenario Information

Armstrong offers our ceiling recycling program as a closed loop end of life solution instead of landfill or alternative disposal methods. Although the ceiling recycling is a successful program, the volume does vary from year to year so a conservative approach was taken within the study to not include the recycle program but to rather consider that all tiles are landfilled or incinerated. The study was also conservative in the fact that it did not take credit for any energy that was recovered in the incineration of landfill process.

## 4.1 Additional Technical Information

In 2012, Armstrong created a third party verified LCA model to represent the environmental impact the grid would have on the entire ceiling system. Since that time there have been minimal changes to our manufacturing process and we maintain the same manufacturing locations. Although the Product Category Rules do not include suspension systems, we have included the 2012 grid LCA data and results below for informational purposes so our customers may have a better understanding of the environmental impacts of the entire ceiling system. The intent is to create a separate EPD for suspension systems in the future.

**Material Content of Suspension Systems**

| Components | FUNCTION | QUANTITY (PERCENT BY WEIGHT) | RECYCLED MINERAL RESOURCE | MINERAL RESOURCE | NON-RENEW-ABLE | RENEW-ABLE | ABUNDANT | RECYCLED MATERIAL | ORIGIN | TRANS-PORTATION MODE | TRANS-PORTATION MILES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot Dipped Galvanized Steel | Suspension | >98% | ■ | ■ | ■ | | ■ | ■ | Global | Truck | 500-600 |
| Paint | Finish | <2% | | ■ | ■ | | | | U.S. | Truck/Rail | 200-500 |

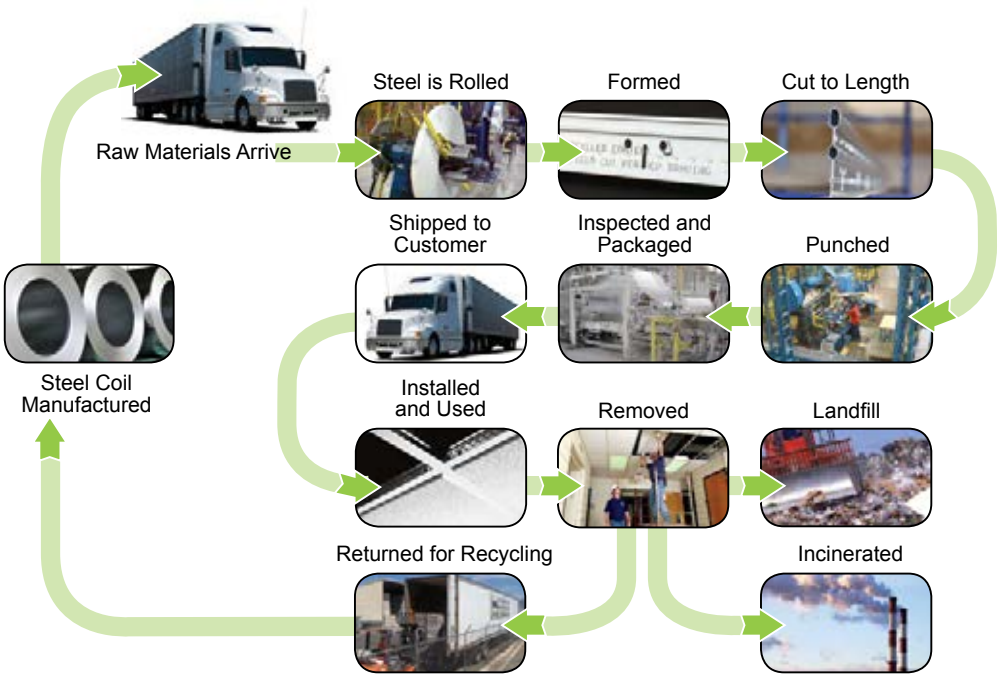
**Representative Suspension System for which Life Cycle Assessment Data was Compiled**

| FAMILY | ITEMS | MANUFACTURING LOCATIONS |
|---|---|---|
| Prelude XL* | | |
| Main Beam | 7300 / 7301 | Aberdeen, MD; Benton Harbor, MI; and Las Vegas, NV |
| Cross Tee 4' | XL7348 / XL7343 / XL7341 | |
| Cross Tee 2' | XL7328 / XL8320 | |
| Molding | 7800 | |
| Hanger Wire | 7891 | |

* Prelude XL LCA data is representative of Suprafine XL, Silhouette XL, and Interlude XL Suspension Systems

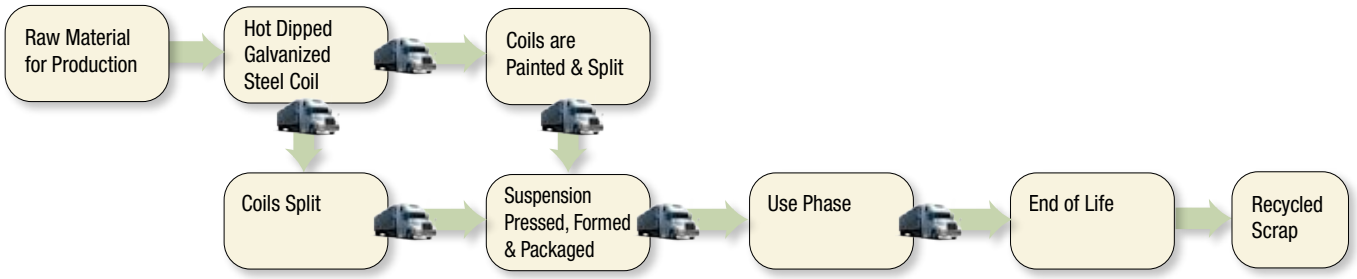
## 4.1 Additional Technical Information (continued)

**Process for Manufacturing Steel Suspension Systems**




Armstrong suspension systems use hot dipped galvanized steel which is formed into coils. A large component of the steel is recycled material. The coils are split and painted, and then sent to Armstrong. At the Armstrong plant, the steel is pressed, roll formed, punched, and packaged. The material is then shipped and installed. When the system is disassembled, the majority of the steel is recycled.

**Life Cycle Phases Included for the Steel Suspension System in Study:**



## 4.1 Additional Technical Information (continued)

### The Cradle-to-Grave Assessment Includes:

– Raw materials production including hot dipped galvanized steel master coil production, forming, and packaging
– Transportation of raw materials to Armstrong manufacturing facility
– Manufacturing of the suspension system at an Armstrong manufacturing facility
– Packaging of finished products including energy to operate packaging equipment
– Transportation from manufacturing facility to distribution centers, retailers, and job site (assumed to be 500 miles by truck)
– Use phase covers a useful life of 75 years as suggested in the PCR and includes the transportation and installation of the system

### The Cradle-to-Grave Assessment Excludes:

– Overhead energy usage (heating, lighting) of manufacturing facilities
– Maintenance and operation of support equipment

**LCA Detail by Life Cycle Stage for 1 ft² of Prelude XL Suspension System in 2' x 2' Module for Use over 75 years**

| | PRODUCTION | USE | END OF LIFE | TOTAL |
|---|---|---|---|---|
| **INDICATORS** | **PRELUDE XL** | | | |
| Primary Energy (MJ) | 2.8 | 0.2 | -0.1 | 2.9 |
| Global warming potential (kg $CO_2$- Eq.) | 0.22 | 0.01 | -0.01 | 0.22 |
| Stratospheric ozone layer depletion (kg CFC-11 Eq.) | 2.56E-09 | 4.1E-10 | 2.48E-10 | 3.218E-09 |
| Acidification potential ($CO_2$ Eq.) | 0.04 | 0 | 0 | 0.04 |
| Eutrophication potential (kg N- Eq.) | 3.30E-05 | 0.00000653 | 2.83E-06 | 0.00004236 |
| Photochemical ozone creation potential (kg $O^3$- Eq.) | 0.009 | 0.001 | 0 | 0.01 |

Heavy-duty suspension system components have greater impacts than intermediate-duty suspension system components, because they contain more steel.

## 5. LCA: Results

The Life Cycle Assessment (LCA) was performed according to ISO 14040 and follows the PCR instructions. The cradle-to-grave LCA encompasses raw material production; transport of raw materials to production facility; manufacturing of ceiling panels; packaging; transportation to job site; use phase; and end of life including disposal or recycling.

**Table 1. Description of the system boundary (X = Included in LCA; MND = Module not declared**

| | PRODUCT STAGE | | | CONSTRUCTION PROCESS STAGE | | USE STAGE | | | | | | | END OF LIFE STAGE | | | | BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw Material supply | Transport | Manufacturing | Transport from gate site | Assembly/Install | Use | Maintenance | Repair | Replacement | Refurbishment | Operational Energy Use | Operational Water Use | Deconstruction | Transport | Waste processing | Disposal | Reuse, Recovery, Recycling potential | RSL |
| EPD type | **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C3** | **C4** | **D** | |
| Cradle to grave – $M^2$ | | | | | | | | | | | | | | | | | | |
| | All A – C modules mandatory | | | | | | | | | | | | | | | | | 75 Yrs |
| | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | |

### Life Cycle Environmental Impact Results: 1 $M^2$ Calla Ceiling Panel

Declared Unit: 1 $M^2$ of ceiling panels for use over 75 years, impacts based on U.S. EPA TRACI 2.1 Impact Factors

**Table 2. North American LCA Environmental Impact Results**

| TRACI 2.1 Impact Assessment, October 2013 | | | | |
|---|---|---|---|---|
| **PARAMETER** | **PARAMETER** | **UNIT** | **1 $M^2$** | **1 $ft^2$** |
| GWP | Global warming potential | kg CO2- Eq. | 10.9607 | 1.0186 |
| ODP | Stratospheric ozone layer depletion | kf CFC-11 Eq. | 1.9287 | 1.7924 |
| AP | Acidification potential | kg SO2- Eq. | 0.0401 | 0.0037 |
| EP | Eutrophication potential | kg N- Eq. | 0.0053 | 0.0004 |
| POCP | Photochemical ozone creation potential | kg O3- Eq. | 0.4055 | 0.0376 |
| ADP | Abiotic resource depletion potential - fossil fuels | Surplus energy per extracted MJ, kg or m3 fossil fuel as a result of lower quality resources | 7.3296 | 0.6811 |

## 5. LCA: Results (continued)

### Table 3. LCA Results: Resource Use

| LCA RESULTS - RESOURCE USE 1 M² CALLA | | | | |
|---|---|---|---|---|
| **Parameter** | **Parameter** | **Unit** | **1 M²** | **1 ft²** |
| PERE | Renewable primary energy as energy carrier | MJ, LHV | 96.9536 | 9.0105 |
| PERM | Renewable primary energy resources as material utilization | MJ, LHV | 6.5289 | 0.6067 |
| PERT | Total use of renewable primary energy resources | MJ, LHV | 103.4826 | 9.6173 |
| PENRE | Non-renewable primary energy as energy carrier | MJ, LHV | 97.5753 | 9.0683 |
| PENRM | Non-renewable primary energy as material utilization | MJ, LHV | 0 | 0 |
| PENRT | Total use of non-renewable primary energy resources | MJ, LHV | 97.5753 | 9.0683 |
| SM | Use of secondary material | MJ, LHV | 2.5386 | 0.2359 |
| RSF | Use of renewable secondary fuels | MJ, LHV | 0 | 0 |
| NRSF | Use of non-renewable secondary fuels | MJ, LHV | 0 | 0 |
| FW | Use of net fresh water | $m^3$ | 0.0025 | 0.0002 |

### Table 4. LCA Results: Output Flows and Waste Categories

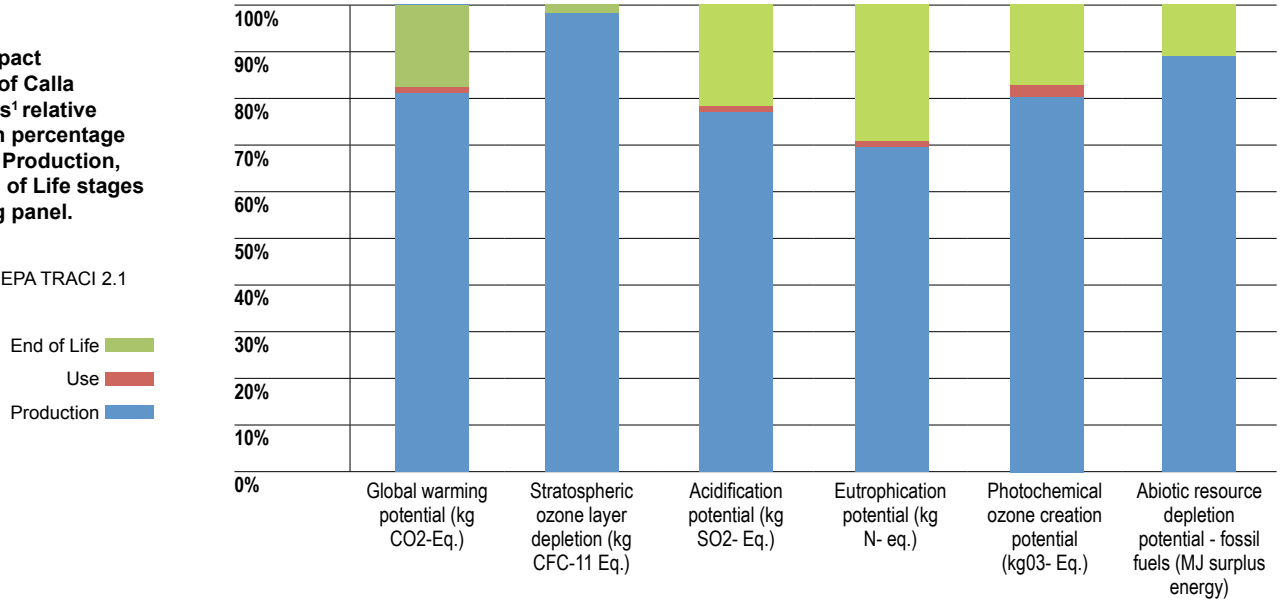
| LCA RESULTS: OUTPUT FLOWS AND WASTE CATEGORIES 1 M² CALLA | | | | |
|---|---|---|---|---|
| **Parameter** | **Parameter** | **Unit** | **1 M²** | **1 ft²** |
| HWD | Hazardous waste disposed | kg | 0.0000 | 0.0000 |
| NHWD | Non-hazardous waste disposed | kg | 0.8883 | 0.0825 |
| RWD | Radioactive waste disposed | kg | 0.0000 | 0.0000 |
| CRU | Components for re-use | kg | 0.0000 | 0.0000 |
| MFR | Materials for recycling* | kg | 0.0000 | 0.0000 |
| MER | Materials for energy recovery | kg | 0.0000 | 0.0000 |
| EE | Exported energy | MJ, LHV | 0.0000 | 0.0000 |
| | HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EE = Exported energy | | | |

## 6. LCA: Interpretation

From the results of the suspended ceiling system life cycle covered in this study, it was concluded that the ceiling panel manufacturing process and raw materials – specifically, mineral wool in the ceiling panel and steel in the suspension systems – have the greatest impact on Primary Energy Demand (PED) and "carbon footprint" (represented by Global Warming Potential [GWP]).

**Life Cycle Impact Assessment of Calla Ceiling Panels[1] relative importance in percentage terms for the Production, Use, and End of Life stages for the ceiling panel.**

[1] Based on U.S. EPA TRACI 2.1




## 7. Supporting Documentation

### Bio-Persistence of Mineral Wool Fibers

Slag wool fibers have been classified as "not classifiable as to its carcinogenicity to humans" (Group 3) by the International Agency for Research on Cancer (IARC). The MSDS for this product can be found at armstrongceilings.com/MSDS as referenced in volume 81.

### Quality Assurance

Armstrong has a robust internal Quality Assurance process that is based on industry-accepted best practices and is led by a team of quality professionals who have been certified by the American Society for Quality. The process involves several hundred different measures made throughout the manufacturing processes. In addition, our products are UL labeled for fire and acoustical performance, a process which involves strict oversight by Underwriters Laboratories. The Armstrong acoustical laboratory is ISO 17025 certified and is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP).

## 8. References

### PCR

**UL Environment**

UL Environment General Program Instructions April 2015, version 2

**Sustainability Reporting Standards**

EN 15804: 2012-04 - Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction product.

ISO 14025: 2006 – Environmental labels and declarations — Type III environmental declarations — Principles and procedures

ISO 14040: 2006 – Environmental management – Life cycle assessment – Principles and framework

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

ISO 14046:2013 – Environmental management- Water footprint- Principles, requirements and guidelines

ISO 15392:2008 – Sustainability in building construction- General principles

ISO 15686-1:2011 – Buildings and constructed assets- Service life planning- Part 1: General principles

ISO 15686-2:2008 – Buildings and constructed assets- Service life planning Part 2: Service life prediction procedures

ISO 15686-7:2008 – Buildings and constructed assets- Service life planning Part 7: Performance evaluation for feedback of service life data from practice

ISO 15686-8:2008 – Buildings and constructed assets- Service life planning Part 8: Reference service life and service life estimation

ISO 21930: 2007 – Sustainability in building construction -- Environmental declaration of building products

**Testing And Classification References**

ASTM C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

ASTM C636 – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustic Panel and Lay-in Panels

ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials

ASTM E1110 – Standard Classification for Determination of Articulation Class

ASTM E1111 – Standard Test Method for Measuring the Interzone Attenuation of Open Office Components

ASTM E1264 – Standard Classification for Acoustical Ceiling Products

ASTM E1414 – Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum

ASTM E1477 – Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers

ASTM E413 – Classification for Rating Sound Insulation

CA Specification 01350 Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers - Version 1.1

## 8. References (continued)

**Relevant Federal Standards and SOPS**

Environment Canada, National Pollutant Release Inventory (http://www.ec.gc.ca/inrp-npri/)

EPCRA 313 Toxic Release Inventory Reporting (U.S.) (http://www2.epa.gov/toxics-release-inventory-tri- program)

US EPA, ORD/NRMRL/Sustainable Technology Division, Systems Analysis Branch, SOP No. S-10637- OP-1-0- Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI), Software Name and Version Number: TRACI version 2.1, USER'S MANUAL, 24 July, 2012

US: Resource Conservation and Recovery Act (RCRA), Clause C (http://www.epa.gov/region6/rcra/)

**Relevant PCRs**

PCR Guidance for Building Related Products and Services, From the range of Environmental Product Declarations of UL Environment: "Part B: Non-Metal Ceiling Panel EPD Requirements", October 2015v1.

UL Environment General Program Instructions April 2015, version 2

PCR Part A: UL Environment and Institute of Construction and Environment e.V., Königswinter (pub.): Product Category Rules for Construction Products from the range of Environmental Product Declarations of Institut Bauen und Umwelt (IBU), Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report. July 2014, version 1.3

EN 15804: 2012-04 - Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction product.

ISO 14025: 2006 - Environmental labels and declarations — Type III environmental declarations — Principles and procedures

ISO 14040: 2006 - Environmental management – Life cycle assessment – Principles and framework

ISO 14044:2006 - Environmental management – Life cycle assessment – Requirements and guidelines