COMMITTED TO SUSTAINABILITY

Armstrong World Industries leads in delivering solutions that meet today’s most stringent industry sustainability standards. We are committed to environmental responsibility in all aspects of our business, and carbon reduction is part of our 2030 Company goals and ambitions.

We were one of the first companies to create and publish the Environmental Product Declaration (EPD) in the ceiling industry. We have over a decade of experience using Life Cycle Assessment (LCA) to evaluate environmental impacts of our products starting with design, to raw materials, and through our operations. We are constantly working to optimize our operations and products to reduce their environmental impact. We believe the use of LCA and our commitment to transparency of our products’ carbon footprint is critical to contributing to decarbonization of the built environment.

Contents:
- Performance features like acoustics, light reflectance, and durability
- Product application and use
- Product ingredients and their sources
- How the product is produced
- LCA results, including global warming potential and primary energy usage
- Total impacts over the product life cycle

For more information visit armstrongceilings.com/transparency

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

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER</td>
<td>General Program Instructions v.2.5 March 2020</td>
</tr>
<tr>
<td>MANUFACTURER NAME AND ADDRESS</td>
<td>Armstrong World Industries 2500 Columbia Avenue Lancaster, PA 17603</td>
</tr>
<tr>
<td>DECLARATION NUMBER (Part A and B)</td>
<td>4790057043.102.1</td>
</tr>
<tr>
<td>DECLARED PRODUCT &amp; FUNCTIONAL UNIT OR DECLARED UNIT</td>
<td>0.093m² (1ft²)</td>
</tr>
<tr>
<td>REFERENCE PCR AND VERSION NUMBER</td>
<td>UL Environment PCR for Building-Related Products &amp; Services - Part A (Dec. 2018, v.3.2), UL Environment PCR Part B: Non-Metal Ceiling Panel &amp; Wall Panel System (April 2021, v.2.0)</td>
</tr>
<tr>
<td>DESCRIPTION OF PRODUCT’S INTENDED APPLICATION AND USE (AS IDENTIFIED WHEN DETERMINING PRODUCT RSL)</td>
<td>Optima® Ceiling Panels, High Performance Fiberglass</td>
</tr>
<tr>
<td>PRODUCT RSL DESCRIPTION (IF APPL.)</td>
<td>30 Years</td>
</tr>
<tr>
<td>MARKETS OF APPLICABILITY</td>
<td>Commercial and Residential Interior Furnishing</td>
</tr>
<tr>
<td>DATE OF ISSUE</td>
<td>October 1, 2021</td>
</tr>
<tr>
<td>PERIOD OF VALIDITY</td>
<td>5 Years</td>
</tr>
<tr>
<td>EPD TYPE</td>
<td>Product-specific</td>
</tr>
<tr>
<td>DATASET VARIABILITY</td>
<td>Industry Average Only</td>
</tr>
<tr>
<td>EPD SCOPE</td>
<td>Cradle to Grave</td>
</tr>
<tr>
<td>YEAR(S) OF REPORTED MANUFACTURER PRIMARY DATA</td>
<td>2020</td>
</tr>
<tr>
<td>LCA SOFTWARE &amp; VERSION NUMBER</td>
<td>GaBi 9 by Sphera Inc</td>
</tr>
<tr>
<td>LCI DATABASE(S) &amp; VERSION NUMBER</td>
<td>GaBi Service Pack 39 by Sphera Inc</td>
</tr>
<tr>
<td>LCIA METHODOLOGY &amp; VERSION NUMBER</td>
<td>TRACI 2.1</td>
</tr>
<tr>
<td>The sub-category PCR review was conducted by:</td>
<td>EPD Review Panel Chair: Dr. Lindita Bushi <a href="mailto:epd@ul.com">epd@ul.com</a></td>
</tr>
<tr>
<td>This declaration was independently verified in accordance with ISO 14025: 2006. The UL Environment “Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report,” serves as the core PCR.</td>
<td>Thomas Gloria, Industrial Ecology Consultants</td>
</tr>
<tr>
<td>This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:</td>
<td>Thomas Gloria, Industrial Ecology Consultants</td>
</tr>
<tr>
<td>This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:</td>
<td>Sphera</td>
</tr>
<tr>
<td>LIMITATIONS</td>
<td>Environmental declarations from different programs (ISO 14025) may not be comparable. Comparison of the environmental performance of Metal Ceiling and Wall System Products using EPD information shall be based on the product’s use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building energy use phase as instructed under this PCR. Full conformance with this PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to differences in results for upstream or downstream of the life cycle stages declared.</td>
</tr>
</tbody>
</table>
2. GENERAL INFORMATION

2.1 DESCRIPTION OF ORGANIZATION

Armstrong World Industries, Inc. (AWI) is a leader in the design and manufacture of innovative commercial and residential ceiling, wall and suspension system solutions in the Americas. At home, at work, in healthcare facilities, classrooms, stores, or restaurants, Armstrong World Industries offers interior solutions that help to enhance comfort, save time, improve building efficiency and overall performance, and create beautiful spaces.

For more than 150 years, we have built our business on trust and integrity. It set us apart then, and it sets us apart now, along with our ability to collaborate with, and innovate for the people we’re here to serve – our customers, our shareholders, our communities, and our employees.

We are committed to developing new and sustainable ceiling solutions, with design and performance possibilities that make a positive difference in spaces where we live, work, learn, heal, and play.

2.2 PRODUCT DESCRIPTION

Fine textured Optima® ceiling panels provide excellent acoustical absorption, light reflectance, and durability including impact, scratch, and soil resistance. Optima is available in a wide range of standard and custom sizes, including large sizes, trapezoid panels, and custom options.

Features:
- Optima® PB panels are part of the Sustain® portfolio, and meet the most stringent industry sustainability compliance standards today
- Smooth, clean, durable finish – Washable, Impact-resistant, Scratch-resistant, Soil-resistant
- Items with PB suffix are manufactured with a plant-based binder
- Outstanding acoustical performance for open plan areas, both Articulation Class 180-200 and NRC 0.90-1.00
- CleanAssure™ family of products – includes disinfectable panels, suspension systems, and trim
- Mold- and mildew-resistant surface
- Energy-saving high light-reflective finish
- Non-directional visual reduces scrap and installation time
- Sag-resistant large-size panels
- DesignFlex® options include shapes and made-to-order sizes available to ship in 3 weeks
- 30-Year Limited System Warranty against visible sag, mold, and mildew

2.2.1 Product Specific EPD

Optima® Ceiling Panels are manufactured by Armstrong World Industries in Hilliard, Ohio (43026). 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 that 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).
2.2.2 Product Identification
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.

2.2.3 Product Specification
This EPD includes Optima and Optima Plant-Based products. These products generally fall under ASTM E1264 Section 5.2 designation as Type III—Mineral base with painted finish.

The modifications typically involve modifications to the thickness, shape, density, basemat composition and/or coating package.

This report covers the entire Optima product line and focuses on highest volume product in the family. Other products within the family that differ by shape, size, and edge details of the panels are well represented within the scope of the study.
2.2.4 Flow Diagram

Optima® fiberglass substrate is formed by combining a binder with fiberglass fibers then compressed and cured to form a board. Optima fiberglass ceiling panels are manufactured by laminating a scrim, painting, cutting to size, and adding edge details. After packaging, the material is shipped and installed. At the end of its useful life, the ceiling panel can then be preferably recycled or refurbished or sent to a landfill. Recycled ceilings can be returned to Armstrong World Industries as part of our recycling business process.
2.3 PRODUCT AVERAGE
2.3.2 Product Specific EPD
In this specific case of Optima® fiberglass product EPD, manufacturing took place exclusively at Hilliard, OH facility. Data collection for energy and other raw materials input stream was specific to this location and was supported by volume-driven mathematical modeling. For the key raw materials specifically, fiberglass substrate and scrim, life cycle impacts data were provided by the supply chain partners. Other primary data were collected at the facility using the internal manufacturing systems and databases that track inputs consumption.

2.4 APPLICATION
The products covered by this EPD are designed to be installed in a suitable metal grid system typically designed to accommodate a nominal 6" x 48", 6" x 60", 12" x 24", 20" x 60", 24" x 24", 24" x 48", 24" x 72", 24" x 96", 30" x 30", 30" x 60", and 48" x 48" panels.

2.5 MATERIAL COMPOSITION
Major raw materials used in ceiling panel manufacturing are summarized in the table below.

<table>
<thead>
<tr>
<th>Material</th>
<th>Optima®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perlite</td>
<td>–</td>
</tr>
<tr>
<td>Mineral Wool</td>
<td>–</td>
</tr>
<tr>
<td>Fiberglass</td>
<td>100%</td>
</tr>
<tr>
<td>Paper</td>
<td>–</td>
</tr>
<tr>
<td>Starch</td>
<td>–</td>
</tr>
</tbody>
</table>

2.6 TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Name &amp; Test Method</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient (NRC) (ASTM C423)</td>
<td>0.90-0.95</td>
<td>NRC</td>
</tr>
<tr>
<td>Light reflectance (ASTM E1477)</td>
<td>0.90</td>
<td>n/a</td>
</tr>
<tr>
<td>Interzone attenuation of open office components (AC) (ASTM E1111 and ASTM E1110)</td>
<td>180-200</td>
<td>n/a</td>
</tr>
<tr>
<td>Sound Transmission Class (STC) (ASTM E413 and ASTM E90)</td>
<td>–</td>
<td>dB</td>
</tr>
<tr>
<td>Sound attenuation between rooms sharing a common ceiling plenum (CAC) (ASTM E1414 and Classification E413)</td>
<td>–</td>
<td>dB</td>
</tr>
<tr>
<td>Surface burning characteristics of building materials (ASTM E84, ASTM E1264)</td>
<td>Class A</td>
<td>Flame spread/smoke developed</td>
</tr>
</tbody>
</table>

2.7 PROPERTIES OF DECLARED PRODUCT AS DELIVERED
The final EPD is available on the Armstrong website (armstrongceilings.com/epd); at UL SPOT (spot.ul.com) and is under the Finish category in the EC3 Tool (buildingtransparency.org)
3. METHODOLOGICAL FRAMEWORK

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 UL® Environments (2021) Part B: Non-Metal Ceiling Panel EPD Requirements.

3.1 FUNCTIONAL UNIT
The declaration refers to the functional unit of 0.093 m² (1 ft²) of installed ceiling panel, as defined by the PCR.

3.2 DECLARED UNIT
The declaration refers to the declared unit of 0.093 m² (1 ft²) of installed ceiling panel, as defined by the PCR.

3.3 FUNCTIONAL/DECLARED UNIT PROPERTIES

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional unit</td>
<td>1</td>
<td>0.093 m² (1 ft²)</td>
</tr>
<tr>
<td>Declared unit (wall, ceiling, and column panels, covers, and assemblies)</td>
<td>1</td>
<td>0.093 m² (1 ft²)</td>
</tr>
<tr>
<td>Declared thickness</td>
<td>2.54</td>
<td>cm</td>
</tr>
<tr>
<td>Surface weight per declared unit</td>
<td>2.03</td>
<td>kg/m²</td>
</tr>
<tr>
<td>Density per declared unit</td>
<td>79.9</td>
<td>kg/m³</td>
</tr>
</tbody>
</table>

3.4 SYSTEM BOUNDARY
The scope of the study includes production, installation, use, end of life, and benefits and loads beyond the product system boundary. Production of capital equipment, facilities, and infrastructure required for manufacture are outside the scope of this assessment. Details of inclusions and exclusions from the system boundary are listed below.

THE CRADLE-TO-GRAVE ASSESSMENT INCLUDES:
– Raw material acquisition and processing for both the product and its packaging (A1)
– Inbound transport of raw materials to production facility (A2)
– Manufacturing energy of ceiling tiles panels (A3)
– Energy production (A3)
– Manufacturing waste disposal (A3)
– Packaging of final products (A3)
– Outbound transport of products to job site (A4)
– Installation and installation waste (A5)
– Use stage considered, but no impact (B1-B7)
– End of life, including transport, deconstruction, waste, processing and disposal (C1-C4)
– Benefits and loads beyond the system boundary (D)
THE CRADLE-TO-GRAVE ASSESSMENT EXCLUDES:
- Overhead facility energy (heating, lighting, etc.) of manufacturing facilities (A3)
- Construction of capital equipment and other infrastructure flows
- Maintenance and operation of support equipment
- Human labor and employee transport
- Manufacture and transport of packaging materials not associated with final product

3.5 PRODUCT SPECIFIC CALCULATIONS FOR USE PHASE (MODULES B1-B7)
Use (B1) of the ceiling panel does not require any activities that would contribute to potential environmental impacts of the product. Armstrong ceiling panels are manufactured using no added formaldehyde coatings. The VOC emissions during the use phase are negligible and the product complies with the Office and Classroom VOC Requirements of CDPH.

The ceiling panels do not require maintenance (B2), repair (B3), replacement (B4), or refurbishment (B5) as part of regular use. Typically, panels are only replaced due to damage from leaking water or if the owner chooses to change them based on design requirements rather than performance concerns. The rate of replacement due to water leaks is minimal and there is currently no published data to help define this. It is believed to be minimal, with negligible effect on the overall potential environmental impacts of the ceiling panel. There is also no operation energy (B6) or water (B7) use for the installed ceiling panels.

3.6 PRODUCT-SPECIFIC CALCULATIONS FOR END-OF-LIFE PHASE (MODULES C1-C4)
At this time, there is no industry consensus for product-specific assumption behind reported scenarios for information in modules C1-C4. Armstrong facilitates ceiling panels recycling through our Takeback program. The recovery data is based on internal averages for commingled ceiling panels that arrived at Armstrong factories from the construction and demolition site at end of product life. Remaining panels were assumed to be landfilled as per standard industry practice.

3.7 REFERENCE SERVICE LIFE AND ESTIMATED BUILDING SERVICE LIFE
The Reference Service Life (RSL) was indicated according to Part A, Section No 2.8.2. in this document. The RSL was assumed to be 30 years for both ceiling and wall panel systems. Similarly the Estimated Building Life (ESL) was assumed to be 75 years for this study.

The assumptions upon which the designated RSL is based, and for which the RSL exclusively applies, shall be provided in Section 4.

3.8 ALLOCATION
No co-product or by-product allocation was necessary during manufacturing, use or, end of life. Allocation of background data (energy and materials) taken from the GaBi databases. In the case of secondary raw materials (i.e., recycled paper), only burdens from the point of recovery forward were considered (cut-off approach). The primary production of recycled materials was outside the system boundary.

3.9 CUT-OFF RULES
No cut-off rules are defined for this study. The system boundary was defined based on relevance to the goal of the study. For the processes within the system boundary, all available energy and material flow data have been included in the model. In cases where no matching life cycle inventories are available to represent a flow, proxy data have been applied based on conservative assumptions regarding environmental impacts.
3.10 DATA SOURCES

The GaBi LCI database provides the life cycle inventory data for the background system. Documentation for all generic datasets can be found at gabi-software.com/america/support/gabi/. National and regional averages for fuel inputs, electricity grid mixes, and process water were obtained from the GaBi database. Data for up- and downstream raw materials and unit processes were obtained from the GaBi database. Data for fiberglass board, adhesive and scrim were obtained from our supplier Owens Corning. Transport processes for the basic material, i.e. the delivery to Armstrong, and the transport for the disposal of production waste are integrated in module A1-A3. The environmental burdens of transport of the packaged product, i.e. from the production site to the construction site (U.S. average) are assigned to module A4. Emission data for all upstream materials, electricity, and energy carriers were obtained from the GaBi database. The emissions (CO₂, NOₓ, SO₂, etc.) due to the use of electricity and combustion of fuels are accounted for with the use of the LCI processes.

Emissions associated with transportation were determined by capturing the average transportation distances and modes for inbound raw materials, distribution to installation, and end-of-life disposal. Energy use and the associated emissions were calculated using pre-configured transportation models from the GaBi database.

3.11 DATA QUALITY

Inventory data quality is judged by its precision (measured, calculated, or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied on a study serving as a data source), and representativeness (geographical, temporal, and technological).

To cover these requirements and to ensure reliable results, first-hand industry data in combination with literature and background LCA information from the GaBi database were used. The LCI data sets from the GaBi database are widely distributed and used with the GaBi software. The datasets have been used in LCA models worldwide in industrial and scientific applications in internal as well as in many critically reviewed studies. In the process of providing these datasets they are cross-checked with other databases and values from industry and science.

3.12 PERIOD UNDER REVIEW

All the primary data in the scope of this analysis was collected from Armstrong manufacturing facilities during 2020.

3.13 COMPARABILITY AND BENCHMARKING

Optima® ceiling panels offer a unique set of product attributes and we do not have any data on comparable non-competitive products to report.

3.14 ESTIMATES AND 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.

### TABLE 3. TRANSPORT, INSTALLATION, AND DECONSTRUCTION PROCEDURES

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Mode: Diesel-powered truck/trailer Distance:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product transport from point of manufacture to building site</td>
<td>800 km</td>
</tr>
<tr>
<td>Product transport from building site to waste processing</td>
<td>35 km</td>
</tr>
<tr>
<td>Installation &amp; deconstruction procedures</td>
<td>Manual (no operational energy use)</td>
</tr>
</tbody>
</table>

3.15 UNITS

Units commonly used in the North American market are included in addition to the required SI units.
4. TECHNICAL INFORMATION AND SCENARIOS

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 recycling program. If product is not recycled, disposal transportation at end of life is assumed to be 50 miles. Transportation emissions and fuels throughout the life cycle phases are included. All transportation associated with raw materials reflect the actual modes of transportation and mileage.

4.1 MANUFACTURING

The manufacturing process has been described in a simple flow chart in Section 2.2.4. When a product is manufactured at multiple locations, a volume-based averaging of the input parameters approach was used. 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.

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. Any manufacturing waste was reported in the primary data for this study.

4.2 PACKAGING

Armstrong® ceiling panels are well packaged in a variety of wooden panels, rigid corrugate, and stretch wrap. Stacks of material are banded to wooden pallets for shipping.
4.3 TRANSPORTATION

The following information specifies any transport after the manufacturing gate. Details of type of transport, type of vehicle, distance, type, and amount of energy carrier.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel type</td>
<td>Diesel</td>
<td></td>
</tr>
<tr>
<td>Liters of fuel</td>
<td>3.41E+03</td>
<td>L/100km</td>
</tr>
<tr>
<td>Vehicle type</td>
<td>Truck</td>
<td></td>
</tr>
<tr>
<td>Transport distance</td>
<td>2.50E+02</td>
<td>km</td>
</tr>
<tr>
<td>Capacity utilization</td>
<td>67</td>
<td>%</td>
</tr>
<tr>
<td>Gross density of products transported</td>
<td>79.92</td>
<td>kg/m³</td>
</tr>
<tr>
<td>Weight of products transported</td>
<td>–</td>
<td>kg</td>
</tr>
<tr>
<td>Volume of products transported</td>
<td>–</td>
<td>m³</td>
</tr>
<tr>
<td>Capacity utilization volume factor packaging products</td>
<td>0.87</td>
<td></td>
</tr>
</tbody>
</table>

4.4 PRODUCT INSTALLATION

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/installationinstructions

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ancillary materials</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Net freshwater consumption specified by water source and fate (X m³ river water evaporated, X m³ city water disposed to sewer)</td>
<td>0</td>
<td>m³</td>
</tr>
<tr>
<td>Other resources</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Electricity consumption</td>
<td>0</td>
<td>kWh</td>
</tr>
<tr>
<td>Other energy carriers</td>
<td>0</td>
<td>MJ</td>
</tr>
<tr>
<td>Product loss per functional unit</td>
<td>–</td>
<td>kg</td>
</tr>
<tr>
<td>Waste materials at the construction site before waste processing, generated by product installation</td>
<td>1.32E-02</td>
<td>kg</td>
</tr>
<tr>
<td>Output materials resulting from on-site waste processing</td>
<td>–</td>
<td>kg</td>
</tr>
<tr>
<td>Mass of packaging waste specified by type</td>
<td>–</td>
<td>kg</td>
</tr>
<tr>
<td>Biogenic carbon contained in packaging</td>
<td>–</td>
<td>kg CO₂</td>
</tr>
<tr>
<td>Direct emissions to ambient air, soil and water</td>
<td>–</td>
<td>kg</td>
</tr>
<tr>
<td>VOC emissions</td>
<td>Negligible</td>
<td>µg/m³</td>
</tr>
</tbody>
</table>

4.5 USE

As per the PCR it was assumed that no energy, material, and water inputs were needed during the use phase of the ceiling panel system under recommended normal operating conditions. Consideration of any resources used during maintenance and repairs during normal use of ceiling system were outside the scope of this study.
Environmental Product Declaration

According to ISO 14025

Maintenance (B2), Repair (B3), Replacement (B4), Refurbishment (B5)

Non-metal ceiling and wall panels were assumed to not need repainting, maintenance, or repairing, and to last the entire duration of the building ESL with no replacement or refurbishment.

Reference Service Life

A product’s RSL depends on the product properties and reference in-use conditions. The default RSL assumed in this PCR is 30 years for both ceiling and wall products.

4.6 Disposal

End of Life

The end-of-life phase for the ceiling panels was included in the study. End-of-life impacts include disposal of ceiling panels, scrap, 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 panels 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 landfill process.

### TABLE 6. END OF LIFE (C1-C4)

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method, and transportation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection process (specified by type)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collected separately</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Collected with mixed construction waste</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Recovery (specified by type)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reuse</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Recycling</td>
<td>1.80E-03</td>
<td>kg</td>
</tr>
<tr>
<td>Incineration</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Incineration with energy recovery</td>
<td>0</td>
<td>kg</td>
</tr>
<tr>
<td>Energy conversion (specify efficiency rate)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Disposal (specified by type)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product or material for final disposal</td>
<td>–</td>
<td>kg</td>
</tr>
<tr>
<td>Removals of biogenic carbon (excluding packaging)</td>
<td>0</td>
<td>kg CO₂</td>
</tr>
</tbody>
</table>

4.7 Reuse Phase

### TABLE 7. REUSE, RECOVERY, AND/OR RECYCLING POTENTIALS (D), RELEVANT SCENARIO INFORMATION

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net energy benefit from energy recovery from waste treatment declared as exported energy in C3 (R&gt;0.6)</td>
<td>0</td>
<td>MJ</td>
</tr>
<tr>
<td>Net energy benefit from thermal energy due to treatment of waste declared as exported energy in C4 (R&lt;0.6)</td>
<td>0</td>
<td>MJ</td>
</tr>
<tr>
<td>Net energy benefit from material flow declared in C3 for energy recovery</td>
<td>0</td>
<td>MJ</td>
</tr>
<tr>
<td>Process and conversion efficiencies</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Further assumptions for scenario development</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>
5. ENVIRONMENTAL INDICATORS DERIVED FROM LCA

5.1 LCA RESULTS FROM LCIA

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

TABLE 8. DESCRIPTION OF THE SYSTEM BOUNDARY MODULES

<table>
<thead>
<tr>
<th>EPD Type</th>
<th>Production</th>
<th>Construction</th>
<th>Use</th>
<th>End Of Life</th>
<th>Benefits And Loads Beyond System Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cradle-to-gate with EOL</td>
<td>Required</td>
<td>Excluded</td>
<td>Required, Depending on Part A, Section 2.8.4.5</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Cradle-to-gate with Options</td>
<td>Required</td>
<td>Optional</td>
<td>Optional, Depending on Part A, Section 2.8.4.5</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Declared Modules</td>
<td>Required</td>
<td></td>
<td></td>
<td>Optional</td>
<td>Required</td>
</tr>
</tbody>
</table>

| Declared Modules (Indicated with an X) | A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
|----------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Cradle-to-gate with EOL                |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    | D |
| Cradle-to-gate with Options            |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    | D |
| Declared Modules                       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | D |
5.2 LCA RESULTS FROM LCI

Life cycle impacts reported below are based on TRACI 2.1 methodology. All the results are provided in reference to the declared unit, and for convenience of the reader we have included additional grouping across the system boundaries and provided conversion in SI unit. For the other impact categories, results are presented in the tables below using the EN15804 standard and for the declared unit. Also for readers convenience conversions are provided in each table to SI units.

**TABLE 9. TRACI 2.1 IMPACT ASSESSMENT**

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Unit</th>
<th>A1 - A3</th>
<th>A4 - A5</th>
<th>B1 - B7</th>
<th>C1 - C4</th>
<th>D</th>
<th>Total 0.093m² (1 ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWP, total</td>
<td>kg CO₂-Eq.</td>
<td>7.07E-01</td>
<td>6.96E-02</td>
<td>0.00E+00</td>
<td>8.84E-03</td>
<td>2.69E-03</td>
<td>8.48E+00 (7.88E-01)</td>
</tr>
<tr>
<td>GWP fossil</td>
<td>kg CO₂-Eq.</td>
<td>7.29E-01</td>
<td>7.04E-02</td>
<td>0.00E+00</td>
<td>8.99E-03</td>
<td>-7.23E-05</td>
<td>8.70E+00 (8.08E-01)</td>
</tr>
<tr>
<td>ODP</td>
<td>kf CFC - 11 Eq.</td>
<td>4.91E-08</td>
<td>3.44E-09</td>
<td>0.00E+00</td>
<td>-4.34E-16</td>
<td>1.01E-14</td>
<td>5.66E+07 (5.26E-08)</td>
</tr>
<tr>
<td>AP</td>
<td>kg SO₂-Eq.</td>
<td>2.76E-03</td>
<td>2.84E-04</td>
<td>0.00E+00</td>
<td>3.95E-05</td>
<td>-4.27E-06</td>
<td>3.31E+00 (3.08E-03)</td>
</tr>
<tr>
<td>EP</td>
<td>kg N - Eq.</td>
<td>2.76E-03</td>
<td>2.01E-04</td>
<td>0.00E+00</td>
<td>2.10E-06</td>
<td>-9.24E-07</td>
<td>3.19E+00 (2.96E-03)</td>
</tr>
<tr>
<td>POCP</td>
<td>kg O₃-Eq.</td>
<td>1.30E-05</td>
<td>-1.89E-05</td>
<td>0.00E+00</td>
<td>2.46E-06</td>
<td>-6.29E-07</td>
<td>-4.38E-05 (-4.07E-06)</td>
</tr>
<tr>
<td>ADP</td>
<td>MJ</td>
<td>1.02E+00</td>
<td>3.32E-01</td>
<td>0.00E+00</td>
<td>1.37E-01</td>
<td>-5.15E-03</td>
<td>1.59E+01 (1.48E+00)</td>
</tr>
</tbody>
</table>

5.3 LCA RESULTS FROM LCI

**TABLE 10. LCA RESULTS - RESOURCE USE**

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Unit</th>
<th>Total 0.093m² (1 ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERE</td>
<td>MJ, LHV</td>
<td>1.47E+00 (1.36E-01)</td>
</tr>
<tr>
<td>PERM</td>
<td>MJ, LHV</td>
<td>0.00E+00 (0.00E+00)</td>
</tr>
<tr>
<td>PERT</td>
<td>MJ, LHV</td>
<td>1.47E+00 (1.36E-01)</td>
</tr>
<tr>
<td>PENRE</td>
<td>MJ, LHV</td>
<td>1.82E+01 (1.69E+00)</td>
</tr>
<tr>
<td>PENRM</td>
<td>MJ, LHV</td>
<td>4.38E+02 (4.07E-03)</td>
</tr>
<tr>
<td>PENRT</td>
<td>MJ, LHV</td>
<td>1.83E+01 (1.70E+00)</td>
</tr>
<tr>
<td>SM</td>
<td>kg</td>
<td>1.34E+00 (1.24E-01)</td>
</tr>
<tr>
<td>RSF</td>
<td>MJ, LHV</td>
<td>0.00E+00 (0.00E+00)</td>
</tr>
<tr>
<td>NRSF</td>
<td>MJ, LHV</td>
<td>0.00E+00 (0.00E+00)</td>
</tr>
<tr>
<td>FW</td>
<td>m³</td>
<td>2.41E-01 (2.24E-02)</td>
</tr>
</tbody>
</table>
TABLE 11. LCA RESULTS: OUTPUT FLOWS AND WASTE CATEGORIES

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWD</td>
<td>Hazardous waste disposed</td>
<td>kg</td>
<td>2.77E-05 (2.58E-06)</td>
</tr>
<tr>
<td>NHWD</td>
<td>Non-hazardous waste disposed</td>
<td>kg</td>
<td>2.88E+00 (2.67E-01)</td>
</tr>
<tr>
<td>HLRW</td>
<td>Radioactive waste disposed</td>
<td>kg</td>
<td>-1.25E-06 (-1.16E-07)</td>
</tr>
<tr>
<td>ILLRW</td>
<td>Intermediate &amp; Low Level Radioactive Waste</td>
<td>kg</td>
<td>-1.05E-03 (-9.73E-05)</td>
</tr>
<tr>
<td>CRU</td>
<td>Components for reuse</td>
<td>kg</td>
<td>0.00E+00 (0.00E+00)</td>
</tr>
<tr>
<td>MFR</td>
<td>Materials for recycling</td>
<td>kg</td>
<td>5.50E-02 (5.11E-03)</td>
</tr>
<tr>
<td>MER</td>
<td>Materials for energy recovery</td>
<td>kg</td>
<td>0.00E+00 (0.00E+00)</td>
</tr>
<tr>
<td>EEE</td>
<td>Exported energy</td>
<td>MJ, LHV</td>
<td>1.78E-02 (1.65E-03)</td>
</tr>
</tbody>
</table>

TABLE 12. CARBON EMISSIONS AND REMOVALS DESCRIPTION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCRP</td>
<td>Biogenic Carbon Removal from Product</td>
<td>kg CO₂</td>
<td>0.00E+00 (0.00E+00)</td>
</tr>
<tr>
<td>BCEP</td>
<td>Biogenic Carbon Emission from Product</td>
<td>kg CO₂</td>
<td>0.00E+00 (0.00E+00)</td>
</tr>
<tr>
<td>BCRK</td>
<td>Biogenic Carbon Removal from Packaging</td>
<td>kg CO₂</td>
<td>2.92E-01 (2.71E-02)</td>
</tr>
<tr>
<td>BCEK</td>
<td>Biogenic Carbon Emission from Packaging</td>
<td>kg CO₂</td>
<td>2.25E-01 (2.09E-02)</td>
</tr>
</tbody>
</table>
6. LCA: INTERPRETATION

The results of this LCA study for the Optima® fiberglass panels are shown in the bar chart format below. It indicates that the production process has the greatest impact on carbon footprint followed by the construction process. Among the production processes the carbon impact associated with the raw materials is the leading contributor.

Key
- Production
- Construction
- End of Life
- Recycle

Life Cycle Impact Assessment of Optima® Ceiling Panels¹² 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. ADDITIONAL ENVIRONMENTAL INFORMATION

7.1 ENVIRONMENT AND HEALTH 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.

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.

7.2 ENVIRONMENT AND HEALTH DURING INSTALLATION
All recommendations shall be utilized as indicated by SDS and installation guidelines. Specific product SDS and installation instructions can be downloaded at: armstrongceilings.com/pdbupimages-clg/217521.pdf

7.3 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 carry a 30-year limited system warranty.

Insulation Value
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 armstrongceilings.com/seismicrx

Acoustical Panel Classification
ASTM E1264 - Standard Classification for Acoustical Ceiling Products
Type XII, Form 2, Pattern E, Fire Class A

Mechanical Destruction – Not applicable to ceiling products

7.4 DELAYED EMISSIONS
Our products contain a number of biobased ingredients such as starch, cellulose, or recycled newspaper, etc. The carbon stored in these products is effectively treated as equal to avoiding fossil fuel emissions while calculating the carbon footprint. There is certainly a benefit to such carbon storage, potential delayed emissions in future extending to several decades are possible. Therefore, we included both total and fossil-fuel-based global warming potential in our results tables.
According to ISO 14025

7.5 ENVIRONMENTAL ACTIVITIES AND CERTIFICATIONS
All environmental certifications can be found at: Armstrongceilings.com


7.6 FURTHER INFORMATION
Additional Information can be found at: armstrongceilings.com Specific product SDS and installation instructions can be downloaded at: armstrongceilings.com/pdbupimages-clg/217521.pdf

8. PROJECT REPORT AND SUPPORTING DOCUMENTATION

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 UL® Environments (2021) Part B: Non-Metal Ceiling Panel EPD Requirements.

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).

9. REFERENCES

SUSTAINABILITY REPORTING STANDARDS
ISO 14025:2006 – Environmental – Principles and procedures
ISO 15392:2019 – Sustainability in building construction – General principles
ISO 15686-7:2017 – Buildings and constructed assets – Service life planning Part 7: Performance evaluation for feedback of service life data from practice
UL PCR Part B:2021 – Non-metal ceilings and interior walls panels
ENVIROINMENTAL PRODUCT DECLARATION

OPTIMA® CEILING PANELS
HIGH PERFORMANCE FIBERGLASS

TESTING AND CLASSIFICATION
American Conference of Governmental Industrial Hygienists (ACGIH®) Threshold Limit Values and Biological Exposure Indices
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 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
ANSI/UL 1784-2015 – Air Leakage Test of Door Assemblies

RELEVANT FEDERAL STANDARDS AND SOPs
Environment Canada, National Pollutant Release Inventory (NPRI) (http://www.ec.gc.ca/inrp-npri/)
EPCRA 313 Toxic Release Inventory Reporting (US) (http://www2.epa.gov/toxics-release-inventory-tri-program)
CERCLA Hazardous Substances (US)

U.S. Department of Labor, Occupational Safety & Health Administration
(OSHA 1910.1200 Hazard Communication Standard—Toxic and Hazardous Substances (US)


RELEVANT PCRs AND PCR GUIDANCE

ISO 21930:2017 – Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services
ISO 21930: 2017 – Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services
Part A: Life Cycle Assessment Calculation Rules and Report Requirements UL® Environment (December 2018, version 3.2)
USGBC and UL Environment. PCR Committee Process and Resources: Part B. July 2017