CARLISLE
SYNTEC SYSTEMS

ENVIRONMENTAL PRODUCT DECLARATION
Reinforced EPDM Membrane

Environmental Product Declaration

According to ISO 14025 and ISO 21930:2017

REINFORCED EPDM MEMBRANE

Carlisle Construction Materials (CCM)

About CCM

More than a half century ago, Carlisle revolutionized the commercial roofing industry with its EPDM membrane, establishing a track record of superior performance and quality that would become the company's hallmark. Today, more than 260,000 warranted Carlisle EPDM roof systems comprising over 17.5 billion square feet of membrane have been installed around the world. The history of Carlisle is built on EPDM, a preferred membrane choice of consultants, contractors, architects, and building owners in numerous areas. Since the beginning, Carlisle's attention has been devoted to the four pillars of success that customers value most: performance, energy efficiency, environmental sustainability, and innovation. These are the foundation of Carlisle's success and commitment to every customer. Carlisle's decades-long experience with EPDM has allowed the company to define the standards of quality and reliability.

CARLISLE CONSTRUCTION MATERIALS

Issue Date: 17-05-2023

Valid Until: 16-05-2028

Declaration Number: ASTM-EPD427

DECLARATION INFORMATION

Declaration	
Program Operator: ASTM International **Company:** Carlisle Construction Materials 1285 Ritner Hwy Carlisle, PA 17013 www.carlisleconstructionmaterials.com	**www.astm.org**
Product Information	**Validity / Applicability**
Name: Reinforced EPDM Single-Ply Roofing Membrane	**Period of Validity:** This declaration is valid for a period of 5 years from the date of publication.
Product Definition: Reinforced ethylene propylene diene monomer (EPDM) Single-Ply Roofing Membrane	
Declaration Type: Business-to-business (B2B)	**Geographic Scope:** North America
PCR Reference: • Core PCR: ISO 21930:2017 (ISO, 2017) • Sub-category PCR: Product Category Rules for Single-Ply Roofing Membranes (NSF International, 2019)	**PCR Review was conducted by:** • Thomas P. Gloria, Ph.D., Industrial Ecology Consultants • Bill Stough, Sustainable Research Group • Jack Geibig, EcoForm
Product Application and/or Characteristics	
Single-ply, reinforced EPDM membrane representative of 45-, 60-, and 75-mil thicknesses are used as a roofing protective layer for building applications.	
Content of the Declaration	
• Product definition and physical building-related data • Details of raw materials and material origin • Description of how the product is manufactured • Life Cycle Assessment results • Additional environmental information	
Verification	
This declaration was independently verified in accordance with ISO 21930:2017, ISO 14025:2006 and the reference PCR by Tim Brooke, ASTM International.	☐ Internal ☒External
This life cycle assessment was independently verified in accordance with ISO 21930:2017 and ISO 14044:2006 and the reference PCR by Lindita Bushi, Ph.D., Athena Sustainable Materials Institute.	
Limitations *The environmental impact results of EPDM products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the EPDM product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted. See Section 3.10 for additional EPD comparability guidelines. Environmental declarations from different programs (ISO 14025) may not be comparable.*	

EPD SUMMARY

This document is a Type III environmental product declaration by Carlisle Construction Materials (CCM) that is certified by ASTM International (ASTM) as conforming to the requirements of ISO 21930 and ISO 14025. ASTM has assessed that the Life Cycle Assessment (LCA) information fulfills the requirements of ISO 14040 in accordance with the instructions listed in the referenced product category rules. 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.

No comparisons or benchmarking are included in this EPD. Environmental declarations from different programs based upon differing PCRs may not be comparable. In general, EPDs may not be used for comparability purposes when not considered in a construction works context. Given this PCR ensures products meet the same functional requirements, comparability is permissible provided the information given for such comparison is transparent and the limitations of comparability explained. Only EPDs prepared from cradle-to-grave life cycle results, and based on the same function, quantified by the same functional unit, and taking account of replacement based on the product reference service life (RSL) relative to an assumed building service life, can be used to assist purchasers and users in making informed comparisons between products. When comparing EPDs created using this PCR, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to different results for upstream or downstream of the life cycle stages declared.

SCOPE AND BOUNDARIES OF THE LIFE CYCLE ASSESSMENT

The Life Cycle Assessment (LCA) was performed according to ISO 14040 (ISO, 2020a) and ISO 14044 (ISO, 2020b) following the requirements of the ASTM EPD Program instructions and the referenced PCR.

System Boundary: Cradle-to-gate

Allocation Method: Mass allocation was selected since the environmental burden in the industrial process (energy consumption, emissions, etc.) is primarily governed by the mass throughput of each sub-process.

Declared Unit: 1 m^2 of single-ply roofing membrane for a stated product thickness. Environmental performance results therefore represent CCM's average production of EPDM, normalized to 1 m^2.

General Information

Description of Company/Organization

Carlisle SynTec Systems, the flagship division of Carlisle Construction Materials (CCM), is the largest supplier of commercial roofing products in the world. Carlisle produces high-performance EPDM, TPO, PVC, and FleeceBACK® single-ply roofing membranes, a full line of polyiso and expanded polystyrene insulation, and a wide variety of solvent-based and low-VOC adhesives. With decades of manufacturing experience and billions of square feet of roofing materials sold, Carlisle continues to lead the industry by providing the best products, services, and warranty options available today.

Product Description

The product system evaluated in this report is a single-ply reinforced EPDM roofing membrane at the finished nominal thicknesses produced by CCM. See Table 1 for membrane specification and standard.

Table 1 Membrane specification and standard

Roof System	Roof System Component	Declared Thicknesses and Weights	Standard
Reinforced ethylene propylene diene monomer (EPDM)	Membrane	45 mils: 1.37 kg/m^2 60 mils: 1.81 kg/m^2 75 mils: 2.25 kg/m^2	ASTM D4637

Product Average

The 2019 production data used in this EPD considers reinforced EPDM roofing membranes produced by CCM in one (1) site in North America during the year. The participating facility is:

- Carlisle, PA

Application

Reinforced EPDM membranes are utilized in mechanically-fastened and fully adhered commercial roofing systems and are known to provide added puncture/tear resistance, excellent long term weatherability, and repairability. The thicker 60-mil and 75-mil membranes provide added weathering material and added puncture resistance making them the natural choice for longer-term performance. Reinforced EPDM membrane is sold with factory-applied splice tape creating a very reliable and productive means to adjoin the sheets on the roof. They are also available in either light or dark colors to fit different geographic climates. Darker-colored EPDM is typically preferred in heating-dominated central and northern climates, whereas white or lighter-colored EPDM is typically preferred in cooling-dominated southern climates.

Material Composition

Table 2 shows the input material for reinforced EPDM roofing membranes and their material percentages for the three membrane thicknesses.

Table 2 Average composition of reinforced EPDM roofing membrane

Material	% Composition
Base resin (EPDM)	40.9
Filler	18.3
Paraffinic oil	14.6
Pigment	17.1
Polyester scrim	4.4
Fire retardant	2.2
Others	2.5

Manufacturing

The main material input into the manufacturing process is EPDM rubber in the form of pellets and (uncured) scrap. Additional materials include various additives, which aid in the manufacturing process (e.g., accelerators) and which enhance the membrane's performance (e.g., fire retardants and pigments). The mix is heated, stirred, and extruded into a sheet with a reinforcing polyester scrim sandwiched in the middle of two EPDM plies. The sheet is then pressed to achieve the specified thickness, trimmed, and rolled up into a master roll. Uncured EPDM edge trimmings generated during the aforementioned steps can be looped directly back as a material input. Vulcanization entails master rolls of membrane being wrapped and placed into a pressurized oven to crosslink and cure the membrane. Once cured, the membrane sheet maintains its shape and size. After vulcanization, the cured EPDM membrane is cut to the desired length and packaged onto a cardboard core.

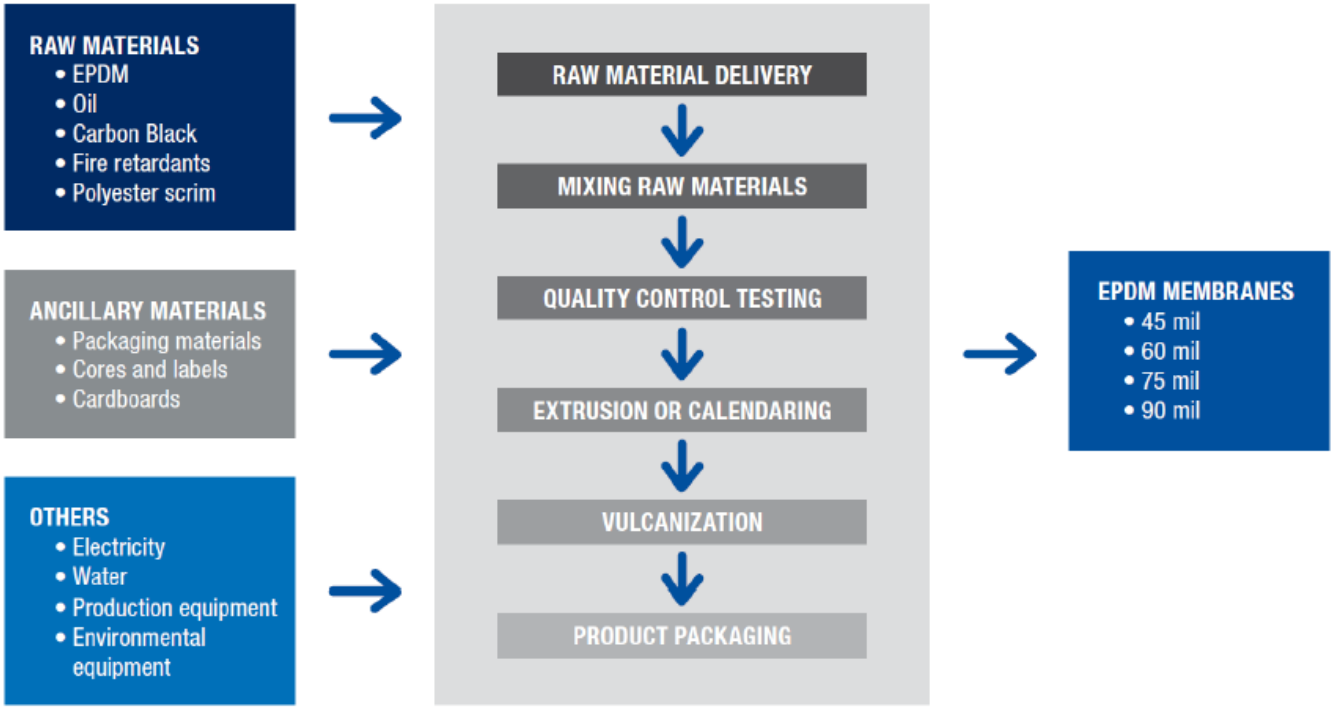

Figure 1: EPDM production process map

Transportation

Primary data on inbound transportation of raw materials and packaging material were collected. These materials included base resin (EPDM), scrim, fillers, pigments, curatives, activators, processing aids, etc. Transportation to the customer or construction site is outside the scope of this EPD.

Product Installation

Installation is outside the scope of this EPD.

Use

Product use is outside the scope of this EPD.

Reuse, Recycling, and Energy Recovery

Product reuse, recycling, and incineration for energy recovery is outside the scope of this EPD.

Recycling – Carlisle continues to research means to increase the use of recycled materials into the membrane and various rubber-related accessory products like rubber pavers and walkway pads.

Energy efficiancy – As a leader in the commercial roofing industry and the largest manufacturer of both white and dark-colored roofing membranes, Carlisle continues to advocate for careful selection of roofing systems based on a building's design, location, and climatic conditions. In general, the heating penalty of white reflective membranes exceeds the cooling benefit in heating-dominated central and northern climates. In the central and northern climates, heating costs are typically 3-5 times greater than cooling costs, and in these climates a dark-colored EPDM roof is typically the energy-efficient choice. In cooling-dominated southern climates a white EPDM roof or a ballasted EPDM roof are typically the energy-efficient choice.

The use of insulating ½" cover boards provide an added 2.5 R-value as another means to enhance the energy efficiency of roofing systems. Cover boards also improve the durability and wind uplift resistance of the roofing assembly.

Specifying the use of multiple layers of insulation with staggered joints in lieu of a single thick layer of insulation is proven to be more thermally efficient.

Utilizing urethane insulation adhesives to bond insulation to the roof deck in lieu of metal fasteners and metal insulation plates eliminates the R-value loss from thermal bridging.

Disposal

Product disposal is outside the scope of this EPD.

EPDM membrane and insulation from aged mechanically fastened roof systems can be repurposed or recycled.

METHODOLOGICAL FRAMEWORK

DECLARED UNIT

The declared unit for this study is :

1 m² of single-ply roofing membrane for a stated product thickness.

Environmental performance results therefore represent CCM's average production of EPDM, normalized to 1 m^2. The reference service life is not specified. Since the use stage is not included in the system boundary, no reference service life needs to be defined for the analysis.

SYSTEM BOUNDARY

System boundaries are summarized in Figure 2 for the analysis scope of "cradle-to-gate". Excluded modules are indicated by "MND" or "module not declared". As is typical of works of life cycle assessment, the construction and maintenance of capital equipment, such as production equipment in the manufacturing stage, are not included in the system, nor are human labor and employee commute. The use stage is also outside the scope of this study.

PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Figure 1 Life cycle stages included in system boundary

CUT-OFF RULES

Per the PCR, the cut-off criteria for flows to be considered within each system boundary are as follows:

- Mass: If a flow is less than 1% of the cumulative mass of the model flows, it may be excluded, provided its environmental relevance is minor, based on a sensitivity analysis.
- Energy: If a flow is less than 1% of the cumulative energy of the system model, it may be excluded, provided its environmental relevance is minor, based on a sensitivity analysis.
- Environmental relevance: If a flow meets the above two criteria but is determined to contribute 2% or more to the selected impact categories of the products underlying the EPD, based on a sensitivity analysis, it is included within

the system boundary.

At least 95% of the mass flows shall be included and the life cycle impact data shall contain at least 95% of all elementary flows that contribute to each of the declared category indicators. A list of hazardous and toxic materials and substances shall be included in the inventory and the cut-off rules do not apply to such substances.

No cut-off criteria had to be applied for this study. All available energy and material flow data were included in the model.

Data Sources

The LCA model was created using the GaBi Software system for life cycle engineering, version 10, developed by Sphera (Sphera, 2022). Background life cycle inventory data for raw materials and processes were obtained from the GaBi 2022.2 database. Primary manufacturing data were provided by the participating companies.

Data Quality

As the majority of the relevant foreground data are measured data or calculated based on primary information sources of the owner of the technology, precision is considered to be high. Seasonal variations were balanced out by using yearly averages that were then weighted according to each manufacturer's production volume. All background data are sourced from GaBi databases with the documented precision. Each foreground process was checked for mass balance and completeness of the emission inventory. No data were knowingly omitted. Completeness of foreground unit process data is considered to be high. All background data are sourced from GaBi databases with the documented completeness.

Geographical Coverage

This study represents production at CCM facilities in North America. As such, the geographical coverage for this study is based on North American system boundaries for all processes and products.

Regionally specific datasets, where available, were used to represent each manufacturing location's energy consumption. Proxy datasets were used as needed for raw material inputs to address lack of data for a specific material or for a specific geographical region. These proxy datasets were chosen for their technological representativeness of the actual materials.

Period under Review

Primary data collected represent production during the 2019 calendar year. This analysis is intended to represent production in 2019. All secondary data come from the GaBi Professional databases and are representative of the years 2018-2021.

Allocation

As several products are often manufactured at the same plant, participating facilities used mass allocation to report data. Mass allocation was selected since the environmental burden in the industrial process (energy consumption, emissions, etc.) is primarily governed by the mass throughput of each sub-process.

Allocation of background data (energy and materials) taken from the GaBi 2022 databases is documented online at http://www.gabi-software.com/support/gabi/gabi-database-2022-lci-documentation/.

ESTIMATES AND ASSUMPTIONS

In cases where no matching life cycle inventories were available to represent a flow, proxy data were applied based on conservative assumptions regarding environmental impacts.

LIFE CYCLE ASSESSMENT RESULTS

The environmental impacts associated with the reinforced roofing membrane is presented below in Table 3 for the production stage (A1-A3).

Table 3: Environmental impact indicators for 1m² of Reinforced EPDM Single-Ply Roofing Membrane

Indicator	A1	A2	A3	Total
Global Warming Potential [kg CO_2 eq.]				
EPDM (R) 45 mils	3.54E+00	1.57E-01	6.88E-01	4.37E+00
EPDM (R) 60 mils	4.68E+00	2.08E-01	9.09E-01	5.78E+00
EPDM (R) 75 mils	5.82E+00	2.58E-01	1.13E+00	7.19E+00
Ozone Depletion Potential [kg CFC-11 eq.]				
EPDM (R) 45 mils	6.85E-14	2.98E-16	8.15E-13	8.85E-13
EPDM (R) 60 mils	9.05E-14	3.94E-16	1.08E-12	1.17E-12
EPDM (R) 75 mils	1.13E-13	4.90E-16	1.34E-12	1.45E-12
Acidification Potential [kg SO2 eq.]				
EPDM (R) 45 mils	5.61E-03	1.23E-03	7.22E-04	7.56E-03
EPDM (R) 60 mils	7.41E-03	1.63E-03	9.54E-04	9.99E-03
EPDM (R) 75 mils	9.21E-03	2.02E-03	1.19E-03	1.24E-02
Eutrophication Potential [kg N eq.]				
EPDM (R) 45 mils	5.43E-04	7.57E-05	7.96E-05	6.99E-04
EPDM (R) 60 mils	7.17E-04	1.00E-04	1.05E-04	9.23E-04
EPDM (R) 75 mils	8.92E-04	1.24E-04	1.31E-04	1.15E-03
Smog Formation Potential [kg O_3 eq.][1]				
EPDM (R) 45 mils	1.08E-01	2.76E-02	1.27E-02	1.49E-01
EPDM (R) 60 mils	1.43E-01	3.65E-02	1.68E-02	1.97E-01
EPDM (R) 75 mils	1.77E-01	4.54E-02	2.09E-02	2.45E-01

[1] Per ISO 21930, TRACI Smog Formation Potential (SFP) is reported instead of Photochemical Oxidant Creation Potential (POCP)

The resource use associated with the reinforced roofing membrane is presented below in Table 4 for the production stage (A1-A3).

Table 4: Resource use indicators for 1m² of Reinforced EPDM Single-Ply Roofing Membrane

Indicator	A1	A2	A3	Total
Renewable Primary Energy Resources as Energy (RPRE) [MJ]				
EPDM (R) 45 mils	2.87E+00	8.03E-02	1.73E+00	4.68E+00
EPDM (R) 60 mils	3.79E+00	1.06E-01	2.28E+00	6.18E+00
EPDM (R) 75 mils	4.72E+00	1.32E-01	2.84E+00	7.68E+00
Renewable Primary Resources as Material (RPRM) [MJ]				
EPDM (R) 45 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EPDM (R) 60 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EPDM (R) 75 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-Renewable Primary Resources as Energy (fuel) (NRPRE) [MJ]				
EPDM (R) 45 mils	6.81E+01	2.28E+00	1.10E+01	8.14E+01
EPDM (R) 60 mils	9.00E+01	3.01E+00	1.46E+01	1.08E+02
EPDM (R) 75 mils	1.12E+02	3.74E+00	1.81E+01	1.34E+02
Non-Renewable Primary Resources as Material (NRPRM) [MJ]				
EPDM (R) 45 mils	2.80E+01	0.00E+00	1.79E-01	2.82E+01
EPDM (R) 60 mils	3.70E+01	0.00E+00	2.36E-01	3.72E+01
EPDM (R) 75 mils	4.60E+01	0.00E+00	2.94E-01	4.63E+01
Secondary Materials (SM) [kg]				
EPDM (R) 45 mils	0.00E+00	0.00E+00	4.62E-02	4.62E-02
EPDM (R) 60 mils	0.00E+00	0.00E+00	6.11E-02	6.11E-02
EPDM (R) 75 mils	0.00E+00	0.00E+00	7.59E-02	7.59E-02
Renewable Secondary Fuels (RSF) [MJ]				
EPDM (R) 45 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EPDM (R) 60 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EPDM (R) 75 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-Renewable Secondary Fuels (NRSF) [MJ]				
EPDM (R) 45 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EPDM (R) 60 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EPDM (R) 75 mils	0.00E+00	0.00E+00	0.00E+00	0.00E+00

The waste generation associated with the reinforced roofing membrane is presented below in Table 5 for the production stage (A1-A3).

Table 5: Output flows & waste categories for 1m² of Reinforced EPDM Single-Ply Roofing Membrane

Indicator	A1	A2	A3	Total
Hazardous Waste Disposed (HWD) [kg]				
EPDM (R) 45 mils	3.91E-09	9.32E-12	1.31E-08	1.71E-08
EPDM (R) 60 mils	5.17E-09	1.23E-11	1.73E-08	2.26E-08
EPDM (R) 75 mils	6.42E-09	1.53E-11	2.16E-08	2.81E-08
Non-Hazardous Waste Disposed (NHWD) [kg]				
EPDM (R) 45 mils	4.36E-02	1.86E-04	7.18E-02	1.16E-01
EPDM (R) 60 mils	5.76E-02	2.46E-04	9.48E-02	1.53E-01
EPDM (R) 75 mils	7.16E-02	3.05E-04	1.18E-01	1.90E-01
Radioactive Waste Disposed (RWD) [kg]				
EPDM (R) 45 mils	8.30E-04	6.17E-06	7.53E-04	1.59E-03
EPDM (R) 60 mils	1.10E-03	8.15E-06	9.95E-04	2.10E-03
EPDM (R) 75 mils	1.36E-03	1.01E-05	1.24E-03	2.61E-03

LCA Interpretation

The major contributor for almost every impact is raw materials (A1) followed by manufacturing (A3) and inbound transportation (A2). The exception is ODP, which is dominated by manufacturing (A3) due to the manufacturing of bio-based packaging materials.

Disclaimer (quoted from sub-category PCR):

Emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in these categories:

- Renewable primary energy resources as energy (fuel), (RPRE);
- Renewable primary resources as material, (RPRM);
- Non-renewable primary resources as energy (fuel) ,(NRPRE);
- Non-renewable primary resources as material (NRPRM);
- Secondary materials (SM);
- Renewable secondary fuels (RSF);

- Non-renewable secondary fuels (NRSF);
- Hazardous waste disposed;
- Non-hazardous waste disposed;
- Radioactive waste disposed (RWD);

The EPDs are comparable only if they comply with the document ISO 21930, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

ADDITIONAL ENVIRONMENTAL INFORMATION

Safety factor against condensation – In testing completed by Oak Ridge National Labs it was proven that white mechanically fastened roofing systems accumulate twice as much condensate as a black mechanically fastened roofing system (Manfred & Pallin, 2013). This is an important built-in safety factor for black reinforced EPDM in cooler central and northern climates.

UV resistance – EPDM has excellent UV resistance as evidenced in the ASTM G155 Accelerated Xenon Arc Weathering test. Black reinforced EPDM has 1.75 times the UV resistance of various white roofing membranes (35,000 kJ/m^2 compared to 20,000 kJ/m^2).

Puncture resistance – Adding internal reinforcement to the membrane increases the puncture resistance compared to a non-reinforced membrane. Adding external fleece reinforcement gives you the highest amount of puncture resistance and provides a full 1.2,1.5, or 1.9mm of weathering membrane above the fleece reinforcement.

Resistance to unwanted biological growth – All of Carlisle's EPDM roofing membranes provide excellent resistance to unwanted biological growth on the surface of the membrane. In the ASTM G21 test, conducted by MicroStar Labs, our EPDM roofing membranes achieved a zero or "no growth" rating (#R2014-131).

Resistance to hail damage – EPDM roofing membranes have had a great track record of resisting hail damage and keeping water out of buildings, which can cut down on owners' financial losses considerably. EPDM stays flexible throughout its life cycle, providing good hail resistance even at the end of its warranty term. Adhered systems, with a minimum 1.5 mm reinforced EPDM membrane over a cover board set in adhesive, are a practical way to eliminate potential hail damage due to a direct hail strike over a fastener or plate that is required in a mechanically fastened system.

Pollution abatement equipment – The Carlisle plant employs pollution abatement equipment, including scrubbers, filter boxes, and dust collectors.

Clarification regarding hazardous substances in the final product – Per EPDM Safety Data Sheet (SDS), the finished product declared in this EPD is considered "Articles" as defined in OSHA Hazardous Communication Standard. This finished product is not hazardous and does not contain any regulated substances of very high concern. No components in the product are listed under the SDS Section 15 Regulatory Requirements, specifically U.S. Federal Regulations, SARA Section 311/312, California Prop 65, or the Canadian WHMIS IDL. Information on ingredients and regulatory information can be found in the SDS.

Clarification regarding release of dangerous substances from the final product – The finished product declared in the EPD is classified as an article with no release of dangerous substances.

Clarification regarding hazardous waste generated during production – No hazardous waste is generated during the production of the product declared in this EPD.

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