

ENVIRONMENTAL PRODUCT DECLARATION

OPTIMA® CEILING PANELS

HIGH PERFORMANCE FIBERGLASS

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



Optima® Plank Ceiling Panels
Bayer Interventional, Coon Rapids, MN
Architectural Alliance, Minneapolis, MN



Committed to Sustainability.

Armstrong World Industries 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

Optima® ceilings deliver a superior combination of performance attributes – superior sound absorption, clean aesthetics, and a reduced environmental footprint – making it a great product for commercial applications.



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CEILING SOLUTIONS

Optima® Ceiling Panels
High Performance Fiberglass

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	4786828541.101.1
DECLARED PRODUCT	Optima® Ceiling Panels- High Performance Fiberglass
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 Information about basic material and the material’s origin Description of the product’s manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications
The PCR review was conducted by:	Review Panel
	Dr. Lindita Bushi
	epd@ul.com
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> 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



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2. Product System Documentation

2.1 Product Description

Armstrong® Optima® Ceiling Panels are fiberglass acoustical ceiling panels, featuring a fine-textured, non-directional DuraBrite® surface for increased durability and superior light reflectance. This EPD includes Optima and Optima Plant Based (PB) items. Optima ceiling panels are manufactured by Armstrong World Industries in Hilliard, Ohio (43026).















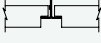




2.2 Application

Commercial Interior Finish. Acoustical, Suspended Ceiling System. The ceiling system must be installed in accordance with Armstrong Ceilings 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/sustain.

2.3 Technical Data

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

Performance of Optima Ceiling Panels¹

Items Included in this EPD	Attributes
Optima Square Tegular Panels for 15/16" Suspension System 	<div style="display: flex; flex-wrap: wrap;"> <div style="width: 33%;"> NRC 0.90-0.95 NRC is measured according to ASTM C423</div> <div style="width: 33%;"> AC 180-200 AC is measured according to ASTM E1110 and E1111</div> <div style="width: 33%;"> Fire Rating: Class A Flame Spread Index (FSI)/Smoke Developed Index (SDI) ASTM E84; UL 723; CAN/ULC – S102M</div> <div style="width: 33%;"> Light Reflectance 0.90</div> <div style="width: 33%;"> Sag-resistant (HumiGuard® Plus humidity resistance)</div> <div style="width: 33%;"> Anti-Microbial (BioBlock® Coating)</div> <div style="width: 33%;"> Washable ASTM D4828</div> <div style="width: 33%;"> Impact-resistant Modified ASTM D1037 Procedure</div> <div style="width: 33%;"> Scratch-resistant</div> <div style="width: 33%;"> Soil-resistant</div> <div style="width: 33%;"> Recyclable</div> </div> <p>In addition to the attributes listed above, Health Zone™ items are:</p> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 33%;"> Water-repellent</div> <div style="width: 33%;"> Scrubbable Modified ASTM D2486 Procedure</div> </div>
Optima Square Tegular Panels for 9/16" Suspension System 	
Optima Vector for 15/16" Suspension System 	
Optima Square Lay-in Panels for 15/16" Suspension System 	
Optima Concealed for 15/16" Suspension System  Quick Kerf Edge  Non-support Edge	

¹ Data shows a range of attributes for the Optima product family.



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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

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

ASTM E1110-06 (2011) Standard Classification for Determination of Articulation Class

ASTM E1111 (2007) Test Method for Measuring the Interzone Attenuation of Ceiling Systems

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.



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2. Product System Documentation (continued)

2.6 Material Content

- **Fiberglass Core** – Consists of glass fibers and an organic resin
- **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 Optima® Ceiling Panel

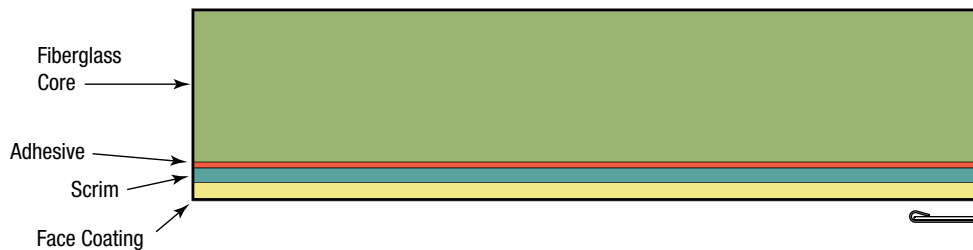
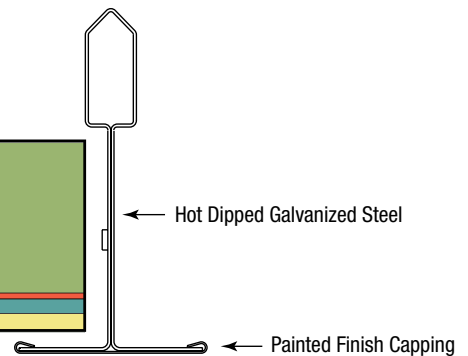


Figure 2. Composition of Prelude® XL® Suspension Systems



Material Content of Optima Ceiling Panels

Fiberglass Core	FUNCTION	QUANTITY (PERCENT BY WEIGHT)	RECYCLED MINERAL RESOURCE	MINERAL RESOURCE	NON-RENEWABLE	RENEWABLE	ABUNDANT	RECYCLED MATERIAL	ORIGIN	TRANSPORTATION MODE	TRANSPORTATION MILES
Glass Fibers	Acoustics	60-75%	■	■	■		■		Global	Truck/Rail	750-1400
Organic Binder	Binder	5-15%			■				Global	Truck/Ship	750-1400
Coating	Finish	15-25%		■	■				U.S.	Truck/Rail	400-4000
Scrim	Finish	1-5%	■	■	■		■		Global	Truck/Ship	6000-7000
Adhesive	Finish	1-5%			■				U.S.	Truck	<500



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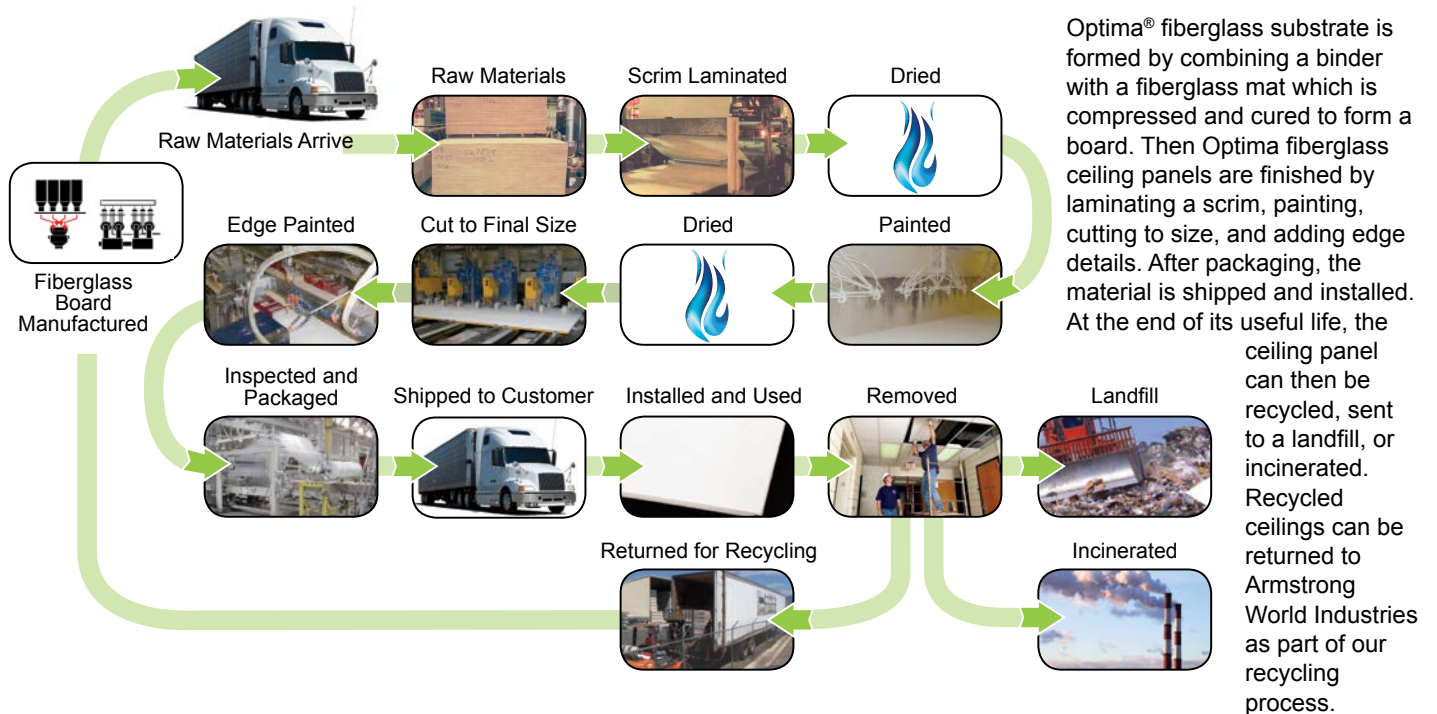
OPTIMA® CEILING PANELS
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According to ISO 14025

2. Product System Documentation (continued)

2.7 Manufacture

Figure 3: Process for Manufacturing Optima Ceiling Panels



2.8 Health, Safety, and Environmental Aspects During Manufacturing

Armstrong World Industries 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 World Industries 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 Ceilings 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 www.armstrongceilings.com/installationinstructions.

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.



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2. Product System Documentation (continued)

2.11 Condition of Use

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

Cleaning instructions for Optima ceilings can be found at www.armstrongceilings.com/installationinstructions.

2.12 Health, Safety, and Environmental Aspects During Installation

There are no recognized systemic hazards associated with installing ceiling panels. Armstrong World Industries recommends that installers handle materials in a manner to minimize airborne dust. Installers should wear appropriate personal protective equipment, such as gloves, safety glasses, and dust mask, 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 panels offer 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 Heat Flow Meter Apparatus

All Optima Items – 1" Tegular

R Factor – 4.0 (BTU units)

R Factor – 0.70 (Watts units)

– Seismic Performance

Seismic Categories C, D, E, and F

ICC-ES ESR-1308 – see www.armstrongceilings.com/seismicrx

– Acoustical Panel Classification

ASTM E1264 - Standard Classification for Acoustical Ceiling Products

Type XII, Form 2, Pattern E, Fire Class A



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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 World Industries 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.

Installation waste is minimized by the modular aspect of the ceiling panel system. A conservative 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 is generated at the job site due to needed border cuts, penetrations, or installer mistakes. While this material can be and is recycled from some jobs, in this case, it is assumed that all of the on-site scrap material will be sent to a landfill located within 50 miles of the job site.

3. Life Cycle Assessment

This study provides life cycle inventory and environmental impacts relevant to Armstrong® suspended ceilings. 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 ceilings, 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 Product Category Rules Guidance for Building-Related Products and Services Part B: Non-Metal Ceiling Panel EPD Requirements.

3.1 Declared and Functional Unit

The declared unit for this EPD is 1 M² of Optima ceiling panel for use over 75 years.

Armstrong World Industries has chosen to also report for 1 ft².

The data reported in this EPD is for Optima 1" tegular items. Items with a square edge and/or a 3/4" thickness resulted in lower LCA impacts when the entire product line was assessed, therefore, this EPD reports the highest potential LCA impacts for this family.

Optima	Value
Declared Unit	ft ²
DeclaredThickness (inches)	1
Surface Weight (lb/ft ²)	0.55
Declared Unit	m ²
DeclaredThickness (cm)	2.540
Surface Weight (kg/m ²)	2.691



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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 Ceilings manufacturing facility
- Manufacturing of the ceiling panels at an Armstrong Ceilings 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.



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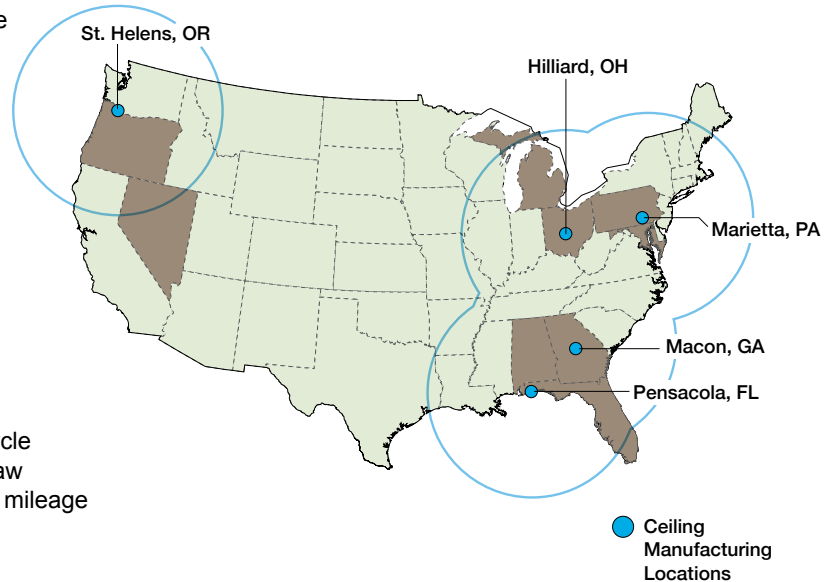
3. Life Cycle Assessment (continued)

3.5 Background Data:

All data is reported as a North American weighted average across our ceiling 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 Ceilings 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 fiberglass substrate and 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

Calendar year 2014 manufacturing data was used to create the LCA model.



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3. Life Cycle Assessment (continued)

3.8 Allocation:

No allocation was performed within the modeling of Armstrong World Industries unit processes for Optima® fiberglass 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

– Ceiling Panel Impacts:

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 glass fibers 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 Optima ceiling panels range from .003% to 15% of all impact categories. For example, End of Life represented approximately 15% of the overall Global Warming Potential impacts for an Optima ceiling tile.

Transport To The Building Site (A4)

	Unit	Optima
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	0.7341
Capacity utilization volume factor	-	0.87



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

Installation Into The Building (A5)

Parameter	Unit	1 M ²	1 ft ²
Auxiliary	kg	0	0
Water Consumption	m ³	0	0
Other Resources	kg	0	0
Electricity Consumption	kWh	0	0
Other Energy Carriers	MJ	0	0
Material Loss	kg	0.1883	0.0175
Ceiling Panel Mounting System (CPMS)	kg	1.1230	0.1043
Ceiling Panel Mounting System (CPMS)	%	0.2949	0.2949
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 World Industries offers a 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 World Industries offers a 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.



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

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

Armstrong World Industries offers a 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 World Industries 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-RENEWABLE	RENEWABLE	ABUNDANT	RECYCLED MATERIAL	ORIGIN	TRANSPORTATION MODE	TRANSPORTATION 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



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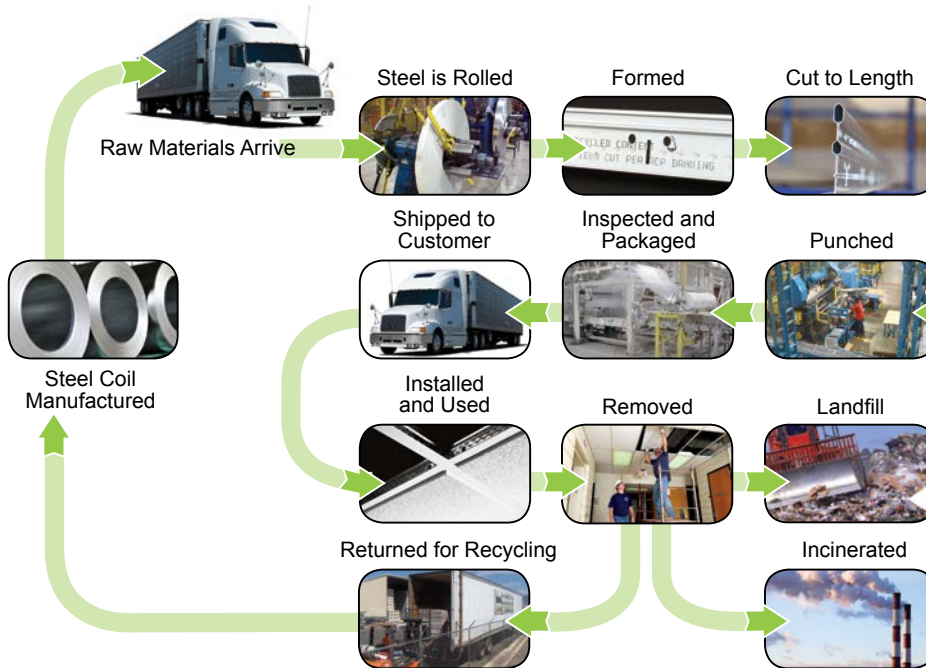


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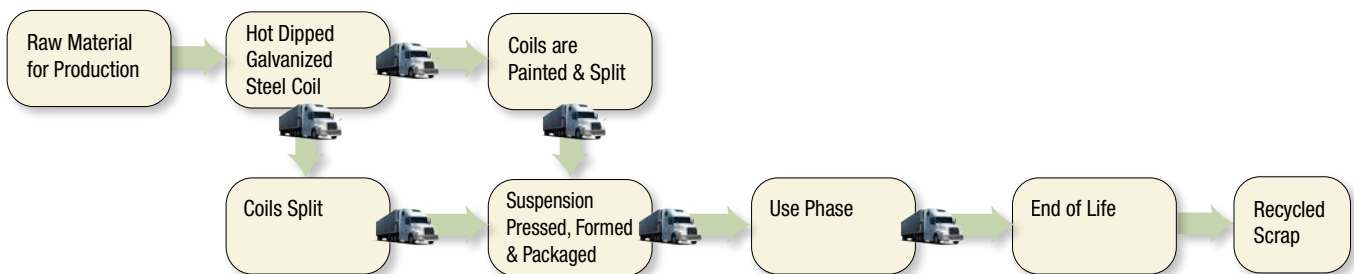
4.1 Additional Technical Information (continued)

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 World Industries. At the Armstrong Ceilings 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:



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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 Ceilings manufacturing facility
- Manufacturing of the suspension system at an Armstrong Ceilings 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.



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According to ISO 14025

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	RSL
	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		
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	X

Life Cycle Environmental Impact Results: 1 M² Optima Ceiling Panel

Declared Unit: 1 M² 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 CO ₂ - Eq.	1.95844	0.182012
ODP	Stratospheric ozone layer depletion	kg CFC-11 Eq.	1.14476E-07	1.0639E-08
AP	Acidification potential	kg SO ₂ - Eq.	0.015021	0.001396
EP	Eutrophication potential	kg N- Eq.	0.000427	3.96922E-05
POCP	Photochemical ozone creation potential	kg O ₃ - Eq.	0.441649	0.041045
ADP	Abiotic resource depletion potential - fossil fuels	Surplus energy per extracted MJ, kg or m ³ fossil fuel as a result of lower quality resources	3.116822	0.289667



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5. LCA: Results (continued)

Table 3. LCA Results: Resource Use

LCA RESULTS - RESOURCE USE 1 M ² OPTIMA				
Parameter	Parameter	Unit	1 M ²	1 ft ²
PERE	Renewable primary energy as energy carrier	MJ, LHV	3.032072	0.281791
PERM	Renewable primary energy resources as material utilization	MJ, LHV	0	0
PERT	Total use of renewable primary energy resources	MJ, LHV	3.032072	0.281791
PENRE	Non-renewable primary energy as energy carrier	MJ, LHV	3.032072	0.281791
PENRM	Non-renewable primary energy as material utilization	MJ, LHV	0	0
PENRT	Total use of non-renewable primary energy resources	MJ, LHV	25.819958	2.399624
SM	Use of secondary material	MJ, LHV	0	0
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	0.0028036	0.000260

Table 4. LCA Results: Output Flows and Waste Categories

LCA RESULTS: OUTPUT FLOWS AND WASTE CATEGORIES 1 M ² OPTIMA				
Parameter	Parameter	Unit	1 M ²	1 ft ²
HWD	Hazardous waste disposed	kg	0.0000	0.0000
NHWD	Non-hazardous waste disposed	kg	0.4890	0.0454
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



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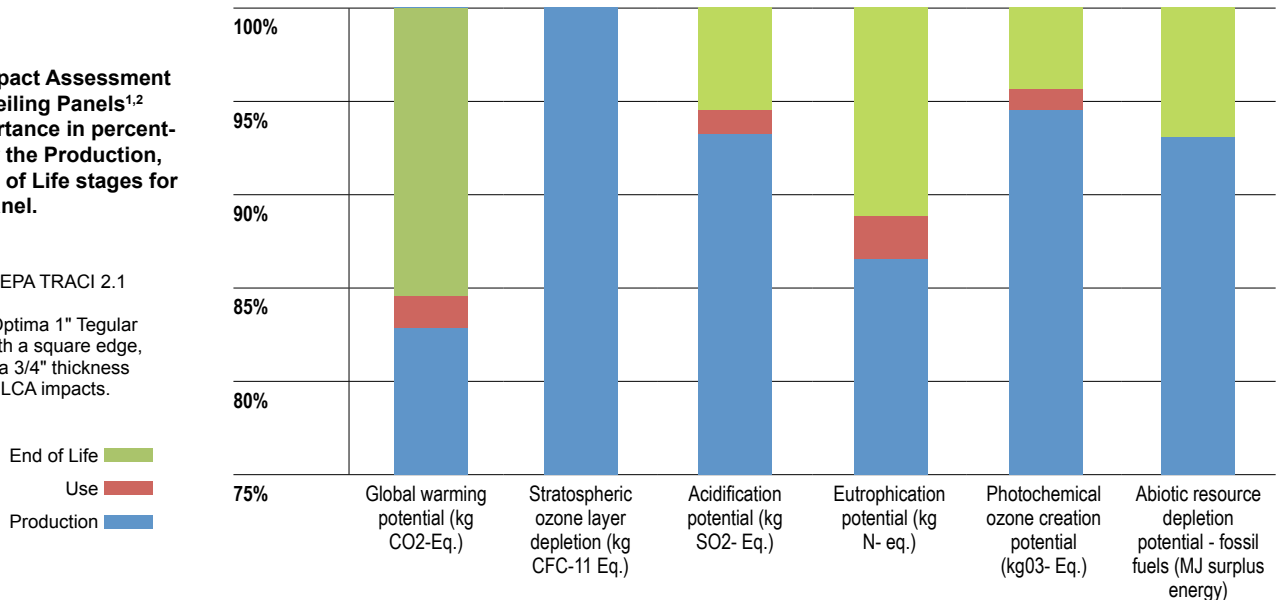
According to ISO 14025

6. LCA: Interpretation

From the 2014 LCA Model of the ceiling life cycle covered in this study, it was concluded that the ceiling panel manufacturing process and raw materials – specifically, fiberglass substrate and scrim in the ceiling panel – have the greatest impact on “carbon footprint” (represented by Global Warming Potential [GWP]).

Life Cycle Impact Assessment of Optima® Ceiling Panels^{1,2} 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 Impact Factors
² Data is from Optima 1" Tegular items. Items with a square edge, and items with a 3/4" thickness will have lower LCA impacts.



7. Supporting Documentation

Biopersistence of Glass Fibers

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

Quality Assurance

Armstrong World Industries 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 Ceilings acoustical laboratory is ISO 17025 certified and is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP).



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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



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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

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