Committed to Sustainability.

Armstrong Flooring 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. This Environmental Product Declaration (EPD) was developed to document the sustainability of our products. Inside this ASTM certified ISO compliant EPD is the following:

- Product application and use
- Product ingredients and their sources
- Information on how Heterogeneous Vinyl Sheet flooring is produced
- Life Cycle Assessment (LCA) results including global warming potential and primary energy usage
- Total impacts over the life cycle of the product
- Performance attributes

Heterogeneous Vinyl Sheet is designed for high visual impact, making it a great product for commercial applications and lasting performance.

**Heterogeneous Vinyl Sheet**

**Functional Unit – 1 m² of 2.0 mm Heterogeneous Vinyl Sheet**

1 year service life

**LCA IMPACT* MEASURES**

<table>
<thead>
<tr>
<th></th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Energy (MJ)</td>
<td>239.8</td>
</tr>
<tr>
<td>Global Warming Potential (kg CO₂ equivalent)</td>
<td>8.08</td>
</tr>
<tr>
<td>Acidification Potential (kg SO₂ equivalent)</td>
<td>4.38E-02</td>
</tr>
<tr>
<td>Eutrophication Potential (kg PO₄³⁻ equivalent)</td>
<td>4.30E-03</td>
</tr>
<tr>
<td>Ozone Depletion Potential (kg R11 equivalent)</td>
<td>2.81E-08</td>
</tr>
<tr>
<td>Photochem Ozone Creation Potential (kg Ethene equivalent)</td>
<td>6.90E-03</td>
</tr>
</tbody>
</table>

**PERFORMANCE ATTRIBUTES**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustics NRC (Absorption)</td>
<td>0.05</td>
</tr>
<tr>
<td>Static Load (psi)</td>
<td>750</td>
</tr>
<tr>
<td>Light Reflectance</td>
<td>Up to 59%</td>
</tr>
<tr>
<td>ASTM F1303 Type 1, ISO 10582, Type I</td>
<td>Meets</td>
</tr>
</tbody>
</table>

Flooring Ingredients: Limestone, Glass Fibers, Polyethylene Terephthalate (PET), Polyvinyl Chloride (PVC), Di-(2-ethylhexyl) terephthalate (DEHT), Stabilizer, and colored pigments

* Based on CML2010 Impact Factors

This document is a Type III Environmental Product Declaration by Armstrong Flooring, Inc. that is certified by ASTM as conforming to the requirements of ISO 14025 and ISO 21930. ASTM has assessed that the Life Cycle Assessment (LCA) information fulfills the requirements of ISO 14040 and ISO 14044 in accordance with the instructions listed in the product category rules cited below. The intent of this document is to further the development of environmentally compatible and sustainable construction methods by providing comprehensive environmental information related to potential impacts in accordance with international standards.

Declaration Number: EPD-0006
Program Operator: ASTM International - 100 Barr Harbor Drive, West Conshohocken, PA, USA
www.astm.org
Declaration Holder: Armstrong Flooring, Inc. - 2500 Columbia Avenue, Lancaster, PA 17603

Declared Product
Heterogeneous Sheet Flooring is a multi-layer product consisting of a factory applied UV-cured polyurethane coating, a transparent wear layer that protects the printed visual, a printed visual which replicates woods, stones, textiles and high end designs, and finally a base layer reinforced with fiberglass adhered to a polyester backing. The surface of the wear layer may be smooth, embossed or textured. The easy maintenance of these sheet products provides a longer life cycle, keeping that just installed look for years, especially in a heavy traffic environment that encounters ever-moving furniture, rolling casters, heels, soil, stains, falling objects, tears, scratches, indents and anything else that can impact the fit and finish of a floor.

Declaration Type
Cradle-to-Grave. Intended for Business-to-Business (B-to-B) audiences. Represents Average Performance.

Applicable Countries

Product Application
Floor covering choice in commercial spaces:
• Hospitality
• Office
• Education
• Retail
• Healthcare
• Assisted Living

Content of the Declaration
This declaration is complete and contains in its full form:
• Product Definition
• Material Content
• Production of the Flooring Systems
• Installation of Flooring Systems
• Use Stage
• End of Life Stage
• Life Cycle Assessment
• Additional Information, Evidence, Test Certificates
• PCR Documentation and Verification
• Extraordinary Effects
• References

PCR Development
☐ New or Revised ☐ Existing - For details on PCR Review, contact ncss@nsf.org

PCR Reference
Product Category Rules for Environmental Product Declarations. Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International, Michael Overcash, PCR Review Chair. Per ISO 14025, environmental declarations from different programs (PCR) may not be comparable.

EPD Date of Issue: December 11, 2014
EPD Period of Validity: December 11, 2019

Verification and Authorization of the Declaration
This declaration and the rules on which this EPD is based have been examined by an independent external verifier in accordance with ISO 14025 and ISO 21930.

Tim Brooke
Vice President, Certification
Date December 11, 2014

Tom Gloria
External Verifier
Date December 11, 2014

ASTM certification of this EPD is not to be construed as representing aesthetics or any other attributes not specifically addressed, nor should it be construed as an ASTM endorsement of the subject of the EPD or a recommendation for its use. There is no warranty by ASTM, express or implied, as to any finding or other matter in the EPD, or as to any product covered by the EPD. The EPD holder is liable for the information and evidence on which the EPD is based.
Summary LCA Results

Scope and Boundaries of the Life Cycle Assessment

The Life Cycle Assessment (LCA) was performed according to ISO 14040 and followed the PCR instructions. The cradle-to-grave LCA encompasses raw material production; transport of raw materials to the production facility; manufacturing of flooring; packaging; transportation to job site; use phase; and end of life including disposal or recycling. Detailed information regarding the LCA is found in Section 10.

Life Cycle Assessment Summary

Declared Unit: 1 ft² of installed flooring for use over 1 year, impacts based on CML 2010 Impact Factors

Table 1: Life Cycle Assessment of Heterogeneous Vinyl Sheet

<table>
<thead>
<tr>
<th>IMPACT MEASURE²</th>
<th>SOURCING / EXTRACTION</th>
<th>PRODUCTION</th>
<th>INSTALLATION</th>
<th>USE STAGE³</th>
<th>END OF LIFE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Energy (MJ)</td>
<td>186.5</td>
<td>10.0</td>
<td>33.6</td>
<td>8.9</td>
<td>0.8</td>
<td>239.8</td>
</tr>
<tr>
<td>Global Warming Potential (kg CO₂ equivalent)</td>
<td>5.57</td>
<td>0.85</td>
<td>1.19</td>
<td>0.41</td>
<td>0.06</td>
<td>8.08</td>
</tr>
<tr>
<td>Acidification Potential (kg SO₂ equivalent)</td>
<td>2.12E-02</td>
<td>4.60E-03</td>
<td>1.68E-02</td>
<td>9.00E-04</td>
<td>3.00E-04</td>
<td>4.38E-02</td>
</tr>
<tr>
<td>Eutrophication Potential (kg PO₄³⁻ equivalent)</td>
<td>1.90E-03</td>
<td>5.00E-04</td>
<td>1.70E-03</td>
<td>1.00E-04</td>
<td>0.00E+00</td>
<td>4.30E-03</td>
</tr>
<tr>
<td>Ozone Depletion (kg R11 equivalent)</td>
<td>5.40E-10</td>
<td>2.54E-08</td>
<td>6.63E-11</td>
<td>4.28E-11</td>
<td>6.68E-13</td>
<td>2.61E-08</td>
</tr>
<tr>
<td>Photochem Ozone Creation Potential (kg Ethene equivalent)</td>
<td>5.20E-03</td>
<td>3.00E-04</td>
<td>1.20E-03</td>
<td>2.00E-04</td>
<td>0.00E+00</td>
<td>6.90E-03</td>
</tr>
</tbody>
</table>

¹ Additional Impact Measures are included in Section 10.
² Impact as based on CML 2001-Nov. 2010.
³ Use stage impacts are based on medium intensity maintenance practices as described in Section 7.

Additional Information

This declaration contains additional information, as listed below, that is outside the scope of the LCA. This additional information, provided by Armstrong®, has not been evaluated by ASTM, but is considered useful for the purpose of comparing this EPD to other EPDs developed from the same PCR. Guidance is recommended in comparing performance data and LCA information for products that perform the same in the areas of Acoustics, Fire Performance, Stain Resistance, Light Reflectance, Durability, Maintenance and End of Life Recyclability. Please refer to page 4 for a summary of performance attributes by item number and note the website references listed below for additional information.

- Resistance to Staining and Reagents: ArmstrongFlooring.com/stainresistance
- Health, Safety, and Installation Information: ArmstrongFlooring.com/sheet
Detailed LCA Results

1.0 Product Definition

1.1 Product Definition and Description

Heterogeneous Sheet Flooring is a multi-layer product consisting of a factory applied UV-cured polyurethane coating, a transparent wear layer that protects the printed visual, a printed visual which replicates woods, stones, textiles and high end designs, and finally a base layer reinforced with fiberglass adhered to a polyester backing. The surface of the wear layer may be smooth, embossed or textured. The easy maintenance of these sheet products provides a longer life cycle, keeping that just installed look for years, especially in a heavy traffic environment that encounters ever-moving furniture, rolling casters, heels, soil, stains, falling objects, tears, scratches, indents and anything else that can impact the fit and finish of a floor.

2.0 Product Application

Heterogeneous Vinyl Sheet flooring is primarily intended for use in commercial and light commercial buildings. It is frequently installed in healthcare facilities because of its superior durability and high resistance to wear, cuts and stains. Perfect for aseptic areas, Armstrong® Heterogeneous Vinyl Sheet flooring can all be heat welded and flash-coved for spaces demanding superior infection control.

3.0 Product Performance Attributes

All Armstrong® Heterogeneous Vinyl Sheet meets or exceeds the performance requirements of ASTM F1303, Standard Specification for Vinyl Sheet Floor Covering With Backing and ISO 10582, Type I, Resilient floor coverings -- Heterogeneous poly(vinyl chloride) floor covering. Heterogeneous Vinyl Sheet is a widely used commercial resilient flooring option and is routinely used with great success in the healthcare and education segments. Properly installed and maintained, Heterogeneous Vinyl Sheet provides decades of proven performance across all commercial segments.

3.1 Performance Selection

Table 2: Performance of Heterogeneous Vinyl Sheet

<table>
<thead>
<tr>
<th>ITEMS INCLUDED IN THIS EPD</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heterogeneous Vinyl Sheet</td>
<td>PSI - 750</td>
</tr>
<tr>
<td>Installation Materials: Armstrong S-599, S-543 Adhesive or S-240 Epoxy with Heat Welded Seams or Armstrong S-761 at Seams</td>
<td>NRC 0.05</td>
</tr>
<tr>
<td>Maintenance Materials: Armstrong S-485 Commercial Floor Cleaner (Neutral Detergent) and S-480 Commercial Polish.</td>
<td>Light Reflectance up to 59% R-Value = 0.07 [ft2 F h/Btu]</td>
</tr>
</tbody>
</table>

3.2 Key Selection Attributes

Armstrong® Heterogeneous Vinyl Sheet is designed for resists indentation from heavy static (bookcases, desks, retail product shelving, display racks, etc.) and rolling loads (medical equipment, patient beds, produce carts, inventory, book carts, etc), and offers superior gouge and abrasion resistance. All Armstrong Heterogeneous Vinyl Sheet flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1., 2010). In non-aseptic spaces, our Armstrong S-761 Seam Sealing System can be used with heterogeneous flooring material. Heterogeneous Sheet products are manufactured in an ISO 14001 facility and offer low maintenance options which can provide lower cost of ownership and lower life-cycle cost assessments.
4.0 Product Characteristics

### Table 3: Product Characteristics of Heterogeneous Vinyl Sheet

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>SHEET DIMENSION (FT.)</th>
<th>THICKNESS (IN. / MM)</th>
<th>AVERAGE WEIGHT (LBS/FT²)</th>
<th>AVERAGE WEIGHT (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heterogeneous Vinyl Sheet</td>
<td>6 x 82</td>
<td>0.080</td>
<td>0.022</td>
<td>0.6</td>
</tr>
</tbody>
</table>

5.0 Material Content

#### 5.1 Definitions

- **Finish** – A factory applied UV cured polyurethane finish to protect the flooring.
- **Wear Layer** – A transparent vinyl layer that protect the print layer.
- **Print Layer** – Consists of a stone, wood, textile or other patterns printed under the wear layer.
- **Fiberglass Layer** – A non-woven glass scrim comprised of chopped glass fibers.
- **Calendared Layer** – A uniform vinyl layer.
- **Polyester Backing** – A non-woven polyester scrim.
- **Adhesive** – A field applied substance used to fasten the Heterogeneous Vinyl Sheet to the sub-floor.

**Figure 1.** Life cycle phases included in the adhesive and polish used during the use stage of the study.

#### 5.2 Production of Heterogeneous Vinyl Sheet

- **Limestone (Calcium Carbonate)** – An abundant mineral used as an inert filler.
- **Polyvinyl Chloride (PVC)** – A synthetic resin made from the polymerization of vinyl chloride.
- **Plasticizer** – Makes vinyl soft and flexible.
- **Titanium Dioxide** – An abundant mineral used as a pigment for whitening.
- **Pigments** – Coloring agents.
- **Stabilizer** – Prevents degradation associated with direct or indirect impacts of heat and ultraviolet light.
5.0 Material Content (continued)

Table 4. Material Content of Heterogeneous Vinyl Sheet to a Concentration of a 1,000ppm (0.1%).

<table>
<thead>
<tr>
<th>COMPONENT*</th>
<th>MATERIAL</th>
<th>CASRN</th>
<th>MASS %</th>
<th>AVAILABILITY</th>
<th>ORIGIN</th>
<th>TRANSPORTATION MODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filler</td>
<td>Limestone (Calcium Carbonate)</td>
<td>1317-65-3</td>
<td>35-40%</td>
<td>Abundant Mineral</td>
<td>Non-renewable</td>
<td>China</td>
</tr>
<tr>
<td></td>
<td>Glass Fibers</td>
<td>99439-28-8</td>
<td>4-7%</td>
<td>Non-renewable</td>
<td>China</td>
<td>Truck</td>
</tr>
<tr>
<td>Backing</td>
<td>Polyethylene Terephthalate (PET)</td>
<td>25038-59-9</td>
<td>3-5%</td>
<td>Abundant Mineral</td>
<td>Non-renewable</td>
<td>China</td>
</tr>
<tr>
<td>Binder</td>
<td>Polyvinyl Chloride (PVC)</td>
<td>9002-86-2</td>
<td>30-35%</td>
<td>Fossil Limited</td>
<td>Non-renewable</td>
<td>China</td>
</tr>
<tr>
<td></td>
<td>9003-22-9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasticizer</td>
<td>Di (2-ethylhexyl) terephthalate (DEHT)</td>
<td>6422-86-2</td>
<td>20-25%</td>
<td>Fossil Limited</td>
<td>Non-renewable</td>
<td>China</td>
</tr>
<tr>
<td>Pigment</td>
<td>Colored Pigments</td>
<td>Various</td>
<td>0.1-0.5%</td>
<td>Abundant Mineral</td>
<td>Non-renewable</td>
<td>Various</td>
</tr>
<tr>
<td>Stabilizer</td>
<td>Barium Salt</td>
<td>6865-35-6</td>
<td>0.1-0.5%</td>
<td>Abundant Mineral</td>
<td>Non-renewable</td>
<td>China</td>
</tr>
</tbody>
</table>

*Proprietary ingredients are protected by intellectual property rights.

5.3 Production of Heterogeneous Vinyl Sheet

Heterogeneous Vinyl Sheet flooring is primarily used in commercial flooring applications and is comprised of limestone in a vinyl binder matrix. The manufacturing process involves the hot mixing of the raw materials milled and calendared into a hot sheet to which wear layers are applied and fused to the calendared layer. Once cooled the sheet is trimmed and packaged for shipment. The sheets are six (6) feet wide and up to 84 feet long and have a factory applied coating that provides for low maintenance which can provide lower cost of ownership and lower life-cycle cost assessments. After packaging, the Heterogeneous Sheet rolls are shipped and installed. At the end of its useful life, the Heterogeneous Vinyl Sheet flooring can be directed to an approved landfill site.
5.4 Health, Safety, and Environmental Aspects During Production

Armstrong Flooring 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 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 annual environmental plans, tailored to meet goals on energy, water, and waste reduction. Armstrong is a registered member with The Climate Registry. This means the company gets third-party verification of our global greenhouse gas (GHG) inventories, which are then made publicly available. As part of this effort, the cumulative energy usage by our facilities is reported in the Armstrong® Climate Registry certification.

6.0 Installation of 2.0 mm Heterogeneous Vinyl Sheet

6.1 Installation Recommendations

The Heterogeneous Vinyl Sheet must be installed in strict accordance with the current edition of the Armstrong® Guaranteed Installation Systems manual, F-5061. This comprehensive guide to Armstrong flooring installation provides all the information needed to properly install Armstrong Heterogeneous Vinyl Sheet and ensure it will look great and perform exactly as it should. You can reference this document at: https://www.armstrongflooring.com/commercial/en-us/resources/guaranteed-installations-systems-manual-F-5061.html

6.2 Health, Safety, and Environmental Aspects During Installation

There are no recognized systemic hazards associated with installing Heterogeneous Vinyl Sheet flooring.

6.3 Waste

Rejected material and process trim scrap are reused in the manufacturing process. Raw material packaging materials are being collected and externally recycled. A conservative 3% 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.

6.4 Packaging

Armstrong® Heterogeneous Vinyl Sheet is rolled and wrapped in craft paper and stored vertically on wooden pallets. All packaging can be recycled, however, the life cycle assessment model assumed all packaging was landfilled.
7.0 Use Stage

For this study, it was assumed that Heterogeneous Vinyl Sheet would last 30 years and therefore would need to be replaced 2 times over the building’s useful life if properly installed and maintained. The useful life indicated in the PCR for flooring is 60 years. Recommended maintenance practices are provided in the Armstrong® Installation Guide and required as part of the warranty. Warranty details can be found at http://www.ArmstrongFlooring.com/commflooringna/flooring-downloads. For Heterogeneous Vinyl Sheet, the recommended maintenance is representative of medium intensity maintenance, as shown in Table 5 and Figure 3. Because maintenance procedures often vary depending on the building owner’s maintenance practices, level of use, and traffic conditions, Table 5 provides low, medium and high maintenance scenarios. The normalized environmental impacts associated with these hypothetical scenarios are shown in Figure 3. The low intensity maintenance scenario results in lower environmental impacts. For example, less scrubbing means less water consumption and a lower eutrophication potential.

Table 5. Estimated Maintenance Intensity for Heterogeneous Vinyl Sheet

<table>
<thead>
<tr>
<th>MAINTENANCE SCHEDULE</th>
<th>NUMBER OF TIMES PERFORMED IN 1 YEAR (365 DAYS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOW</td>
</tr>
<tr>
<td>Sweep /Dry Mop</td>
<td>260</td>
</tr>
<tr>
<td>Damp Mop</td>
<td>26</td>
</tr>
<tr>
<td>Scrubbing</td>
<td>6</td>
</tr>
</tbody>
</table>

Figure 3. LCA Results for Estimated Maintenance Intensity (1 Year)

7.1 Cleaning and Maintenance

Recommended cleaning and maintenance can be found in Armstrong® Installation and Maintenance Guides: http://www.ArmstrongFlooring.com/pdbupimages/197960.pdf

7.2 Health Aspects During Usage

All Armstrong® Heterogeneous Vinyl Sheet flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1, 2010).
8.0 Extraordinary Effects

8.1 Fire Performance

Heterogeneous Vinyl Sheet demonstrates the following fire performance:

- Class 1 when tested in accordance with ASTM E 648/NFPA 253, Standard Test Method for Critical Radiant Flux
- Meets 450 or less when tested in accordance with ASTM E 662/NFPA 258, Standard Test Method for Smoke Density
- Flame Spread Index – 155 and Smoke Developed Index 470 or less when tested in accordance with CAN/ULC S102.2, Standard Test Method for Flame Spread Rating and Smoke Development

8.2 Insulation Value


R-value = 0.07 [ft² F h/ft²] R-value = 0.012 [m² K/W]

9.0 End of Life Stage

9.1 Disposal

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

10.0 Life Cycle Assessment

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

The methods for conducting the life cycle assessments, upon which this EPD is based, were consistent with ISO 14040 and 14044. This report is intended to fulfill the reporting requirements in Section 5 of ISO 14044 and the Product Category Rules for Flooring: Carpet, Resilient, Laminate, Ceramic, Wood.

10.1 Information on the Product System Definition and Modeling of the Life Cycle

The functional unit for this EPD is 1 m² of 2.0 mm Heterogeneous Vinyl Sheet for use over 1 year.

Flooring System View: In order to understand the complete view of a flooring system, life cycle information is included for the total flooring system based on 1 square meter (m²) view. This includes the flooring, adhesives and finishes applied during the use stage.
10.0 Life Cycle Assessment (continued)

System Boundaries:
The system boundaries studied as part of this life cycle assessment include extraction of primary materials, raw materials manufacture, flooring production, installation, and end of life.

The phases below outline a “cradle-to-grave” life cycle assessment for flooring (Figure 4).

Figure 4. Life cycle phases included for Heterogeneous Vinyl Sheet in study:

[Schematic diagram of the life cycle phases]

As Shown in Figure 5 and Figure 6, the Cradle-to-Grave Assessment Includes:
- Production including raw material and packaging materials for 2.0 mm Heterogeneous Vinyl Sheet.
- Installation includes raw materials for adhesive and polish.
- Transportation of raw materials to the manufacturing facility.
- Manufacturing of the flooring at the 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 60 years as required by the PCR and includes the transportation and installation of the system including adhesive, polish and maintenance.
- End of life includes landfill disposal of 2.0 mm Heterogeneous Vinyl Sheet with assumed 50 miles by truck.

The Cradle-to-Grave Assessment Excludes:
- Overhead energy usage (heating, lighting) of manufacturing facilities
- Maintenance and operation of support equipment
Assumptions:
Armstrong Flooring, Inc. began conducting life cycle assessments in 2006 and completed a baseline LCA of key flooring products in 2012. Disposal transportation at end of life is assumed to be 50 miles.

This map shows the location of the Armstrong® Heterogeneous Vinyl Sheet manufacturing facility. 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.

Cutoff Criteria:
The cutoff criteria for the study are as follows:

- 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.

Data Quality:
The LCA model was created using the GaBi 6 Software system for life cycle engineering, developed by PE INTERNATIONAL GmbH. 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. No data set was over 10 years old.

All gate-to-gate, primary foreground data was collected for the flooring manufacturing process. This foreground data was from annual production for the year of 2011. Background data was collected from suppliers or generic data was used. When generic data was used, it was verified and triangulated against several sources.

Allocation:
Co-Product Allocation – No co-product allocation occurs in the product system.

Multi-Input Processes Allocation – No multi-input allocation occurs in the product system.

Reuse, Recycling, and Recovery Allocation – The cut-off allocation approach is adopted in the case of any recycled content, which is assumed to enter the system burden-free. Only environmental impacts from the point of recovery and forward (e.g., collection, sorting, processing, etc.) are considered.

Product and packaging waste is modeled as being disposed in a landfill rather than incinerated or recycled. Plastic and other construction waste is assumed to be inert in landfills so no system expansion or allocation is necessary as landfill gas is not produced. In the case of biobased packaging waste disposed during installation, landfill gas from the decomposition of this waste is assumed to be collected and used to produce electricity. It is assumed that this recovered energy offsets energy produced by the US average grid.
10.0 Life Cycle Assessment (continued)

10.2 Results of the Life Cycle Assessment

The LCA results are documented separately for the following stages:

1. Sourcing/Extraction
2. Production
3. Installation
4. Use Phase
5. End of Life

Table 6 shows the results for 1 m² of 2.0 mm Heterogeneous Vinyl Sheet installed and maintained for one year and 60 years.

Table 6: LCA of Heterogeneous Vinyl Sheet for 1 m² of installed Heterogeneous Vinyl Sheet flooring including medium intensity maintenance for 1 year

<table>
<thead>
<tr>
<th>IMPACT MEASURE ¹,²</th>
<th>SOURCING / EXTRACTION</th>
<th>PRODUCTION</th>
<th>INSTALLATION</th>
<th>USE PHASE ³</th>
<th>END OF LIFE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Year Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Energy (MJ)</td>
<td>186.5</td>
<td>10.0</td>
<td>33.6</td>
<td>8.9</td>
<td>0.8</td>
<td>239.8</td>
</tr>
<tr>
<td>Global Warming Potential (kg CO₂ equivalent)</td>
<td>5.57</td>
<td>0.85</td>
<td>1.19</td>
<td>0.41</td>
<td>0.06</td>
<td>8.08</td>
</tr>
<tr>
<td>Acidification Potential (kg SO₂ equivalent)</td>
<td>2.12E-02</td>
<td>4.60E-03</td>
<td>1.68E-02</td>
<td>9.00E-04</td>
<td>3.00E-04</td>
<td>4.38E-02</td>
</tr>
<tr>
<td>Eutrophication Potential (kg PO₄³⁻ equivalent)</td>
<td>1.90E-03</td>
<td>5.00E-04</td>
<td>1.70E-03</td>
<td>1.00E-04</td>
<td>0.00E+00</td>
<td>4.30E-03</td>
</tr>
<tr>
<td>Ozone Depletion Potential (kg R11 equivalent)</td>
<td>5.40E-10</td>
<td>2.54E-08</td>
<td>6.63E-11</td>
<td>4.28E-11</td>
<td>6.68E-13</td>
<td>2.61E-08</td>
</tr>
<tr>
<td>Photochem Ozone Creation Potential (kg Ethene equivalent)</td>
<td>5.20E-03</td>
<td>3.00E-04</td>
<td>1.20E-03</td>
<td>2.00E-04</td>
<td>0.00E+00</td>
<td>6.90E-03</td>
</tr>
<tr>
<td>60 Year Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Energy (MJ)</td>
<td>373.1</td>
<td>20.2</td>
<td>67.2</td>
<td>537.8</td>
<td>1.7</td>
<td>1000.0</td>
</tr>
<tr>
<td>Global Warming Potential (kg CO₂ equivalent)</td>
<td>11.10</td>
<td>1.70</td>
<td>2.40</td>
<td>24.50</td>
<td>0.10</td>
<td>39.80</td>
</tr>
<tr>
<td>Acidification Potential (kg SO₂ equivalent)</td>
<td>4.24E-02</td>
<td>9.30E-03</td>
<td>3.36E-02</td>
<td>5.17E-02</td>
<td>6.00E-04</td>
<td>1.38E-01</td>
</tr>
<tr>
<td>Eutrophication Potential (kg PO₄³⁻ equivalent)</td>
<td>3.90E-03</td>
<td>1.10E-03</td>
<td>3.40E-03</td>
<td>6.50E-03</td>
<td>0.00E+00</td>
<td>1.49E-02</td>
</tr>
<tr>
<td>Ozone Depletion Potential (kg R11 equivalent)</td>
<td>1.08E-09</td>
<td>5.08E-08</td>
<td>1.33E-10</td>
<td>2.57E-09</td>
<td>1.34E-12</td>
<td>5.46E-08</td>
</tr>
<tr>
<td>Photochem Ozone Creation Potential (kg Ethene equivalent)</td>
<td>1.03E-02</td>
<td>6.00E-04</td>
<td>2.40E-03</td>
<td>1.29E-02</td>
<td>0.00E+00</td>
<td>2.63E-02</td>
</tr>
</tbody>
</table>

¹ Additional Impact Measures are included in Section 10.
² Impact as based on CML 2001-Nov. 2010.
³ Use phase impacts are based on medium intensity maintenance practices as described in Section 7.
### 10.0 Life Cycle Assessment (continued)

**Table 7. Cradle to Gate Life Cycle Assessment Results for One Square Meter of Heterogeneous Vinyl Sheet for 1 Year**

<table>
<thead>
<tr>
<th>IMPACT MEASURE (CML 2001-Nov. 2010)</th>
<th>SOURCING / EXTRACTION</th>
<th>PRODUCTION</th>
<th>CRADLE–GATE TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Energy (MJ)</td>
<td>186.5</td>
<td>10.0</td>
<td>196.5</td>
</tr>
<tr>
<td>Global Warming Potential (kg CO₂ equivalent)</td>
<td>5.57</td>
<td>0.85</td>
<td>6.42</td>
</tr>
<tr>
<td>Acidification Potential (kg SO₂ equivalent)</td>
<td>2.12E-02</td>
<td>4.60E-03</td>
<td>2.58E-02</td>
</tr>
<tr>
<td>Eutrophication Potential (kg PO₄³⁻ equivalent)</td>
<td>1.90E-03</td>
<td>5.00E-04</td>
<td>2.40E-03</td>
</tr>
<tr>
<td>Ozone Depletion Potential (kg R11 equivalent)</td>
<td>5.40E-10</td>
<td>2.54E-08</td>
<td>2.59E-08</td>
</tr>
<tr>
<td>Photochem Ozone Creation Potential (kg Ethene equivalent)</td>
<td>5.20E-03</td>
<td>3.00E-04</td>
<td>5.50E-03</td>
</tr>
<tr>
<td>Abiotic Depletion, Elements (kg Sb-equivalent)</td>
<td>3.39E-05</td>
<td>2.28E-07</td>
<td>3.41E-05</td>
</tr>
<tr>
<td>Abiotic Depletion, Fossil (MJ)</td>
<td>167.0</td>
<td>9.0</td>
<td>176.0</td>
</tr>
</tbody>
</table>

**Table 8. Cradle to Grave Life Cycle Assessment Results for 1 m² of 2.0 mm Heterogeneous Vinyl Sheet for 1 Year**

<table>
<thead>
<tr>
<th>IMPACT MEASURE (CML 2001-Nov. 2010)</th>
<th>CRADLE–GATE</th>
<th>INSTALLATION</th>
<th>MAINTENANCE INTENSITY</th>
<th>END OF LIFE</th>
<th>TOTAL IMPACTS (Cradle–Grave)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOW</td>
<td>MED</td>
<td>HIGH</td>
<td>LOW</td>
<td>MED</td>
</tr>
<tr>
<td>Primary Energy (MJ)</td>
<td>196.5</td>
<td>33.6</td>
<td>4.5</td>
<td>8.9</td>
<td>17.8</td>
</tr>
<tr>
<td>Global Warming Potential (kg CO₂ equivalent)</td>
<td>6.42</td>
<td>1.19</td>
<td>0.21</td>
<td>0.41</td>
<td>0.82</td>
</tr>
<tr>
<td>Acidification Potential (kg SO₂ equivalent)</td>
<td>2.58E-02</td>
<td>1.68E-02</td>
<td>4.50E-04</td>
<td>9.00E-04</td>
<td>1.80E-03</td>
</tr>
<tr>
<td>Eutrophication Potential (kg PO₄³⁻ equivalent)</td>
<td>2.40E-03</td>
<td>1.70E-03</td>
<td>5.00E-05</td>
<td>1.00E-04</td>
<td>2.00E-04</td>
</tr>
<tr>
<td>Ozone Depletion Potential (kg R11 equivalent)</td>
<td>2.59E-08</td>
<td>6.63E-11</td>
<td>2.14E-11</td>
<td>4.28E-11</td>
<td>8.56E-11</td>
</tr>
<tr>
<td>Photochem Ozone Creation Potential (kg Ethene equivalent)</td>
<td>5.50E-03</td>
<td>1.20E-03</td>
<td>1.00E-04</td>
<td>2.00E-04</td>
<td>4.00E-04</td>
</tr>
<tr>
<td>Abiotic Depletion, Elements (kg Sb-equivalent)</td>
<td>3.41E-05</td>
<td>3.72E-07</td>
<td>1.98E-07</td>
<td>3.96E-07</td>
<td>7.92E-07</td>
</tr>
<tr>
<td>Abiotic Depletion, Fossil (MJ)</td>
<td>176.0</td>
<td>33.0</td>
<td>4.0</td>
<td>8.0</td>
<td>16.0</td>
</tr>
</tbody>
</table>
10.0 Life Cycle Assessment (continued)

Figure 6. Life Cycle Impact Results for Heterogeneous Vinyl Sheet (1 year)*

Figure 6 shows the relative importance in percentage terms for the raw material Sourcing/Extraction, Production, Installation, Use, and End of Life stages for 2.0 mm Heterogeneous Vinyl Sheet.

![Graph showing life cycle impact results](image)

*Based on CML 2010 Impact Factors.

Table 9: Traci 2.0 LCA Results for 1m² of Heterogeneous Vinyl Sheet for 1 yr

<table>
<thead>
<tr>
<th>IMPACT MEASURE</th>
<th>SOURCING / EXTRACTION</th>
<th>PRODUCTION</th>
<th>INSTALLATION</th>
<th>USE PHASE (1 yr)</th>
<th>END OF LIFE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential (kg CO₂ equivalent)</td>
<td>5.57</td>
<td>0.85</td>
<td>1.19</td>
<td>0.41</td>
<td>0.06</td>
<td>8.08</td>
</tr>
<tr>
<td>Acidification Potential (kg mol H⁺ equivalent)</td>
<td>1.13</td>
<td>0.25</td>
<td>0.94</td>
<td>0.05</td>
<td>0.02</td>
<td>2.39</td>
</tr>
<tr>
<td>Eutrophication Potential (kg PO₄³⁻ equivalent)</td>
<td>9.00E-04</td>
<td>5.00E-04</td>
<td>6.00E-04</td>
<td>1.00E-04</td>
<td>0.00E+00</td>
<td>2.10E-03</td>
</tr>
<tr>
<td>Ozone Depletion Potential (kg CFC11 equivalent)</td>
<td>5.67E-10</td>
<td>3.39E-08</td>
<td>6.84E-11</td>
<td>4.55E-11</td>
<td>7.10E-13</td>
<td>3.46E-08</td>
</tr>
<tr>
<td>Smog (kg O₃ equivalent)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>0.02</td>
</tr>
</tbody>
</table>
10.0 Life Cycle Assessment (continued)

Figure 7 shows the sources of primary energy separated into non-renewable and renewable resources. Figures 8 and 9 show the contribution of different resources to renewable and non-renewable primary energy. All figures refer to energy sources used to manufacture Heterogeneous Vinyl Sheet in 2011.

Figure 7. Sources of Primary Energy

Figure 8. Renewable Energy by Source

Figure 9. Non-Renewable Energy by Source
10.0 Life Cycle Assessment (continued)

Waste and Water Consumption

The waste shown in Table 10 accounts for the waste generated at Armstrong® manufacturing facility (“Production”). The “Use” phase waste accounts for the disposal of the packaging and scrap materials generated during installation; the quantity of flooring disposed of following removal from a building is shown in the “End of Life” phase. These waste values do not include the waste generated in the upstream processes. Other waste categories specified in the PCR were excluded due to data quality.

The life cycle of this product consumes water during production while producing non-hazardous wastes. The quantities are separated into contribution per life cycle stage as shown in Table 10 for 1 m² of 2.0 mm Heterogeneous Vinyl Sheet.

Table 10: Resources and Wastes for Heterogeneous Vinyl Sheet (1 m²)

<table>
<thead>
<tr>
<th>RESOURCES AND WASTES</th>
<th>UNIT</th>
<th>SOURCING / EXTRACTION</th>
<th>PRODUCTION</th>
<th>INSTALLATION</th>
<th>USE PHASE (1 YR)</th>
<th>END-OF-LIFE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Renewable Material Sources</td>
<td>kg</td>
<td>6.00</td>
<td>3.60</td>
<td>0.60</td>
<td>0.30</td>
<td>0.40</td>
<td>10.90</td>
</tr>
<tr>
<td>Water Use</td>
<td>kg</td>
<td>2250.0</td>
<td>371.0</td>
<td>203.0</td>
<td>94.0</td>
<td>29.0</td>
<td>2947.0</td>
</tr>
<tr>
<td>Hazardous Waste Production</td>
<td>kg</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Non Hazardous Waste Production</td>
<td>kg</td>
<td>4.13</td>
<td>3.62</td>
<td>0.55</td>
<td>0.27</td>
<td>3.17</td>
<td>11.74</td>
</tr>
<tr>
<td>Secondary Fuels (Net)</td>
<td>MJ</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

10.3 Interpretation of Life Cycle Assessment

From the results of the flooring system life cycle covered in this study, it was concluded that the flooring manufacturing process had the greatest impact on Primary Energy Demand (PED) and “carbon footprint” (represented by Global Warming Potential [GWP]).

10.4 Flooring Impacts:

As shown in Table 6 on page 12, the majority of the environmental impacts for this product occurs during the extraction and processing of raw materials detailed in the Production Stage. For most flooring, the opportunity for reduction is in the manufacturing process as well as reductions associated with raw materials.

10.5 Use Stage:

The use stage is defined in the PCR at 60 years and this is what was used in the LCA. The assumption is that the flooring requires normal maintenance as shown in Table 5. Additional details regarding the assumptions and details of how the use phase was modeled in this study can be found in Section 7. Impacts associated with the Use Stage vary depending on the building owner’s maintenance practices, level of use, and traffic conditions. Figure 5 provides details of three (3) maintenance scenarios and the impacts resulting from the scenarios are provided in Table 8. The low intensity maintenance scenario results in lower environmental impacts. For example, less scrubbing means less water consumption and a lower eutrophication potential.

10.6 End of Life Impacts:

End of Life Impacts associated with landfilling of Heterogeneous Vinyl Sheet flooring had the greatest effect on eutrophication and global warming potential. When the impacts associated with end of life and raw materials that would be derived are considered, recycling Heterogeneous Vinyl Sheet flooring can reduce the GWP by over 50% and eutrophication by 48%.
11.0 Additional Information, Evidence, Test Certificates

11.1 VOC Emissions

All Armstrong® Heterogeneous Vinyl Sheet flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1., 2010). Total Volatile Organic compounds are <0.5 mg/m3

12.0 References

12.1 PCR


12.2 Standards

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 10582:2010 Resilient floor coverings – Heterogeneous poly(vinyl chloride) floor coverings – Specification
ISO 21930:2007 Sustainability in building construction – Environmental declaration of building products
ASTM C423-09a Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM E662-14 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials

13.0 Third Party Evaluations

- Certificate of Compliance for VOC Emissions: Berkeley Analytical and FloorScore
- Climate Registry certification of our greenhouse gas (GHG) inventories
14.0 Quality Assurance

Armstrong Flooring 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. All Armstrong® Heterogeneous Vinyl Sheet is manufactured in ISO 9001 certified plant.

15.0 References

Table 11. Life Cycle Impact Assessment Categories, Indicators of Contribution to Environmental Issues, Units of Measure, and Brief Descriptions

<table>
<thead>
<tr>
<th>IMPACT CATEGORY</th>
<th>INDICATOR</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidification</td>
<td>Acidification Potential (AP)</td>
<td>A measure of emissions that cause acidifying effects to the environment. The acidification potential is assigned by relating the existing $S^-$, $N^-$, and halogen atoms to the molecular weight.</td>
<td>mol H⁺ equivalent</td>
<td>J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011.</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Global Warming Potential (GWP)</td>
<td>A measure of greenhouse gas emissions, such as CO₂ and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, magnifying the natural greenhouse effect.</td>
<td>kg CO₂ equivalent</td>
<td>Intergovernmental Panel on Climate Change (IPCC). IPCC Guidelines for National Greenhouse Gas Inventories 2006.</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>Eutrophication Potential (EP)</td>
<td>An indicator of the potential to cause an increase in biomass production. In water, this can lead to algal blooms resulting in oxygen depletion that affects higher species such as fish. Undesirable shifts in numbers of species can also occur, resulting in a threat to biodiversity.</td>
<td>kg PO₄³⁻ equivalent</td>
<td>J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011.</td>
</tr>
<tr>
<td>Ozone Creation</td>
<td>Photochemical Oxidant Potential (POCP)/Smog Potential</td>
<td>A measure of emissions of precursors that contribute to low level smog, produced by the reaction of nitrogen oxides and VOC’s under the influence of UV light.</td>
<td>kg CFC11 equivalent</td>
<td>J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011.</td>
</tr>
<tr>
<td></td>
<td>Primary Energy Demand</td>
<td>A measure of the total amount of primary energy extracted from the earth. PED is expressed in energy demand from non-renewable resources (e.g., petroleum, natural gas, etc.) and energy demand from renewable resources (e.g., hydropower, wind energy, solar, etc.). Efficiencies in energy conversion (e.g., power, heat, steam, etc.) are taken into account.</td>
<td>MJ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water Consumed</td>
<td>Water consumption is the sum of all water inputs to the life cycle. Includes water required for production of raw materials, upstream datasets, and manufacturing processes. Does not capture the end of life of the water consumed.</td>
<td>kg/m²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waste Disposed</td>
<td>Waste disposed is the sum of all waste outputs from the life cycle. This includes hazardous and non-hazardous wastes and does not capture end of life of the waste generated.</td>
<td>kg/m²</td>
<td></td>
</tr>
</tbody>
</table>

15.1 Definitions

GaBi 6.0 – LCA Modeling Software

CML-2010 – is an impact assessment tool developed by the Center of Environmental Science of Leiden University (CML). The CML methodology groups the LCI results into midpoint categories, according to themes. These themes are common mechanisms (e.g. climate change) or groupings. The impact categories used in this report are Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP), Ozone Depletion Potential (ODP), Photochemical Ozone Creation Potential (POCP), Abiotic Depletion Elements (ADE) and Abiotic Depletion Fossil (ADF).