ENVIRONMENTAL PRODUCT DECLARATION

GENERAL COATINGS MANUFACTURING

ULTRA-THANE 230 HFO ROOFING SPRAY POLYURETHANE FOAM

Spray Foam Roofing application.

General Coatings Manufacturing Corp and its roofing brand, Ultra-Thane, produce superior exterior closed cell spray polyurethane foam for residential, institutional, and commercial uses.

GCMC manufactures in Arlington, Texas, and Fresno, California, SPF foam systems provide exceptional R value, high yield and easy to use chemistry for weatherproofing roofs and storage tanks.

Ultra-Thane 230-2.5/2.7/3.0 HFO contains next generation and environmentally responsible low GWP blowing agent technology.

ENVIRONMENTAL PRODUCT DECLARATION

General Coatings Manufacturing Corporation
Ultra-Thane 230 HFO Roofing Spray Polyurethane Foam

According to ISO 14025, ISO 21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	ASTM INTERNATIONAL 100 BARR HARBOUR DR, WEST CONSHOHOCKEN, PA 19428, USA WWW.ASTM.ORG
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	ASTM Program Operator for Product Category Rules (PCR) and Environmental Product Declarations (EPDs), General Program Instructions, Version: 8.0, Revised 04/29/20
ASSOCIATION NAME AND ADDRESS	General Coatings | 1220 E North Ave, Fresno, CA 93725, United States
DECLARATION NUMBER	EPD 942
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Ultra-Thane 230 HFO roofing spray polyurethane foam insulation, 1 m^2 of installed insulation material with a thickness that gives an average thermal resistance of RSI = 1m^2·K/W
REFERENCE PCR AND VERSION NUMBER	PCR Part A: UL Environment Building Related Products and Services. (UL Environment, 2022) and PCR Part B: UL Environment. Building-Related Products and Services. Building Envelope Thermal Insulation EPD Requirements (UL Environment, 2024)
DESCRIPTION OF PRODUCT APPLICATION/USE	Ultra-Thane 230 HFO roofing spray polyurethane foam used in building and construction
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	03/06/2025
PERIOD OF VALIDITY	5 Years
EPD TYPE	Product average
RANGE OF DATASET VARIABILITY	N/A
EPD SCOPE	Cradle-to-grave
YEAR(S) OF REPORTED PRIMARY DATA	2022-2023
LCA SOFTWARE & VERSION NUMBER	LCA FE v10.9 (formerly GaBi Software)
LCI DATABASE(S) & VERSION NUMBER	Managed LCA Content 2024.2 (formerly GaBi Database)
LCIA METHODOLOGY & VERSION NUMBER	IPCC AR6 + CML 2001 Aug 2016 + TRACI 2.1

The PCR review was conducted by:	ASTM International
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Timothy S Brooke, ASTM International tbrooke@astm.org
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	Sphera Solutions Inc.
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas P. Gloria, Ph.D, Industrial Ecology Consultants t.gloria@industrial-ecology.com

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

1. Product Definition and Information

1.1. Description of Company/Organization

General Coatings Manufacturing Corporation (GCMC) is a well-known spray polyurethane foam (SPF) manufacturer based in the United States, with facilities in Arlington, TX and Fresno, CA. GCMC specializes in the production of coatings such as high performance spray polyurethane foam systems for residential, industrial, and commercial application. With a strong focus on quality and innovation, GCMC prides themselves in ensuring their products meet stringent industry standards by regularly upgrading their ISO 9001:2015 compliant facilities with the latest manufacturing technologies.

GCMC brand closely monitors incoming raw materials, its formulas, manufacturing process and finished foam systems with its ISO 9001:2015 program as well as meeting ASTM C1029 and many ASTM coated foamed roofing standards. They utilize Intertek, Underwriters Laboratory, and FM Global for their audit services to ensure code compliance performance for their spray foam products.

1.2. Product Description

Product Identification

SPF is made on the jobsite by combining polymeric methylene-diphenyl diisocyanate (pMDI/MDI or side-A) with an equal volume of a polyol blend (side-B). Sides A and B react and expand at the point of application in the building envelope to form polyurethane foam. The formed-in-place SPF provides both thermal insulation and air sealing to the building. There are various classes of SPF, one of them being the closed-cell spray foam for roofing systems using hydrofluoroolefins (HFO) as the blowing agent.

Ultra-Thane 230 (UT 230) HFO Roofing is GCMC's closed-cell spray foam for roofing system that uses HFO as its blowing agent. It is a Class A fire-rated, spray-in-place, exerior, polyurethane foam system. It provides thermal insulation and water proofing for roofs, cold storges, and insulated tanks.

Figure 1. UT 230 HFO Roofing

Product Specification

UT 230 HFO is available in three nominal densities. Table 1 displays the product's physical characteristics.

Table 1. Physical properties of UT 230 HFO Roofing

NAME	UT 230 HFO
Density [lb / ft^3]	2.5, 2.7, and 3
Thermal resistivity [R / in]	6.65 to 6.90
Air impermeable material	✓
Integral vapor retarder	✓
Water resistant	✓
Continuous insulation	✓
Low-slope roofing	✓
Structural improvement	✓

All SPF products must meet numerous performance requirements to comply with building codes. The details of these requirements are described in specific tests listed in consensus standards for material performance and code compliance. UT 230 HFO must follow the following standards:

ASTM Standards:

- C1029-15 Type III and IV, Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
- D7425-13 Standard Specification for Spray Polyurethane Foam Used for Roofing Applications

International Code Council Standards:

- ICC-ES AC-377 Acceptance Criteria for Spray-Applied Foam Plastic Insulation
- ICC-1100-2025 Standard for Spray-applied Polyurethane Foam Plastic Insulation

Typical material performance requirements per ICC-1100 are provided in Table 2 below.

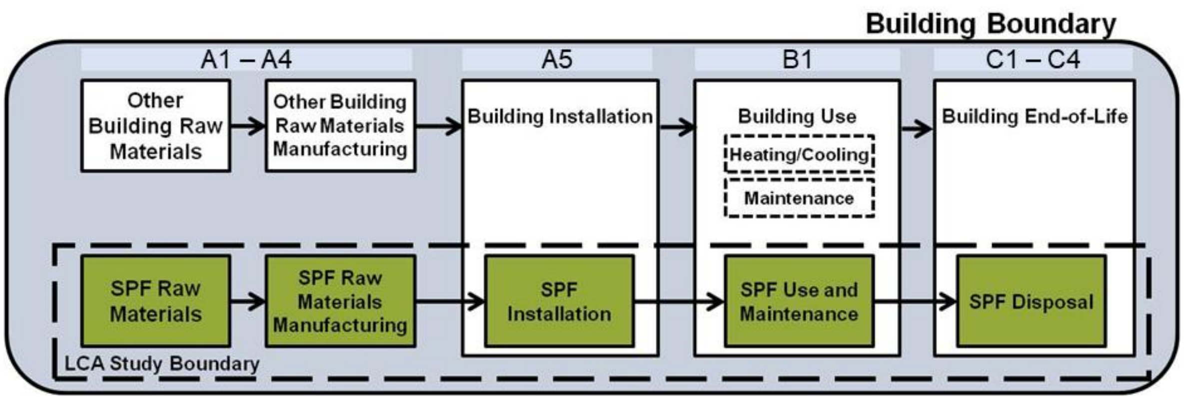
Table 2. Summary of typical material performance requirements for UT 230 HFO in Construction

STANDARD TYPE		UT 230 HFO
Thermal Performance (R-value)	ASTM C518, C177 or C1363	As reported (typ R_{IP}6.0-7.0/inch / 4.2-4.8/100 mm)
Surface Burning Characteristics	ASTM E84 or UL723	Flame spread index ≤ 75
Core Density	ASTM D1622	As reported (typ 2.5-4.0 pcf / 40-64 kg/m^3)
Closed-Cell Content	ASTM D2856 or ASTM D6226	>90%
Tensile Strength	ASTM D1623	40 psi min (276 kPa)
Compressive Strength	ASTM D1623	40 psi min (276 kPa)
Dimensional Stability	ASTM D2126	15% max change

STANDARD TYPE		UT 230 HFO
Water Vapor Permeance	ASTM E96 (dry cup)	As reported (typ 1 US perm @ 2" thk / 0.66 SI perm @ 51 mm)
Air Permeance	ASTM D E283 or D2178	As reported (typ imperm @ 1.5" thk / 38 mm)
Water Absorption	ASTM D2842	5% max

The UT 230 HFO meets the requirements of both UL fire classification and ASTM E108 for its coated foam assemblies.

Flow Diagram



Product Specific EPD

The data collected represents 2022 – 2023 production of UT 230 HFO from GCMC's Arlington and Fresno facilities.

1.3. Application

UT 230 HFO are commonly used in residential, light commercial, commercial, institutional, and certain industrial applications. Roofing spray foam is used on the external surface of low slope roofs. Its higher density provides additional compressive strength needed for roofing applications.

1.4. Declaration of Methodological Framework

This EPD is "cradle-to-grave" in scope with all modules declared except for module D.

1.5. Technical requirements

Spray foam insulation products, including UT 230 HFO, must be installed in compliance with building codes. Nearly all jurisdictions have adopted a version of the following building codes:

a) International Code Council (ICC) - International Residential Code (IRC) – For 1 and 2 family dwellings

b) International Code Council (ICC) - International Building Code (IBC) – For multifamily dwellings, as well as commercial, institutional and industrial buildings.

c) International Code Council (ICC) - International Energy Conservation Code (IECC) – Providing envelope energy efficiency requirements for all buildings.

d) American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1- Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

e) American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.2- Energy-Efficient Design of Low-Rise Residential Buildings

To meet code requirements, UT 230 HFO must meet minimum performance requirements, demonstrated by laboratory testing using approved test methods. These tests are performed by third-party laboratories and test data typically submitted to a certification agency for evaluation of the results and the creation of an independent code compliance report for the product. Certification agencies also perform regular quality control testing from random samples taken from the manufacturer's facilities.

There are two guides that are followed by these certification bodies to collect and evaluate data to generate code compliance reports:

- ICC 1100 Standard for Spray-applied Polyurethane Foam Plastic Insulation (2021)
- IAPMO/ANSI ES1000 Building Code Compliance Spray-Applied Polyurethane Foam (2020)

Table 3. Testing Requirements per ICC 1100 and IAPMO ES1000 Standards

Testing Requirements per ICC 1100 and IAPMO ES1000 Standards			
Property	**Measurement**	**Test Method**	**Requirement**
Thermal Resistance	R-value at thickness or thermal resistance	ASTM C177-19 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus, ASTM C518-21 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, OR ASTM C1363-24 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	Report
Air Permeance	Thickness where foam is air impermeable	ASTM E283/E283M-19 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen OR	Report minimum thickness where air impermeable

TESTING REQUIREMENTS PER ICC 1100 AND IAPMO ES1000 STANDARDS			
PROPERTY	**MEASUREMENT**	**TEST METHOD**	**REQUIREMENT**
		ASTM E2178-21a Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials	
Water Vapor Permeance	Thickness where foam meets Class I, II or III vapor retarder performance	ASTM E96/E96M-24 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials (Method A)	Report thickness at vapor retarder class I, II or III.
Density	Mass density of foam	ASTM D1622-20 Standard Test Method for Apparent Density of Rigid Cellular Plastics	Report
Surface Burning Characteristics	Flame Spread Index	ASTM E84-24 Standard Test Method for Surface Burning Characteristics of Building Materials	75 or less
	Smoke Developed Index	ASTM E84-24 Standard Test Method for Surface Burning Characteristics of Building Materials	450 or less for insulation, unlimited for roofing
Thermal Barrier Testing	Pass fire test with prescriptive thermal barrier for thickness over 4"	NFPA 286, FM 4880, UL 1040 or UL1715	Pass 15 minute criteria
Alternate Thermal Barrier Assembly	Pass fire test with specific covering or coating	NFPA 286, FM 4880, UL 1040 or UL1715	Pass 15 minute criteria
Ignition Barrier Testing	Pass fire test with or without covering or coating	Various special test methods	See standard for details

In addition to these standards, there are also two ASTM material standards for UT 230 HFO:

- ASTM C1029 Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation – Including closed-cell insulation and roofing foams,
- ASTM D7425 Standard Specification for Spray Polyurethane Foam Used for Roofing Applications.

Table 4. Testing Requirements per ASTM C1029 and D7425 Material Standards

TESTING REQUIREMENTS PER ASTM C1029 AND D7425 MATERIAL STANDARDS				
PROPERTY	**MEASUREMENT**	**TEST METHOD**	**ASTM C1029 REQUIREMENT**	**ASTM D7425 REQUIREMENT**
Thermal Resistance	R-value at thickness or thermal resistance	ASTM C177-19 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus, ASTM C518-21 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, OR ASTM C1363-24 Standard Test Method	R6.2/inch minimum	R5.6/inch minimum

TESTING REQUIREMENTS PER ASTM C1029 AND D7425 MATERIAL STANDARDS				
PROPERTY	MEASUREMENT	TEST METHOD	ASTM C1029 REQUIREMENT	ASTM D7425 REQUIREMENT
		for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus		
Water Vapor Permeability	perm-inches	ASTM E96/E96M-24 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials (Method A)	3.0 perm-inches	3.0 perm-inches
Density	Apparent density of foam	ASTM D1622-20 Standard Test Method for Apparent Density of Rigid Cellular Plastics	Report	2.5 lb/ft^3 minimum
Surface Burning Characteristics	Flame Spread Index	ASTM E84-24 Standard Test Method for Surface Burning Characteristics of Building Materials	Report (75 limit in building codes)	Not required
	Smoke Developed Index	ASTM E84-24 Standard Test Method for Surface Burning Characteristics of Building Materials	Report (no limit in building codes)	Not required
Closed-cell Content	Percentage of closed cells	ASTM D6226-21 Standard Test Method for Open Cell Content of Rigid Cellular Plastics	90% or greater	90% or greater
Compressive Strength	psi	ASTM D1621-16(2023) Standard Test Method for Compressive Properties of Rigid Cellular Plastics	Minimum determined by Type per ASTM C1029: Type I - 15 psi Type II - 25 psi Type III - 40 psi Type IV - 60 psi	40 psi minimum
Tensile Strength	psi	ASTM D1623-17(2023) Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics	Minimum determined by Type per ASTM C1029: Type I - 20 psi Type II - 32 psi Type III - 42 psi Type IV - 56 psi	40 psi minimum
Response to Thermal/Humid Aging	dimensional stability percent	ASTM D2126-20 Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging	Maximum determined by Type per ASTM C1029: Type I - 12% Type II - 9% Type III - 6% Type IV - 5&	6% maximum
Water Absorption	Percentage by volume	ASTM D2842-19 Standard Test Method for Water Absorption of Rigid Cellular Plastics	5% maximum	5% maximum

GCMC Ultra-Thane 230 HFO has been tested and certified to meet FM Global I-90 for various assemblies using elastomeric roof coatings. Please GCMC website for details and testing parameters.

1.6. Properties of Declared Product as Delivered

The two chemicals required to produce UT 230 HFO (side-A and side-B) are delivered as a set to the job site in separate containers. On the job site, these chemicals are mixed in equal volume proportions to create the final product.

A total mass of 0.91 kg (or 2.02 lb) of UT 230 HFO is delivered per functional unit.

1.7. Material Composition

The side-A of UT 230 HFO is made from a blend of polymeric methylene diphenyl diisocyanate (MDI). The side-B is a mixture of polyester and polyether polyols, flame retardants, blowing agents, catalysts, and other additives that, when mixed with side-A, creates foam that can be applied for insulation. Due to company confidentiality, the industry average side-B formulation is displayed in Table 5.

While some of the ingredients may be classified as hazardous, per the Resource Conservation and Recovery Act (RCRA), Subtitle C, the product as installed and ultimately disposed of is not classified as a hazardous substance, as hazardous ingredients are rendered chemically inert after installation.

There are no toxic materials or hazardous wastes directly associated with either the manufacturing of these components or the installation of the spray foam systems.

Table 5. Industry Roofing SPF, HFO side-B formulation

Chemical (% Composition)		Industry Roofing, HFO
Polyol	Polyester	34
	Polyether	14
	Mannich	24
	Compatibilizer	4
Fire Retardant	TCPP	10
Blowing Agent	HFO-1233zd or HFO-1336mzzZ	8
	Reactive (H2O)	2
Catalyst	Catalyst, amine	1
	Catalyst, aggregate	2
Surfactant	Silicone	1

1.8. Manufacturing

A significant majority the side-A of SPF is manufactured by US. based chemical manufacturing companies with processing facilities located in Texas and Louisiana. The side-B formulation is produced by GCMC in their Arlington, TX and Fresno, CA facilities. Most of the primary chemicals used in the side-B formulation are processed in facilities in Texas, Louisiana, and Virginia.

During the side-B production process, materials are blended together in closed tanks and packaged. The side-B blending process utilizes internal scrap from their own operations. Additionally, GCMC utilizes technology to minimize the release of gaseous material inputs, such as blowing agents, during material transfer and processing. Waste materials are typically reintegrated into the formulation without additional collection, transport, or processing.

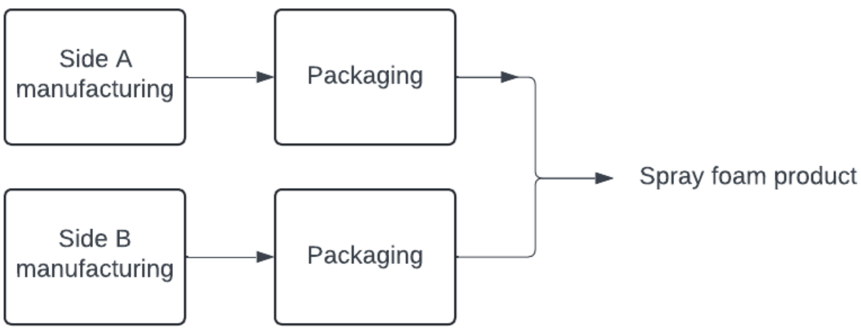


Figure 2. Manufacturing process

1.9. Packaging

UT 230 HFO are high-pressure SPF chemicals that are packaged in unpressurized containers of varying types, most commonly in 55-gallon (208 L) steel drums and plastic totes. Finished packaged products are loaded onto pallets. In this study, it is assumed that the empty chemical containers are properly cleaned and taken to a drum recycler.

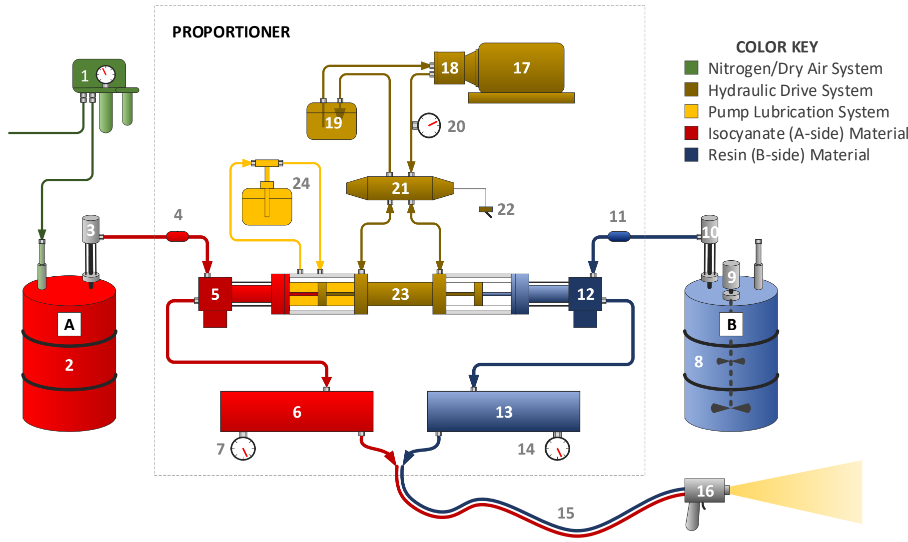
Disposal of packaging materials is modeled in accordance with the assumptions outlined in Part A of the PCR (UL Environment, 2022). Plastic based packaging is disposed in landfill (68%), incineration (17%), and recycled (15%). Metal based packaging is disposed in landfill (34%), incineration (9%), and recycled (57%). Paper based packaging is disposed in landfill (20%), incineration (5%), and recycled (75%).

1.10. Transportation

Final products are distributed via container truck, which are fueled by diesel. These final products are either directly to customers, or first to warehouse, prior to being sent to customers. Table 7 details distribution assumptions for finished UT 230 HFO products.

1.11. Product Installation

UT 230 HFO products are high pressure SPF systems that are installed by professional applicators by on-site mixing of the side-A and side-B chemicals.



1. Nitrogen/Dry Air System
2. Isocyanate Drum/Tote
3. Isocyanate Transfer Pump
4. Isocyanate Filter
5. Isocyanate Proportioning Pump
6. Isocyanate Primary Heater
7. Isocyanate Output Pressure Gauge
8. Resin Drum/Tote
9. Resin Drum Mixer
10. Resin Transfer Pump
11. Resin Filter
12. Resin Proportioning Pump
13. Resin Primary Heater
14. Resin Output Pressure Gauge
15. Dual Heated Hose
16. Spray Gun
17. Electric Motor
18. Hydraulic Pump
19. Hydraulic Fluid Reservoir
20. Hydraulic Pressure Gauge
21. Hydraulic Directional Valve
22. hydraulic Directional Switch
23. Hydraulic Cylinder
24. Pump Lube System

Figure 3. Schematic of a High-Pressure SPF system

Installation includes insulation of the walls, floors and ceilings of entire buildings, or application as an insulated low-slope roofing system. These chemicals are delivered to the jobsite in unpressurized containers (usually 55-gallon / 208 L drums) and heated to approximately 120-130 °F (49-54 °C) and pressurized to about 1000 psi (6,895 kPa) by specialized equipment. The chemicals are transferred by a heated hose and aerosolized by a spray gun and combined by impingement mixing at the point of application. Personal protective equipment such as goggles, protective suits, and respirator cartridges is required to protect applicators from chemical exposure during installation. Also needed are disposable materials such as masking tape and drop cloths. The schematic in Figure 3 shows the typical equipment components used to produce high-pressure SPF foam, including unpressurized side-A and side-B liquid drums with transfer pumps, which are connected to the proportioner system for heating and pressurizing the chemicals, and then through a heated hose connected to a spray gun for application.

After the foam cures and expands, any excess that may prevent installation of the interior cladding is cut off and discarded. For SPF with physical blowing agents, this study assumes 10% of the installed blowing agent is released to surrounding air during the installation phase. Discarded foam from installation also experiences blowing agent release while in landfill. Disposal of packaging materials is modeled in accordance to the assumptions outlined in Part A of the

PCR (UL Environment, 2022). All ancillary installation materials are assumed to be sent to landfill.

Although foam will assist with noise reduction in building assemblies, there are no specific requirements for noise reduction for insulation in the building codes. Some manufacturers have measured and published noise reduction in terms of Sound Transmission Class (STC) rating per ASTM E90, and Noise Reduction Coefficient (NRC) for sound absorption per ASTM C423. These measurements are highly dependent on the assembly in which the foam is applied, and the sound frequencies used for testing.

1.12. Use

As this study only looks at the life cycle of spray foam insulation, and not the building, the use phase only contains the emissions of any chemicals off-gassed from the foam. This study assumes 24% of the original chemical blowing agent is off-gassed over a 75-year lifetime (Honeywell International).

1.13. Reference Service Life and Estimated Building Service Life

The reference service life (RSL) and estimated building service life (ESL) for UT 230 HFO is the life of the building of 75 years.

1.14. Reuse, Recycling, and Energy Recovery

UT 230 HFO is typically not reused or recycled following its removal from a building. Thus, reuse, recycling, and energy recovery are not applicable for this product.

1.15. Disposal

When the building is decommissioned, it is assumed that only manual labor is involved to remove the foam. Waste is assumed to be transported 30 miles (48 km) to the disposal site. The spray foam is assumed to be landfilled at end-of-life, as is typical for construction and demolition waste in the U.S. This study assumes 16% of the original physical blowing agent is emitted at this stage in the life cycle. It is further assumed the spray foam is inert in the landfill and 50% of the blowing agent remains in the product after disposal (Kjeldsen & Jensen, 2001).

2. Life Cycle Assessment Background Information

2.1. Functional or Declared Unit

The product's function is to provide thermal insulation to buildings. Accordingly, the functional unit for the study is 1 m^2 of installed insulation material with a thickness that gives an average thermal resistance of R_{SI}=1m^2·K/W (R = 5.68 hr·ft^2·°F/Btu) with a building service life of 75 years (packaging included).

Table 6. Functional Unit Properties

NAME	VALUE	UNIT
Functional Unit	1 m² of installed insulation material with a thickness that gives an average thermal resistance of RSI=1m²·K/W	
Mass	2.02	lb
	0.91	kg
Thickness to achieve functional unit	0.82	in
	0.02	m

2.2. System Boundary

The study uses a cradle-to-grave system boundary. As such, it includes upstream processing and production of raw materials (A1), auxiliary material and energy resources needed for production (A3), transport of materials (all chemical inputs for production and packaging) to manufacturing sites (A2), transport of the components to the installation site (A4), installation of insulation (A5), removal and transport of insulation to disposal site (A5), use phase (B1), transportation to end-of-life (C2), and end-of-life-disposal (C4). Building energy savings from the use of insulation are excluded from this analysis. Module D has been excluded from this analysis.

Capital goods and infrastructure flows were excluded from this analysis due to the minimal extent that it affects the LCIA results. For the manufacturing of UT 230 HFO, capital goods and infrastructure last for 20 to 40 years with periodic replacement of valves and repair of control systems, with an annual production of around 39 million lbs of side-B product. During the final stage of manufacturing (Installation) performed by SPF contractors, the life expectancy of the most expensive piece of equipment, the proportioner, is around 20 to 25 years. Diesel generators, compressors and spray guns may be around 15 to 20 years.

GCMC manufacturing facilities contain capital infrastructure (storage tanks, chillers, valves, plumbing and laboratory) that has useful service life of 25 - 50 years with routine maintenance. GCMC conducts quarterly and annual inspections for fire safety, mechanical & electrical performance.

2.3. Estimates and Assumptions

The material and energy inputs and outputs were modeled according to primary data collected from GCMC, while the electricity grid and natural gas mix were chosen based on the locations of each production facility. The material and energy inputs were allocated based on mass.

Lastly, this study assumes 50% of blowing agent consumed in the production of the formulation is eventually emitted, with 10% released during installation, 24% released during lifetime in building, and 16% released during end-of-life. The remaining 50% remains in the product (Honeywell International) (Kjeldsen & Jensen, 2001).

2.4. Cut-off rules

The cut-off criteria for including or excluding materials, energy and emissions data of the study are as follows:

- **Mass** – According to ISO guidelines, if a flow is less than 1% of the cumulative mass of the model it may be excluded, providing its environmental relevance is not a concern. For the purpose of this LCA, all known mass flows are reported, and no known flows were deliberately excluded.
- **Energy** – According to ISO guidelines, if a flow is less than 1% of the cumulative energy of the model it may be excluded, providing its environmental relevance is not a concern. For the purpose of this LCA, all known energy flows are reported, and no known flows were deliberately excluded.
- **Environmental relevance** – If a flow meets the above criteria for exclusion, yet is thought to potentially have a significant environmental impact, it was included. Material flows which leave the system (emissions) and whose environmental impact is greater than 1% of the whole impact of an impact category that has been considered in the assessment must be covered. This judgment was made based on experience and documented as necessary.

Packaging of incoming raw materials (e.g. pallets, totes, super-sacks) are excluded as they represent less than 1% of the product mass and are not environmentally relevant. Capital goods and infrastructure required to produce and install the product (e.g. batch mixers, spraying equipment) are presumed to produce millions of units over the course of their life, so impact of a single functional unit attributed to these equipment is negligible; therefore, capital goods and infrastructure were excluded from this study. No known flows are deliberately excluded from this EPD.

2.5. Data Sources

The LCA model was created using the LCA for Experts (LCA FE) v10.9 software system for life cycle engineering, developed by Sphera (Sphera, 2024). Background life cycle inventory data for raw materials and processes were obtained from the Sphera Managed LCA Content (MLC) 2024.2 database. Primary manufacturing data were provided by GCMC.

2.6. Data Quality

A variery of tests and checks were performed by the LCA practitioner throughout the project to ensure high quality of the completed LCA. Checks in cluded an extensive internal review of the project-specific LCA models developed as well as the background data used. A full data quality assessment is documented in the background report.

Temporal coverage

The data are intended to represent UT 230 HFO production during the 2022 calendar year. As such, primary data was provided for 12 consecutive months during the 2022 calendar year.

Geographical coverage

This background LCA represents GCMC's production in the US. Primary data are representative of the Arlington, TX and Fresno, CA facilities. Regionally specific datasets 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.

Technological coverage

Data on material composition were developed using specific side-B formulation. Manufacturing data were collected directly from GCMC. Waste, emissions, and energy use are calculated from reported annual production during the reference year.

2.7. Period under Review

Primary data collected represent production during the 2022 calendar year. This analysis is intended to represent production in 2022.

2.8. Allocation

Multi-output allocation follows the requirements of ISO 14044, section 4.3.4.2 (ISO, 2006a; ISO, 2006b). When allocation becomes necessary during the data collection phase, the allocation rule most suitable for the respective process step was applied. Energy and waste outputs were allocated based mass allocation.

The background MDI dataset used in the LCA study, which was developed by the European diisocyanates and polyols producers' association known as ISOPA is based on a combination of mass and elemental allocation approach (European Diisocyanate and Polyol Producers Association (ISOPA), 2021). This also aligns with the 2022 LCA study conducted by the American Chemistry Council. (American Chemistry Council, 2022)

The cut-off allocation approach is adopted in the case of any post-consumer and post-industrial recycled content, which is assumed to enter the system burden-free. Only environmental impacts from the point of recovery and forward (e.g., inbound transports, grinding, processing, etc.) are considered.

3. Life Cycle Assessment Scenarios

The following tables show additional information for the declared modules: inbound transportation (A4), installation (A5), Use (B1), and End of Life (C4). The following tables report results per functional unit.

Table 7. Transport to the building site (A4) per Functional Unit

NAME	VALUE		UNIT
Fuel type	Diesel		
Liters of fuel	0.0017	0.0023	l/100km
Vehicle type	Truck-heavy/bulk	Truck-TL/dry van	
Transport distance	707	42	km
Capacity utilization (including empty runs, mass based	100	100	%
Gross density of products transported	43.73		kg/m^3

Table 8. Installation into the building (A5) per Functional Unit

NAME	VALUE	UNIT
Ancillary materials	0.029	kg
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)	-	m^3
Other resources	N/A	kg
Electricity consumption	0.055	kWh
Other energy carriers	3.62	MJ
Product loss per functional unit	0.034	kg
Waste materials at the construction site before waste processing, generated by product installation	0.0042	kg
Output materials resulting from on-site waste processing (specified by route; e.g. for recycling, energy recovery and/or disposal)	-	kg
Biogenic carbon contained in packaging	0.0011	kg CO_2
Direct emissions to ambient air, soil and water	0.004	kg
VOC content	-	μg/m^3

Table 9. Reference Service Life per Functional Unit

NAME	VALUE	UNIT
Direct emissions to ambient air, soil and water	0.0096	kg

Table 10. End of life (C1-C4) per Functional Unit

NAME		VALUE	UNIT
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)		Landfill	
Collection process (specified by type)	Collected with mixed construction waste	0.914	kg
Recovery (specified by type)	Landfill	0.914	kg
Disposal (specified by type)	Product or material for final deposition	0.914	kg
Removals of biogenic carbon (excluding packaging)		-	kg CO_2

4. Life Cycle Assessment Results

Table 11. Description of the System Boundary Modules

	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	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
EPD Type	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	MND

MND = module not declared

4.1. Life Cycle Impact Assessment Results

North American life cycle impact assessment (LCIA) results are declared using TRACI 2.1 (Bare, 2012; EPA, 2012) methodology, with the exception of GWP100 and ADP fossil. GWP100 is reported using the IPCC AR6 (IPCC, 2023) methodology, excluding biogenic carbon. ADP fossil is reported using CML 2001, Version 4.8, Aug 2016 (CML, 2001). Primary energy from non-renewable resources (NRPRe) and renewable resources (RPRe) represent the lower heating value (LHV) a.k.a. net calorific value (NCV).

The GWP100 indicators reported in this study exclude land use change impacts since manufacturing, use, and disposal of SPF products do not have a significant impact on land use, as it does not consume any agricultural products or chemicals that have a direct impact on land use.

Results reported are per functional unit.

Table 12. North American Impact Assessment Results per Functional Unit

TRACI v2.1	A1	A2	A3	A4	A5	B1	C2	C4
GWP 100 [kg CO_2 eq]	2.87E+00	2.14E-02	2.47E-01	6.36E-02	3.88E-01	4.81E-03	1.47E-03	2.29E-02
ODP [kg CFC-11 eq]	1.84E-08	5.44E-17	2.93E-15	1.62E-16	5.57E-12	-	3.73E-18	9.47E-16
AP [kg SO_2 eq]	4.53E-03	9.67E-05	6.35E-04	2.92E-04	1.67E-03	-	6.26E-06	1.02E-04
EP [kg N eq]	4.92E-04	8.66E-06	3.54E-05	2.60E-05	1.45E-04	-	5.70E-07	4.41E-06
SFP [kg O_3 eq]	8.32E-02	2.23E-03	1.09E-02	6.72E-03	5.67E-02	2.68E-03	1.44E-04	3.62E-03
ADP_{fossil} [MJ, LHV]	6.68E+01	2.81E-01	2.79E+00	8.35E-01	5.85E+00	-	1.93E-02	2.91E-01

4.2. Life Cycle Inventory Results

Table 13. Resource Use per Functional Unit

PARAMETER	A1	A2	A3	A4	A5	B1	C2	C4
RPR_E [MJ, LHV]	4.52E+00	1.23E-02	1.63E-01	3.64E-02	3.60E-01	-	8.41E-04	3.71E-02
RPR_M [MJ, LHV]	-	-	1.58E-02	-	4.37E-03	-	-	-
RPR_T [MJ, LHV]	4.52E+00	1.23E-02	1.79E-01	3.64E-02	3.64E-01	-	8.41E-04	3.71E-02
$NRPR_E$ [MJ, LHV]	4.63E+01	2.83E-01	2.84E+00	8.41E-01	5.35E+00	-	1.94E-02	3.00E-01
$NRPR_M$ [MJ, LHV]	2.33E+01	-	3.92E-03	-	7.24E-01	-	-	-
$NRPR_T$ [MJ, LHV]	6.96E+01	2.83E-01	2.85E+00	8.41E-01	6.07E+00	-	1.94E-02	3.00E-01
SM [kg]	-	-	-	-	-	-	-	-
RSF [MJ, LHV]	-	-	-	-	-	-	-	-
NRSF [MJ, LHV]	-	-	-	-	-	-	-	-
RE [MJ, LHV]	-	-	-	-	-	-	-	-
FW [m^3]	1.53E-02	4.13E-05	1.42E-02	1.23E-04	1.16E-03	-	2.83E-06	3.87E-05

Table 14. Output Flows and Waste Categories per Functional Unit

PARAMETER	A1	A2	A3	A4	A5	B1	C2	C4
HWD [kg]	-	-	-	-	-	-	-	-
NHWD [kg]	-	-	-	-	6.69E-02	-	-	9.14E-01
HLRW [kg] or [m^3]	1.15E-06	8.68E-10	8.22E-09	2.58E-09	9.26E-08	-	5.95E-11	3.56E-09
ILLRW [kg] or [m^3]	1.02E-03	7.32E-07	6.91E-06	2.18E-06	7.76E-05	-	5.02E-08	3.18E-06
CRU [kg]	-	-	-	-	-	-	-	-
MR [kg]	-	-	-	-	-	-	-	-
MER [kg]	-	-	-	-	7.48E-03	-	-	-
EE [MJ, LHV]	-	-	-	-	-	-	-	-

Table 15. Carbon Emissions and Removals per Functional Unit

PARAMETER	A1	A2	A3	A4	A5	B1	C2	C4
BCRP [kg CO_2]	-	-	-	-	-	-	-	-
BCEP [kg CO_2]	-	-	-	-	-	-	-	-
BCRK [kg CO_2]	-	-	1.08E-03	-	-	-	-	-
BCEK [kg CO_2]	-	-	-	-	-	-	-	-

5. LCA Interpretation

Figure 4 presents the results for the environmental performance of 1 m^2 of installed UT 230 HFO with a thickness that provides a thermal resistance of 1 $m^2 \cdot K/W$ (5.68 $hr \cdot ft^2 \cdot °F/Btu$).

It is clear from the figure that raw materials (A1) have the largest contribution on the environmental footprint, followed by installation (A5). Transporation modules (A2, A4, and C2) have a cumulative contribution of 0% to 5% across the impact categories. Use (B1) and end-of-life (C4) have negligible impact (< 2%) overall.

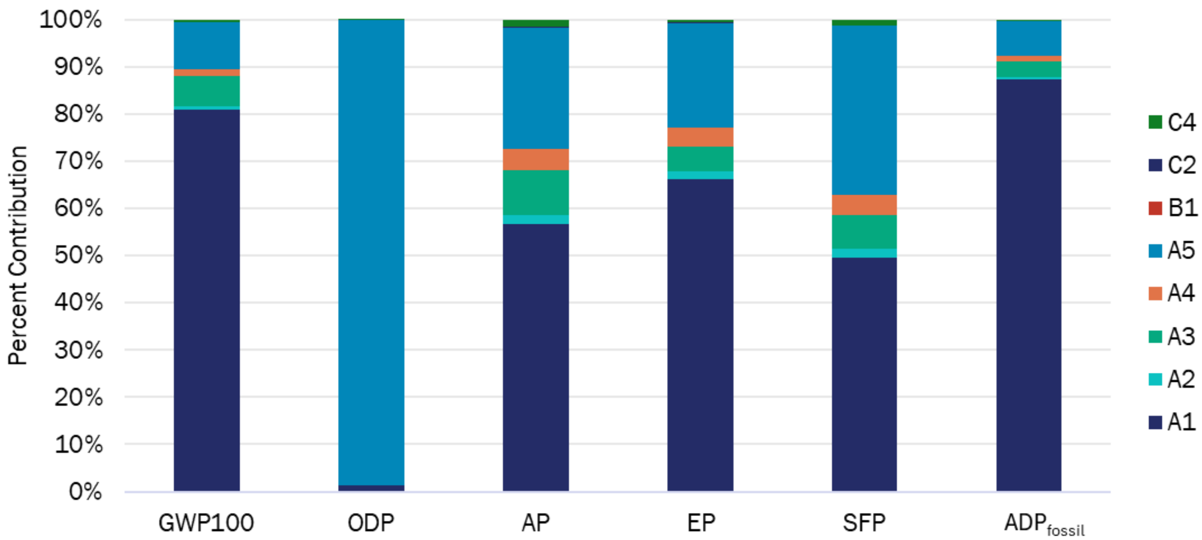


Figure 4. Contribution Analysis by Module of UT 230 HFO per Functional Unit

6. Additional Environmental Information

6.1. Environment and Health During Manufacturing

Manufacturing of UT 230 HFO products and upstream chemicals are performed in an industrial manufacturing facilities. Like many manufacturing processes, hazardous chemicals and manufacturing procedures may be employed. These manufacturers follow all local, state and federal regulations regarding safe use and disposal of all chemicals (United States EPA, 2024) (United States EPA, 2024), as well as safety requirements required of the generally manufacturing operation of equipment and processes (U.S. and State OSHA) (Occupational Safety and Health Standards) (Safety and Health Regulations for Construction) (US Department of Labour, 2024) (US Department of Labour, 2024) and safe transport of all materials (US DOT)Environment and Health During Installation (US Code of Federal Regulations, November)

GCMC maintains a safe and well monitored working enviroment to ensure employee and visitor good health with clean, properly maintained & ventilated manufacturing & isloated storage facitllities.

6.2. Energy Savings during Use

The use of any insulation in a building will provide substantial energy savings. Based on a third-party use phase analysis performed in 2018, the energy savings from SPF will offset the embodied energy of SPF within a few years, depending on climate zone and amount of insulation installed (Sustainable Solutions Corporation, 2020).

6.3. Environment and Health During Installation

Installation of SPF involves potential exposure to certain hazardous chemicals that requires risk mitigation through the use of personal protective equipment and on-site actions including ventilation and restricted access. Of greatest concern is the potential exposure to airborne and liquid isocyanates during and immediately after installation of SPF. Isocyanates are known chemical sensitizers and exposure can occur through contact with the skin, eyes and respiratory system. Ventilation of the work zone, coupled with use of proper personal protective equipment is required during and immediately after installation SPF. For more information on health and safety during and immediately after SPF installation, please visit www.spraypolyurethane.org.

GCMC fully supports SPFA PCP training programs, ACC / SFC MDI health & safety online course as well as their own GCMC contractor training in safe use and proper installation practices.

6.4. Extraordinary Effects

Fire

Spray polyurethane foam, like all foam plastics and many construction materials – including wood - is a combustible material and will emit toxic gases including carbon monoxide during a fire. When used in buildings and other construction applications, foam plastics employ flame retardants to control ignition and spread of fire and development of smoke. In addition, foam plastics may need to be protected with fire-resistant coverings or coatings when used in certain construction applications, as dictated by the building codes. All foam plastic materials and assemblies should meet the fire test requirements of the applicable building codes.

Water

Closed-cell and roofing SPF products meet the FEMA Class 5 requirements[1] for flood-damage resistant insulation materials for floors and walls.

Mechanical Destruction

Should the assembly the SPF is installed in, i.e. the wall or roof, have to be replaced then the SPF will have to be replaced as well. Typically, Coated Foamed Roofing can be recoated with an additional layer of elastomeric roof coating to extend its service life and prevent premature removal from its effective life span.

[1] "Flood Damage-Resistant Materials Requirements", FEMA Technical Bulletin 2, 2008, Table 2.

6.5. Environmental Activities and Certifications

Several SPF interior foam insulation manufacturers have certified or tested their products, but exterior or roofing are usually exempt or not required to be tested. Currently, an ASTM workgroup is developing a small-chamber emissions test protocol for chemical compounds specific to SPF that include MDI, blowing agents, flame retardants and catalysts.

6.6. Further Information

Additional information can be found here: https://www.generalcoatings.net/

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8. Contact Information

6.7. Study Commissioner

General Coatings Manufacturing Corporation
1220 E. North Ave
Fresno, CA 93725
https://www.generalcoatings.net/

6.8. LCA Practitioner

Sphera Solutions, Inc.
130 E Randolph St, #2900
Chicago, IL 60601
https://sphera.com/contact-us/
www.sphera.com