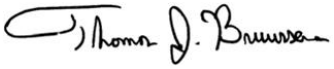
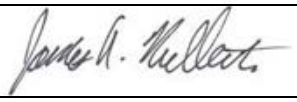
MANNINGTON COMMERCIAL

Mannington is a fourth generation, family-owned company with manufacturing facilities in eight communities across America. Known for creating high performance products for nearly 100 years, the past decade has seen our company rise to a leadership position in the styling and development of long-lasting, low-maintenance flooring systems that incorporate reclaimed waste streams. We divert waste from America's landfills, incorporating it into our manufacturing, helping make us a net user of waste in our carpet manufacturing – capturing and using more waste than we create. Our energy leadership, including one of the largest solar arrays in the flooring industry helped prompt the US Secretary of Energy to name us an original member of the Save Energy Now-Better Plants program, setting the standard for reducing energy usage by 2020. From 2007-2012, we also reduced water usage at our carpet operations by nearly 35%. We also hold certifications for ISO-14001, NSF/ ANSI environmentally preferable products, CRI Green Label Plus, and FloorScore. Our products contribute to LEED credits Green Globes & other rating systems.

Infinity® RE, Mannington Commercial's revolutionary carpet tile backing, diverts one of the largest construction waste streams from landfill. As a result of ongoing research and improvement, carpet product backed with Infinity RE contains a range of 20% - 27% recycled content by total product weight, including 10% - 17% post consumer recycled content, without any compromise of Mannington's legacy of performance.

Mannington Commercial | 1844 US Highway 41 S.E. Calhoun, GA 30701 | 1-800-241-2262 www.mannington.com

ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

EPD Information			
Program Operator	NSF International		
Declaration Holder	Mannington Commercial		
	Date of Issue November 15, 2013	Period of Validity 5 years	Declaration Number EPD10004
This EPD was independently verified by NSF International in accordance with ISO 14025: ☐ Internal ☒ External			 Thomas J. Bruursema Bruursema@nsf.org
This life cycle assessment was independently verified by in accordance with ISO 14044 and the reference PCR:			 Jim Mellentine Sustainable Solutions Corporation Jim@SustainableSolutionsCorporation.com

LCA Information	
Basis LCA	Mannington Life Cycle Assessment for Infinity® RE modular carpet September 30, 2013
LCA Preparer	Michael Schiffli Mannington Commercial Mike_Schiffli@mannington.com
This life cycle assessment was critically reviewed in accordance with ISO 14044 by:	Jim Mellentine Sustainable Solutions Corporation Jim@SustainableSolutionsCorporation.com

PCR Information	
Program Operator	NSF International
Reference PCR	Flooring: Carpet, Resilient, Laminate, Ceramic, Wood
Date of Issue	May 22, 2012
PCR review was conducted by:	Dr. Michael Overcash Environmental Clarity movercash@earthlink.net

ENVIRONMENTAL PRODUCT DECLARATION: DETAILED VERSION

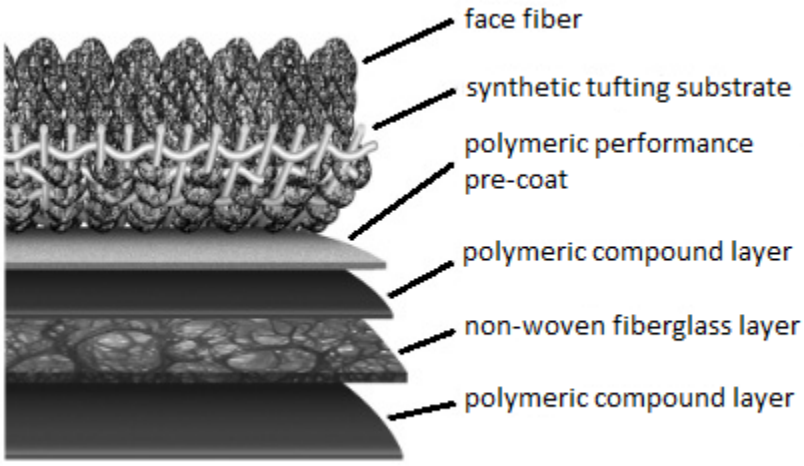
Product Description

Product classification and description

Products covered in this EPD are a broad variety of carpet styles and colors manufactured by Mannington Commercial, backed with our Infinity® RE modular backing system and made with either nylon 6,6 or nylon 6 yarn. Infinity® RE modular carpet is a polymeric vinyl compound modular backing system. Infinity® RE contains a minimum of 20% total recycled content, including a minimum of 12% post-consumer recycled content by total product weight. Infinity® RE modular backing system is guaranteed by Mannington's warranted performance. The fiber in these products (product wear layer) is constructed using nylon 6,6 or nylon 6 yarn that is either solution dyed, space dyed, or a combination of the two methods. Like with most Mannington Commercial backing systems, these products are certified as environmentally preferable products to NSF/ANSI 140:2012 Sustainability Assessment for Carpet, to the Platinum level, and manufactured in the USA in an ISO 14001 registered facility.

The aggregate weight of Infinity® RE modular backing system is approximately 98.9 oz/yd^2. The variation in weight across the Infinity® RE modular carpet products is due to the yarn weight. The life cycle assessment for this product group was completed using a yarn weight of 24.3 oz/yd^2 with a sensitivity check being completed using the product group's minimum yarn weight of 14 oz/yd^2 and the maximum yarn weight of 26 oz/yd^2. Unless otherwise noted, data within this EPD represents an average yarn weight of 24.3 oz/yd^2 and the Infinity® RE modular backing system weighing 98.9 oz/yd^2 for a total product weight of 123.2 oz/yd^2.

Figure 1: Diagram of Infinity® RE modular carpet



Definitions

- Face fiber – Fibers of Nylon 6,6 or Nylon 6 yarn that are solution dyed, space dyed or a combination of the two.
- Synthetic tufting substrate – The yarn is tufted into a polyester woven sheet or PET/nylon blended non-woven sheet, also known as *primary backing*. The polyester woven sheet is composed of 85% post-consumer recycle content.
- Polymeric performance pre-coat – A Vinyl Acetate / Ethylene (VAE) copolymer mixture that is water based which bonds the tufts to the primary backing, giving the yarn fibers strength and durability.
- Polymeric compound layers – A polymeric compound backing containing both post-consumer recycled and pre-consumer recycled content.
- Non-woven fiberglass layer – A fiberglass fabric embedded into the backing, which provides dimensional stability.

Applicability

Infinity® RE modular carpet is intended for use in high traffic commercial interior spaces. The type of manufacturing (see Table 1) will determine if the flooring is suitable for extra- heavy traffic, as defined in the guidelines developed by the Carpet and Rug Institute.[1]

[1] http://www.carpet-rug.org/documents/factsheets/Guidelines_for_levels_of_traffic.pdf

Product Characteristics

Table 1: Product characteristic table for Infinity® RE modular carpet

Type of manufacture	Tufted Textured Loop, Tufted Texture Cut Pile, Tufted Patterned Loop, Tufted Patterned Tip Sheared, Tufted Tip Sheared or Tufted Cut Pile	
Yarn type	Nylon 6,6 or Nylon 6	100%
Secondary backing	Polymeric vinyl compound	100%
Characteristics	**Nominal Value**	**Unit**
Number of tufts or loops	1,302 – 2,579 (12,096 – 23,962)	dm^2 (ft^2)
Yarn weight	475 – 882 (14 - 26)	g/m^2 (oz/yd^2)
Backing weight	3,353 (98.9)	g/m^2 (oz/yd^2)
Total product weight	3,831 – 4,238 (113 – 125)	g/m^2 (oz/yd^2)
Pile thickness	2.134 – 6.858 (0.084 – 0.270)	mm (inch)
Backing thickness	6.35 (0.250)	mm (inch)
Total thickness	8.484 – 13.208 (0.334 – 0.520)	mm (inch)
Post-consumer recycle	10 – 15	%
Total recycled content	19 – 25	%
Product Standard / Approval		**Results**
AATCC 134-2011 Electrostatic Propensity		≤3.0 kV
AATCC 16-2004 Colorfastness to Light		≥4 at 40 AFUs
ASTM E648 – Radiant Panel Test		CLASS 1
ASTM E662 – NBS Smoke Test (Flaming Mode)		≤ 450
ASTM D2859 – Methenamine Pill Test		PASSES
ASTM D3936 – Delamination Strength		≥ 3 lbs / in
ASTM D5252, ASTM D7330, CRI TM-101 – Test for Surface Appearance Change (CRI-TARR rating)		≥ 3
ISO 2551/ASTM D7570 – Dimensional Stability (AACHEN TEST)		± .027 inches
The laboratories used for testing have NVLAP Accreditation (NIST)[2].		
Accreditation		
Carpet and Rug Institute Green Label Plus – Category 17X (CRI indoor air quality control green label plus ID: GLP7616)		
EN14041:2004 CE-Labeling		
NSF/ANSI 140:2012 Sustainability Assessment for Carpet: Platinum		

[2] http://www.nist.gov/nvlap/

Material Content

Material Content of the product

Table 2: Material content table for Infinity® RE modular carpet

Component	Material	Mass %	Availability (nature of resource, renewable / recycled, availability)	Origin
Nylon face fiber	Nylon 6,6 (products: 98%)	12 - 21 %	Fossil resource, non renewable, limited	Global
	Nylon 6 (products: 2%)		Fossil resource, non renewable, limited	Global
Synthetic tufting substrate	Polyester (products: 75%)	3 – 4 %	Fossil resource, non renewable, limited (15%) Post-consumer recycled, abundant (85%)	Global
	PET / Nylon (products: 25%)		Fossil resource, non renewable, limited	Global
Polymeric performance pre-coat	Vinyl Acetate / Ethylene copolymer	14 – 18 %	Fossil resource, non renewable, limited	Global
	Calcium carbonate		Mineral, non renewable, abundant	Global
Polymeric compound layer	Polyvinyl chloride polymer	24 – 27 %	Fossil resource, non renewable, limited	Global
	DOTP		Fossil resource, non renewable, limited	Global
	BBCH		Fossil resource, non renewable, limited	Global
	Calcium carbonate		Mineral, non renewable, abundant	Global
Reinforcement layer	Glass	1 – 2 %	Mineral resource, non renewable, abundant	US
Polymeric compound layer	Polyvinyl chloride polymer	36 – 40 %	Fossil resource, non renewable, limited	Global
	DOTP		Fossil resource, non renewable, limited	Global
	Calcium carbonate		Mineral, non renewable, abundant	Global
	Post consumer carpet		recycled material, abundant	US
	Pre consumer carpet		recycled material, abundant	US
Modifiers	Various	1 – 2%		Global

Production of main materials

Nylon 6,6, CAS# 32131-17-2, is synthesized by polycondensation of hexamethylene diamine and adipic acid. (Nylon 6-6, 2007)

Nylon 6, CAS# 25038-54-4, is synthesized by ring opening polymerization of caprolactam. Caprolactam is comprised of 6 carbons creating the 6 in Nylon 6. (Nylon 6, 2005)

Polyester (PET), CAS# 25038-59-9, *is a synthetic polymer made of purified terephthalic acid (PTA). (Polyester, 2002)*

Vinyl Acetate/Ethylene copolymer, CAS# 24939-78-8, *is prepared by polymerization of vinyl acetate monomer and ethylene.*

Calcium carbonate, CAS# 1317-65-3, *is an abundant mineral found worldwide and is the chief substance found in rocks (i.e., marble and limestone). It can be ground into varying particle sizes and is widely used as filler material in formulated flooring systems.*

Polyvinyl chloride (PVC), CAS# 9002-86-2, *is prepared by polymerization of vinyl chloride monomer. Vinyl chloride monomer is produced from salt and ethylene.*

Glass, CAS# 065997-17-3, is produced by fusing silicon dioxide (sand).

Dioctyl terephthalate (DOTP), CAS# 6422-86-22, is prepared by the reaction of dimethyl terephthalate and 2-ethylhexanol.

1,2-cyclohexanedicarboxylic acid, 1-butyl 2-(phenylmethyl) ester (BBCH), CAS# 1200806-67-2, is synthesized from reacting the salt of mono-butyl dicarboxylic acid and benzyl chloride.

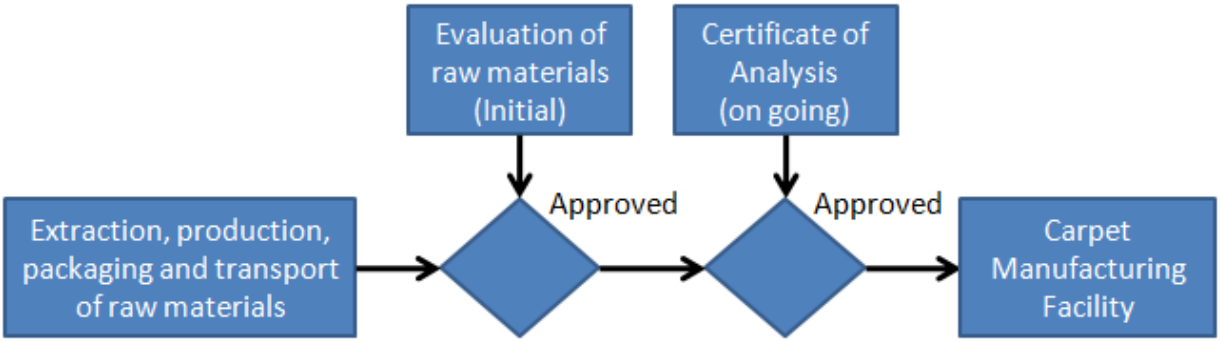
Post consumer carpet, CAS# NA, is carpet that has reached its end of life as a consumer product.

Pre consumer carpet, CAS# NA, is carpet waste from the manufacturing process.

Life Cycle Assessment Stages and Reported EPD Information

Sourcing/extraction (raw material acquisition) stage

Figure 2: Diagram of the raw material sourcing and extraction stage

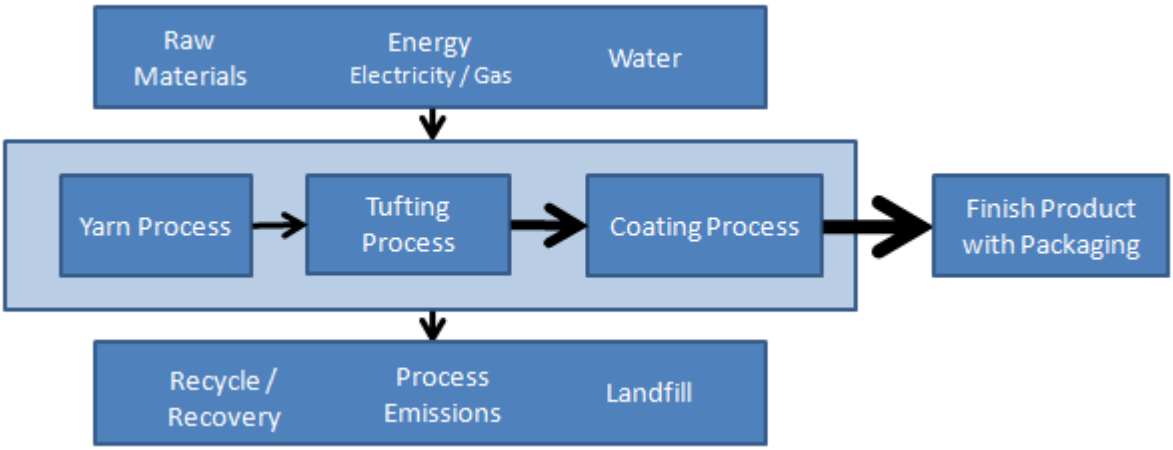


The life cycle assessment stage for sourcing and extraction begins at the point of the raw material being extracted and ends at the point when the packaged raw material is received by the carpet manufacturing facility.

Before a raw material is used, it must first be evaluated for quality, availability, consistency, performance and value before the material will be considered acceptable. Once the material has passed the initial evaluation process; future shipments are evaluated using the suppliers' certificate of analysis.

Manufacturing stage

Figure 3: Diagram of the manufacturing stage



The manufacturing stage begins with the yarn process. The yarn is processed by converting the raw yarns (singles) into a finished yarn that is sent to the tufting process. The processing of raw yarn usually requires electricity, gas and water.

The tufting process involves using a tufting machine utilizing needles to insert the finished yarn into a synthetic tufting substrate (primary backing) to produce various aesthetically pleasing products which are generically referred to as greige carpet. The tufting process requires electricity.

The coating process is the final manufacturing step. The coating process applies a polymeric performance pre-coat that bonds the finished yarn into the primary backing and applies two polymeric compound layers to complete the product. The product is cut, packaged and ready for shipment at the end of the coating process. The coating process requires electricity, gas and water.

Health, safety, and environmental aspects during production

- ISO 14001:2004 Environmental Management System
- Better Plants Partner in the U.S. Department of Energy's Better Plants Program
- NSF/ANSI 140:2012 Sustainability Assessment for Carpet – Section Public health and environment
- Aggressive water conservation program began in 2007 which, as of 2012, has yielded nearly a 35% reduction in site water usage.

Production waste

- All packaging materials (cardboard, stretch wrap, shrink wrap and pallets) are recycled / repurposed.
- All scraps and trimmings of yarn, primary backing and backing material are recycled / repurposed.
- Any finished carpet tile waste is recycled / repurposed.
- Trim material generated during the tile cutting process is being landfilled.

Delivery and installation stage

Delivery

Infinity® RE modular carpet and sundries are typically transported to the installation site using a diesel powered semi truck. Truck transportation plays a significant role in the distribution of the product. Mannington Commercial is an EPA SmartWay℠ Transport Partner with the goal of helping to reduce the impact of transportation[3].

This life cycle assessment has modeled the delivery using an average distance of 500 miles (805 km) with the diesel powered semi truck having an 85% utilization of its payload.

Installation

The recommended method for installing Infinity® RE modular carpet is to use the full adhesive method with Mannington Commercial INFINITY adhesive. The instructions for this installation procedure can be found on the Mannington Commercial web site (Mannington/Commercial Flooring/Technical/Carpet Installation).[4]

The life cycle assessment modeled the installation stage with INFINITY adhesive being applied at a rate of 0.174 kg/m^2 or 0.320 lb/yd^2.

Health, safety, and environmental aspects during installation

The Mannington Commercial INFINITY adhesive is CRI Green Label Plus (GLP# 70522) certified.[5] The MSDS for INFINITY can be found on the Mannington Commercial web site (Mannington/Commercial Flooring/Technical/Carpet Adhesives).[6]

Waste

Packaging and flooring installation wastes can be recycled at local recycling centers.

The life cycle assessment modeled a 3% loss of modular carpet during the installation process. This life cycle assessment modeled all of the installation waste as being disposed of in a commercial landfill.

Packaging

Each bundle contains a cardboard tray cap secured with polyethylene shrink wrap covering. The wrapped bundles are then stacked on to a wooden pallet and secured with polyethylene stretch wrap. Each pallet contains 124.8 m^2 (149.3 yd^2) of product. The material, category and weight of packaging are identified in Table 3.

[3] http://www.epa.gov/smartway/
[4] http://www.mannington.com/commercial/assets/pdfs/Literature/ModularTile%20Inst%20-%20Infinity.pdf
[5] http://www.mannington.com/commercial/assets/pdfs/Literature/INFINITY%20Adhesive%20Spec.pdf
[6] http://www.mannington.com/commercial/assets/pdfs/Literature/MSDS%20INFINITY%20Adhesive.pdf

Table 3: Packaging Material

Material	Category	Weight
Pallet	wood	15.3 kg (33.8 lbs)
Tray caps	cardboard	7.8 kg (17.1 lbs)
Shrink wrap (bundles), Stretch wrap	plastics	2.7 kg (5.9 lbs)
Labeling and Instructions	paper	128.9 gr (0.3 lbs)

Use stage

Use of the floor covering

The service life for Infinity® RE modular backing system will vary depending on the amount of floor traffic, level of maintenance and the desired appearance of the floor covering. The reference service life for Infinity® RE modular backing system is 15 years.

The EPD must present results for both a one year and sixty year period; impacts are calculated for both time periods. The standard assumes that the life of a building is sixty years.

- The one year impacts are based on the initial installation of one square meter of flooring (production, transport, installation and end-of-life) and the use phase impacts are based on annual cleaning and maintenance model.
- The sixty year impacts are based on four replacements (occurring once every 15 years) of one square meter of flooring (production, transport, installation and end-of-life) and the use phase impacts for 60 years of total floor maintenance.

Infinity® RE modular backing system is guaranteed by Mannington's warranted performance.

Cleaning and maintenance

The level of cleaning and maintenance varies depending on the amount of floor traffic and the desired appearance of the floor that the end user is seeking. The Carpet and Rug Institute's publication titled *Carpet Maintenance Guidelines for Commercial Applications* offers guidance on how to maintain the carpet at various floor traffic levels.[7] Mannington Commercial's web site also has guidance on the maintenance of carpet (Mannington/Commercial Flooring/Technical/Carpet Maintenance).[8]

The cleaning and maintenance for the life cycle assessment was modeled as shown in table 4.

[7] http://www.carpet-rug.org/documents/publications/078_Carpet_Maintenance_Guidelines.pdf
[8] http://www.mannington.com/commercial/assets/pdfs/Literature/CarpetCleaning_Brochure_08.pdf

Table 4: Cleaning and Maintenance

Level of use	Cleaning process	Cleaning frequency	Consumption of energy and resources
Commercial (light to moderate)	Vacuum	2 x week or 100 x year	Electricity
Commercial (heavy)	Vacuum	5 x week or 250 x year	Electricity
Commercial (light to heavy)	Hot water extraction	2 x year	Electricity, water, cleaning chemicals

Structural damage

The subfloor requirements and instructions for floor preparation can be found on the Mannington Commercial web site (Mannington/Commercial Flooring/Technical/Carpet Installation).[9]

End of life stage

Recycling, reuse, or repurpose

Recycling, reuse and repurpose of carpet is the preferred method of disposal for used carpet. According to the Carpet America Recovery Effort℠ (CARE) latest annual report, over 351 million pounds of carpet was diverted from U.S. landfills in 2012.[10] The CARE website provides information on recycling, reuse and repurposing opportunities across the U.S. Mannington Commercial is an original and long-standing member of CARE.

Mannington Commercial LOOP® carpet reclamation program allows for the recycling of used carpet.[11]

Disposal

Another method of disposal for used carpet is through a local municipal landfill or commercial incinerator facility.

The life cycle assessment modeled the end of life stage with 9% of carpet being recycled, reused, repurposed or incinerated while the remainder was disposed of in a commercial landfill. The benefit of waste to energy from the incineration of used carpet was not factored into this model. The transport of the used carpet to a commercial landfill was modeled using an average distance of 75 miles (121 km) with a diesel power semi truck.

[9] http://www.mannington.com/commercial/assets/pdfs/Literature/ModularTile%20Inst%20-%20Infinity.pdf
[10] http://www.carpetrecovery.org/
[11] http://www.mannington.com/commercial/Loop.aspx

Life Cycle Assessment (LCA)

General

A cradle to grave life cycle assessment (LCA) was completed on this product group in accordance with ISO 14040 (ISO, 2006), ISO 14044 (ISO, 2006) and *Product Category Rule for Environmental Product Declarations Flooring: Carpet, Resilient, Laminate, Ceramic, Wood*. (NSF International, 2012)

The life cycle stages for this study were:

- Production stage – Sourcing/extraction stage and manufacturing stage
- Delivery and installation stage
- Use stage
- End of life stage

All life cycles stages as described in System Boundaries, section 6.7 of the Product Category Rule (PCR) have been included. (NSF International, 2012)

Description of the functional unit

The functional unit has been defined as one square meter (m^2) for the two time periods defined in section 6.8.1 *Impact declaration and use stage normalization* of the PCR. (NSF International, 2012) The reference service life for this product group is 15 years while the reference service life for a building is 60 years.

Cut-off criteria

The Mass / energy flows and environmental impacts consisting of less than 1% may be omitted from the inventory analysis. Cumulative omitted mass / energy flows or environmental impacts shall not exceed 5%.
This does not apply to background data. Variations of these rules shall be documented and justification provided.

To avoid complicating the analysis, this study did not omit any mass / energy flows or environmental impacts from the life cycle inventories.

Allocation

The allocation procedure used in this study focused on either mass or square yards of output. For example: gallons of process water metered, pounds of griege waste, or finished carpet generated would be allocated proportionately to the square yards of carpet produced by the production line.

The principle of modularity was maintained throughout the study by modeling the material and energy flows to/from the environment at each material, or process element, where they occurred.

An open-loop allocation procedure was used for the packaging of raw materials. An example would be the stretch wrap used to unitize the bags of raw material on a pallet. The stretch wrap life cycle inventory includes transport to the recycle vendor. However, none of the life cycle inventories required to prepare the recycled material for its new life are included nor any credits are taken for the recycled material.

Open-loop allocation procedure was used for the recycled raw materials. An example would be post consumer carpet and pre consumer carpet. The life cycle inventory includes the transportation from the recycle center to the vendor, energies to transform, wastes, packaging and transport to the Calhoun, GA facility. However, none of the life cycle inventories of the materials former life were included.

Background data

As a general rule, specific data derived from specific production processes and/or average data derived from specific production processes was the first choice for the basis of creating this environmental product declaration.

SimaPro 7.3.3, developed by Pre' Consultants, was used to create the model used for this life cycle assessment.[12] SimaPro 7.3.3 software database was used in most of the background datasets required for this model.[13] SimaPro 7.3.3 software database were used for energy, transportation and auxiliary materials to ensure comparability of the results in the life cycle assessment, see table 5.

Table 5: Background data sources

Material	Data Source	Date
Nylon 6,6	US-EI Database version 2.2	2010 - 2013
Nylon 6	Life Cycle Inventory by Vendor	January 2012
Polyester	US-EI Database version 2.2	2010 - 2013
Vinyl Acetate / Ethylene Copolymer	US-EI Database version 2.2	2003 - 2013
Calcium Carbonate	US-EI Database version 2.2	2003 - 2013
Polyvinyl chloride	US-EI Database version 2.2	2010 - 2013
Bis(2-ethylhexyl) terephthalate (DOTP)	Life Cycle Inventory by Vendor	November 2011
BBCH	US-EI Database version 2.2	2007 - 2013
Glass	US-EI Database version 2.2	2003 - 2013
Post consumer carpet	US-EI Database version 2.2	2003 - 2013
Pre consumer carpet	US-EI Database version 2.2	2003 - 2013

[12] http://www.pre-sustainability.com/
[13] http://www.earthshift.com/software/simapro/databases

Data quality

The data used in the life cycle assessment represents current products and processes. This data is considered to be good to very good which meets the requirements of the product category rules. (NSF International, 2012) A variety of checks were built into the model. Additionally, a series of tests were conducted on the model to ensure that the model quality is very good.

Time related coverage – The process data (foreground data) was based on one year of data between 2012 and 2013. The background data sources are based on data less than 10 years old. All of the background data sources are modeled using 2010 or newer North American energies. The time related coverage is good.

Geographical coverage – The process data was based on North America. The background data sources were first selected based on technological appropriateness and then geographical appropriateness was considered. An example of this is calcium carbonate. Calcium carbonate was modeled on a technological equivalent process while the geographical location of the process was Europe and the energies were modeled for North America. The geographical coverage is good.

Technology coverage – Process data was collected from the actual processes and thus the technology coverage is very good. The background data was selected for technology relevance to ensure the best fit of the life cycle inventory to the real world. The technology coverage is very good.

Table 6: Process data quality (foreground data)

Process	Type of data	Period	Origin of data	Data source	Completeness	Accuracy
Yarn Process	input-output analysis	2012 - 2013	North America	Manufacturing Plant	Very Good	Very Good
Tufting Process	input-output analysis	2012 - 2013	North America	Manufacturing Plant	Very Good	Very Good
Coating Process	input-output analysis	2012 - 2013	North America	Manufacturing Plant	Very Good	Very Good

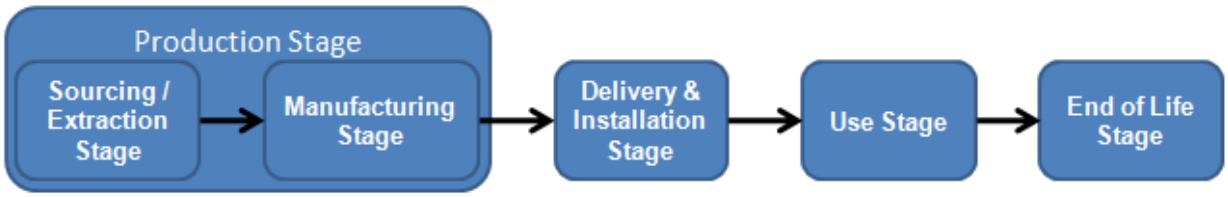
System boundaries

The life cycle assessment for Infinity® RE modular backing system was a cradle to grave study. The system boundaries for this study are as follows:

- Sourcing / extraction stage – This stage begins with the design of product concepts, selection and sourcing or materials, evaluation of optimum alternatives, and the results of design decisions through the extraction of materials. This includes extraction of virgin materials from the earth (pre-consumer supply chain). This may include the growth or extraction of all raw materials, and their delivery to the production site. Packaging materials are included.

- Manufacturing stage – This includes all relevant manufacturing processes once the optimum materials to manufacture a product have been selected. Packaging is included. Production of capital goods, infrastructure, production of manufacturing equipment, and personnel-related activities are not included. Heating, artificial lighting, and transport within the production site are excluded, unless they are directly used for the production process.
- Delivery and installation stage – This stage includes the delivery of the floor covering to the point of installation, fitting, and the raw material extraction, and manufacturing of all sundry material for the fitting, if relevant.
- Use stage – The use stage includes the cleaning and maintenance of the floor covering during its life time as well as extraction, manufacturing and transport of all sundry material, it relevant (e.g. cleaning materials, floor finishes) for the maintenance.
- End of life stage – The end of life stage includes the transport of the floor covering to end of life processes such as incineration, recycling and final disposition. All waste management processes are included in the calculation until final disposition, with the exception of the disposition of nuclear waste, which cannot be modeled due to its extremely long disposition times.

Figure 4: System Boundaries



Note on use stage

"The estimated service of a floor covering and references thereof depend on the type of floor covering, its application, the user, and required maintenance of the product. Comparisons of different floor coverings are allowed only if these parameters are considered in a consistent way and if LCA impacts are evaluated under the same normalized conditions. For this purpose, the use stage impacts shall be reported for a single year (1/60th of the total) of use and for the expected life of the building (60 years)." (NSF International, 2012)

Infinity® RE modular carpet has a reference service life of 15 years. The recommended maintenance schedule for Infinity® RE modular carpet can be reviewed in Table 4.

Impact declaration and use stage normalization

The life cycle impact assessments (LCIA) were calculated for multiple model scenarios of one square meter of Infinity® RE modular carpet as per *Section 6.8.1 Impact declaration and use stage normalization*. (NSF International, 2012)

- "For Table A, the LCIA for each life cycle stage shall be based on the RSL (reference service life) of a building which is currently 60 years. The use stage shall be for one year of routine maintenance (cleaning and other daily/weekly/monthly/annual maintenance) and extrapolated out to the reference service life of a building. This one year of LCA impacts will not include the maintenance activities that occur infrequently to the flooring product (refinishing, grout restoration, etc.) during the RSL of the building.
- For Table B, the LCA impacts for each life cycle stage shall be based on the RSL of a building which is currently 60 years. Table B use stage will not only include the annual maintenance activities calculated in table A, but also includes the activities that occur infrequently (refinishing, grout restoration, etc.) throughout the RSL of the building. For example, tile re-grouting impact every 30 years would be included in the use stage for Table B." (NSF International, 2012)

However, since all maintenance activities for the product are performed on a frequent basis, the results for Table B are identical to those of Table A for Infinity® RE modular carpet, and thus presented in a single table, Table 11. In addition, life cycle impacts are also presented for a single installation of one square meter of flooring with a single year of use included, Table 10.

Results of the Assessment

The CML 2001 Nov 09 methodology was used to calculate the LCIA values.[14] The LCIA results were calculated for the Production Stage, Installation & Delivery Stage, Use Stage and the End of Life Stage. The following categories from the CML 2001 Nov 09 methodology were selected for the assessment. (NSF International, 2012)

- Global warming potential (GWP) – 100 year
- Acidification potential (AP)
- Ozone depletion potential (ODP) – Steady State / Infinite
- Photochemical oxidant formation potential (POCP)
- Eutrophication (NP)
- Abiotic resource depletion potential (ADP), not including primary energy

[14] http://cml.leiden.edu/software/data-cmlia.html

Life Cycle Inventory Analysis

The primary energy values in tables 7 and 8 are calculated based on one square meter of Infinity® RE modular carpet product with a face weight of 24.3 oz/yd^2.

Table 7: Primary Energy, non renewable

Source	Units	Production Stage	Delivery & Installation Stage	Use Stage	End of Life Stage	Total	Percent
Total	MJ	2.960E+02	1.966E+01	5.144E+00	1.083E+00	3.219E+02	99.3
Lignite	MJ	6.603E-01	4.144E-03	1.958E-02	6.888E-05	6.841E-01	00.2
Mineral coal	MJ	6.022E+01	9.472E-01	2.346E+00	1.764E-02	6.353E+01	19.7
Natural gas	MJ	1.289E+02	5.767E+00	1.260E+00	5.595E-02	1.360E+02	42.3
Oil	MJ	7.078E+01	1.244E+01	9.947E-02	1.005E+00	8.432E+01	26.2
Nuclear	MJ	3.320E+01	4.910E-01	1.387E+00	4.793E-03	3.508E+01	10.9

Table 8: Primary Energy, renewable

Source	Units	Production Stage	Delivery & Installation Stage	Use Stage	End of Life Stage	Total	Percent
Total	MJ	9.628E+00	8.656E-02	1.920E-01	1.055E-03	9.907E+00	100
Hydropower	MJ	2.906E+00	4.083E-02	1.063E-01	7.166E-04	3.054E+00	30.8
Wind power	MJ	5.821E-01	7.539E-03	3.930E-02	1.426E-04	6.291E-01	6.3
Solar energy	MJ	6.135E+00	3.820E-02	4.645E-02	1.954E-04	6.220E+00	62.8

The values in table 9 include other resources and wastes in the life cycle inventory for one square meter of Infinity® RE modular carpet product with a face weight of 24.3 oz/yd^2.

Table 9: Other resources and Wastes

Source	Units	Production Stage	Delivery & Installation Stage	Use Stage	End of Life Stage	Total
Secondary Fuels	MJ	2.212E+00	1.290E-02	3.191E-02	1.132E-04	2.257E+00
Non-renewable material	kg	3.309E+00	1.779E-01	0.000E+00	0.000E+00	3.487E+00
Non-hazardous waste	kg	1.061E+01	3.937E-01	6.354E-01	3.930E+00	1.557E+01
Hazardous waste	kg	1.077E-02	9.915E-04	1.626E-05	1.278E-04	1.191E-02

Life cycle impact assessment

The CML 2001 Nov 09 methodology was used to calculate the impact assessments for one square meter of Infinity® RE modular carpet product with a face weight of 24.3 oz/yd^2, and the results presented for both a one year and a 60 year service life. Table 10 displays the impacts for a single installation (Production Stage, Delivery & Installation Stage, End of Life Stage) and one year of use.

Table 10: Life Cycle Stage Impacts for a one year Use Stage

Impact Category	Units	Production Stage	Delivery & Installation Stage	Use Stage	End of Life Stage	Total
GWP	kg CO_2 eq.	1.734E+01	1.030E+00	3.145E-01	7.648E-02	1.876E+01
AP	kg SO_2 eq.	1.047E-01	6.326E-03	2.386E-03	4.826E-04	1.139E-01
ODP	kg CFC-11 eq.	2.346E-06	6.975E-08	6.880E-09	7.618E-09	2.430E-06
POCP	kg C_2H_4 eq.	5.725E-03	2.906E-04	9.403E-05	1.309E-05	6.123E-03
NP	kg PO_4 eq.	1.778E-02	9.412E-04	4.628E-04	1.017E-04	1.929E-02
ADP	kg Sb eq.	1.870E-05	5.074E-08	8.985E-09	1.417E-10	1.876E-05

Figure 5 reviews at the percentage that each stage represents of the total value of each individual impact category in table 10.

Figure 5: Life cycle stages as a percentage of each impact category (Table 10 values)

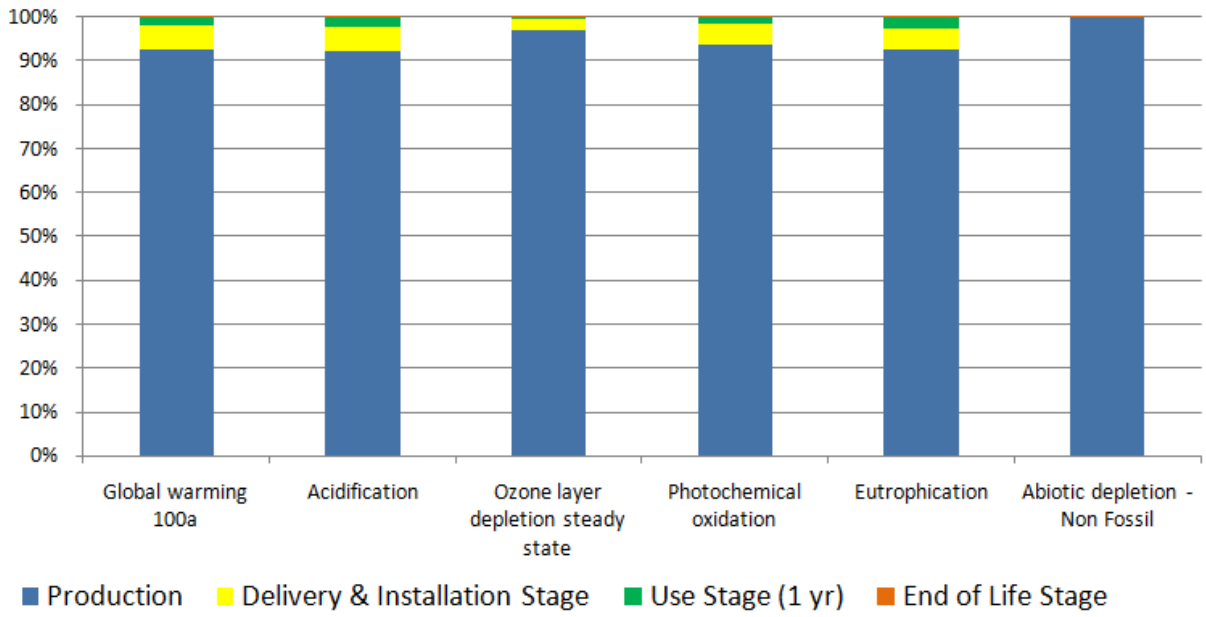


Table 11 displays the impacts associated with one square meter of one square meter of Infinity® RE modular carpet product over a 60 year service life. Since all maintenance activities for the product are performed routinely on a frequent basis, the results in Table 11 satisfy the requirements for both Tables A and B in the PCR.

Table 11: Life Cycle Stage Impacts for a building life of 60 years

Impact Category	Units	Production Stage	Delivery & Installation Stage	Use Stage	End of Life Stage	Total
GWP	kg CO_2 eq.	6.936E+01	4.119E+00	1.887E+01	3.059E-01	9.265E+01
AP	kg SO_2 eq.	4.190E-01	2.531E-02	1.432E-01	1.930E-03	5.894E-01
ODP	kg CFC-11 eq.	9.382E-06	2.790E-07	4.128E-07	3.047E-08	1.010E-05
POCP	kg C_2H_4 eq.	2.290E-02	1.162E-03	5.642E-03	5.236E-05	2.976E-02
NP	kg PO_4 eq.	7.114E-02	3.765E-03	2.777E-02	4.068E-04	1.031E-01
ADP	kg Sb eq.	7.479E-05	2.030E-07	5.391E-07	5.667E-10	7.553E-05

Figure 6 reviews at the percentage that each stage represents of the total value of each individual impact category in table 11.

Figure 6: Life cycle stages as a percentage of each impact category (Table B)

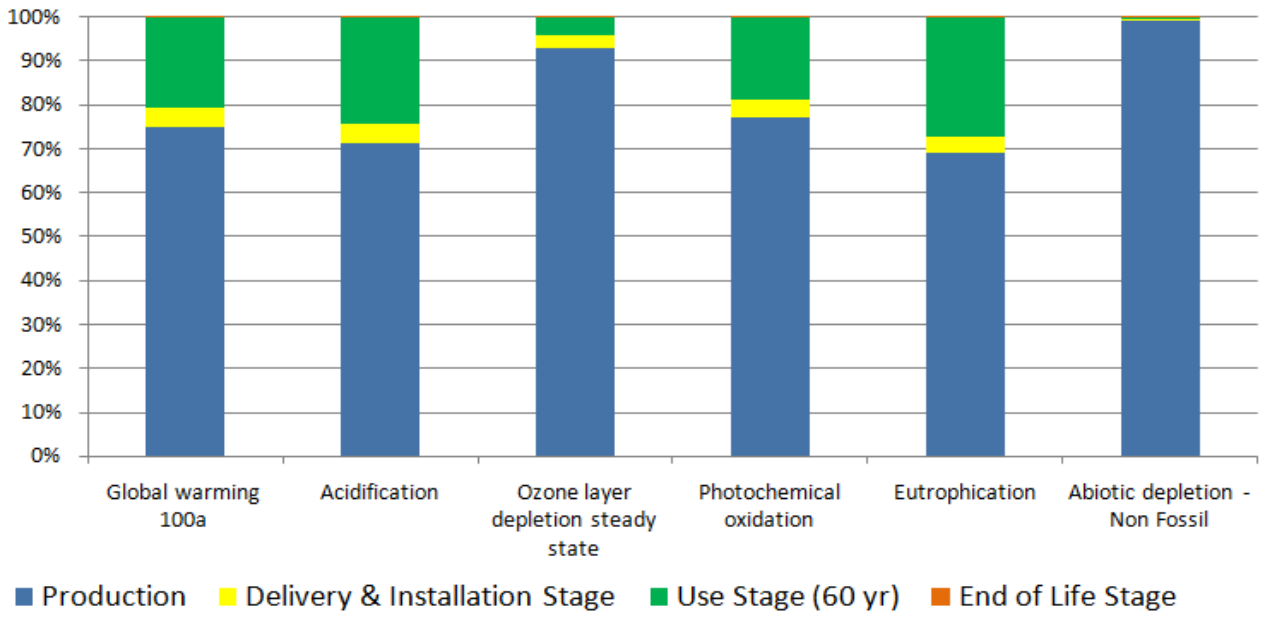


Table 12 has the CML 2001 Nov 09 impact assessments for the use stage of one square meter of Infinity® RE modular carpet product with a face weight of 24.3 oz/yd^2. The 1 Year Use represents the annual maintenance suggested for the flooring while the 60 Year Use represents the total maintenance of the flooring for the life of a building.

Table 12: Life Cycle Stage Impacts for 1 year and 60 years of use

Impact Category	Units	1 Year Use	60 Year Use
GWP	kg CO_2 eq.	3.145E-01	1.887E+01
AP	kg SO_2 eq.	2.386E-03	1.432E-01
ODP	kg CFC-11 eq.	6.880E-09	4.128E-07
POCP	kg C_2H_4 eq.	9.403E-05	5.642E-03
NP	kg PO_4 eq.	4.628E-04	2.777E-02
ADP	kg Sb eq.	8.985E-09	5.391E-07

The final table shows the LCIA using CML 2001 Nov 09 methodology for one square meter of Infinity® RE modular carpet product with one year of annual use at a variety of face weights, table 13.

Table 13: Life Cycle Stage Impacts for a one year Use Stage with a variety of face weights

Impact Category	Units	14 oz/yd^2 475 gr/m^2	16 oz/yd^2 542 gr/m^2	18 oz/yd^2 610 gr/m^2	20.2 oz/yd^2 685 gr/m^2	22 oz/yd^2 746 gr/m^2	24.3 oz/yd^2 824 gr/m^2	26 oz/yd^2 882 gr/m^2
GWP	kg CO_2 eq.	1.478E+01	1.555E+01	1.633E+01	1.710E+01	1.787E+01	1.876E+01	1.942E+01
AP	kg SO_2 eq.	9.494E-02	9.862E-02	1.023E-01	1.060E-01	1.097E-01	1.139E-01	1.171E-01
ODP	kg CFC-11 eq.	2.369E-06	2.381E-06	2.393E-06	2.405E-06	2.416E-06	2.430E-06	2.440E-06
POCP	kg C_2H_4 eq.	5.289E-03	5.450E-03	5.612E-03	5.774E-03	5.936E-03	6.123E-03	6.260E-03
NP	kg PO_4 eq.	1.468E-02	1.558E-02	1.647E-02	1.737E-02	1.826E-02	1.929E-02	2.005E-02
ADP	kg Sb eq.	1.673E-05	1.712E-05	1.752E-05	1.791E-05	1.830E-05	1.876E-05	1.909E-05

Interpretation

The interpretation of the LCIA results for one square meter of Infinity® RE modular carpet yields several observations. After reviewing figures 5 and 6, the largest contributor in all of the studied impact categories is the production stage.

Over the life of the building, noted in figure 6, the second largest contributor to the impact categories is the use stage. However if the reader reviews figure 5, which has a single year of use, the delivery & installation stage would be rated second. The noted differences would be due to the time frame referenced. The delivery & installation stage only occurs once every 15 years; whereas, the use stage occurs continuously over the life of the product.

The sensitivity analysis of the model with respect to the face weight demonstrates that even though a change in the face weight from 14 oz/yd^2 to 26 oz/yd^2 is an 11% increase in the total mass of the material, some impact categories increased more than 11%. Take for example, global warming potential (GWP); the value increased by 30%. Examples of other increases greater than the 11% total mass are photochemical oxidation (POCP) and eutrophication potential (NP).

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