American Carbon Registry
at WINROCK INTERNATIONAL

METHODOLOGY FOR THE QUANTIFICATION, MONITORING, REPORTING AND VERIFICATION OF GREENHOUSE GAS EMISSIONS REDUCTIONS AND REMOVALS FROM

THE TRANSITION TO ADVANCED FORMULATION BLOWING AGENTS IN FOAM MANUFACTURING AND USE

VERSION 1.0

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ABOUT AMERICAN CARBON REGISTRY® (ACR)

A leading carbon offset program founded in 1996 as the first private voluntary GHG registry in the world, ACR operates in the voluntary and regulated carbon markets. ACR has unparalleled experience in the development of environmentally rigorous, science-based offset methodologies as well as operational experience in the oversight of offset project verification, registration, offset issuance and retirement reporting through its online registry system.

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Foam Supplies, Inc.

Global Chemical Consultants

ACRONYMS AND DEFINITIONS

If not explicitly defined here, the current definitions in the most recent version of the American Carbon Registry (ACR) Standard apply.

TERM	ACRONYM (if applicable)	DEFINITION
Baseline blowing agent	Baseline BA	The BA that is being transitioned to an Eligible BA through the Project Activity.
Blowing agent	BA	The material used to propel foam mixture for its required use. BAs can also be used as an insulating component of foam. BAs are the main component that make up the GHG emissions associated with foam manufacturing, use and EOL.
Blowing agent blends	BA blends	The use of two or more BAs in the baseline or project.
Blowing agent ratio	BA ratio	The quantity of the Eligible BA that is required to replace the baseline BA to produce the same quality of foam including equivalent thermal performance. This ratio is applied to the quantity of Eligible BA that is used in the project to calculate the amount of baseline BA that would have been used.
Carbon dioxide equivalent	CO_2e	CO_2e is a metric to compare other GHGs based on their GWP relative to CO_2 over the same timeframe. The IPCC publishes GWP values for converting all GHGs to a CO_2e basis (see “Global Warming Potential”).
Carbon offset credits	Offsets	A carbon offset is a reduction in emissions of GHG made to compensate for or to offset an emission of GHG made elsewhere (one offset = 1 MT CO_2e).

TERM	ACRONYM (if applicable)	DEFINITION
Default BA		For foam applications required to transition to a different BA as the result of a regulation, *the default BA will be the BA that the project developer would have used instead of the Eligible BA. In these scenarios, the Default BA becomes the Baseline BA. See sections 4 and 5 for additional information regarding Default BA.*
Design specifications	Design specs	Documents such as spec sheets, formulation recipes, etc. showing the amount of BA required to produce the foam material for the project or job.
Eligible blowing agent	Eligible BA	Foam BAs which are eligible to create carbon credits under this Methodology meet the following criteria: • Low-GWP (GWP less than 30) • Low-ODP (ODP less than .01) • Is not a hydrofluorocarbon • Is not a hydrocarbon • Is not prevented from use by any regulation
Eligible foam application		Those applications within the foam manufacturing industry for which the demonstrable adoption rate of an Eligible BA is not considered common practice (Table 1).
End of life	EOL	The emissions associated with the decommissioning recovery and destruction of the foam. Does not include the emissions associated with manufacturing and use of the foam.
Foam manufacturing		The process of combining a BA with additional chemicals to produce foam. The process may be

TERM	ACRONYM (if applicable)	DEFINITION
		conducted to produce a product either in a manufacturing facility or at a construction location.
Foam use		After the foam is manufactured (e.g., blown with the BA) the material is then “used” (e.g. insulates a refrigerator, a building, etc.). The use of a foam can extend many years after manufacturing and this methodology captures the emissions associated with the use of the product for 10 years after manufacturing.
Formulators		Also known as "Systems Supply Houses". These entities provide the "A" side and the "B" side chemicals which are then blown at a manufacturing site to produce foam products or at a construction site for buildings.
Global warming potential	GWP	Global warming potential is a relative scale translating the global warming impact of any GHG into its CO_2e over the same timeframe. This methodology references the 100-year GWPs in the IPCC Fourth Assessment Report (AR4) and, if unavailable, the GWPs from the IPCC Fifth Assessment Report (AR5). If neither are available, GWPs cited by the U.S. EPA SNAP Program shall be applied. GWPs found in this Methodology (Tables 3 and 10) shall be applied in the quantification of baseline and project emissions.
Hydrocarbon	HC	An organic compound containing only hydrogen and carbon atoms (e.g. pentane (C_5H_{12}) and propane (C_3H_8)).
Hydrofluorocarbon	HFC	A gaseous compound that contains carbon, fluorine, and hydrogen. Most common HFCs used in foam

TERM	ACRONYM (if applicable)	DEFINITION
		blowing are *HFC-134a, HFC-152a, HFC-365mfc, HFC-245fa and HFC-227ea.*
Isocyanate	ISO or "A-side"	Isocyanate is the reactive chemical used in the manufacture of Polyurethane Foams.
Meter readings		The readings from meters used to record the quantity of BA and other materials used in the foam blowing process.
Polyol	"B-side"	Polyol is a blend of various chemicals and blowing agents to produce the foam structure and density.
Polyurethane foam	PUF	Foam created through the mix of polyurethane chemicals and a BA.
Production data		The records maintained (either from historical production data, MSDS sheets, industry standards, etc.) that accurately represent the foam production volume, the quantity of BA used, and any other relevant recordkeeping information for the baseline and project activity.
Project Activity		Transition to an Eligible BA in an Eligible Foam Application for foam manufacturing and use. See Applicability Conditions in Section 1.2.
Significant New Alternatives Policy	SNAP	The U.S. Environmental Protection Agency's (EPA) SNAP program implements section 612 of the amended Clean Air Act of 1990, which requires EPA's continuous review of alternatives to find those that pose less overall risk to human health and the environment. Through these evaluations, SNAP generates lists of acceptable and unacceptable substitutes for each of the major industrial use

TERM	ACRONYM (if applicable)	DEFINITION
		sectors. The intended effect of the SNAP program is to promote a smooth transition to safer alternatives. Version 1.0 of this Methodology references the SNAP rule adopted in July 2015. [See 80 FR 42870 et seq (July 20, 2015)].
Sources, sinks, and reservoirs	SSRs	Sources: Any process that releases carbon into the atmosphere is known as a carbon source. Sinks: A natural or artificial reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period. Reservoirs: A pool of carbon that has the potential to accumulate or lose carbon over time. Generally applicable in the land use sector (aboveground biomass, belowground biomass, litter, dead wood, soil organic carbon, and wood products).
Systems supply houses		See "Formulators".
Metric ton	MT	The metric unit of measurement for one carbon offset. 1 MT = 2,204.62 pounds or 1.10 US tons.
Transition dates		The dates under the EPA SNAP rule adopted in July 2015 that transition out previously allowed BA (see Table 4).

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1 BACKGROUND AND APPLICABILITY

1.1 PURPOSE

Certain industries use blowing agents (BAs) in the production of foam. These BAs contain chemicals that contribute to global warming by releasing greenhouse gases (GHGs) during manufacture, use, and end-of-life (EOL). Over the years, industry has begun a transition away from BAs that have high global warming potential (GWP) and high ozone depleting potential (ODP) toward BAs with lower GWP and low or zero ODP. However, certain foam applications have low market adoption rates for low GWP BA and that is generally a result of technical and financial barriers limiting use of low GWP options in these applications. This Methodology is meant to stimulate innovation and accelerate a transition to low GWP BA in certain foam applications more rapidly than would otherwise occur. The Methodology is based on a robust data set from the United Nations Framework Convention on Climate Change (UNFCCC) Clean Development Mechanism (CDM) methodology AMS-III.N (Avoidance of HFC Emissions in Rigid Polyurethane Foam Manufacturing).

1.2 APPLICABILITY CONDITIONS

A transition to the use of an Eligible BA for the production of foam is considered a “Project Activity” under this Methodology.

In addition to satisfying the latest ACR program eligibility requirements as found in the ACR Standard, projects must satisfy the following conditions:

- The project is located in North America.
- The project is within an Eligible Foam Application (See Table 1).
- Other than for projects which use a default BA, records of the baseline BA used in the project must show a minimum of 2 years of usage of a BA with a GWP >30 prior to the Project Activity.

Table 1: Eligible Foam Applications[1]

FOAM APPLICATION	DESCRIPTION
XPS boardstock	XPS boardstock, block, and billet that is used for insulation in the following applications: roofing, walls, flooring, and pipes. Does not include XPS sheet foam applications.
Two-component rigid PU spray foam	Spray foam is a two-part polyurethane application that when combined forms a solid foam insulation; involves a gun, nozzle or straw and forms foam as the ingredient chemicals are blended together.
Rigid PU injected foam	A manufacturing process for producing component parts by injecting two or more liquid streams into a mold or part. Materials are fed into a mix-head, mixed, and forced into the mold cavity where they react, foam, cool and harden to the configuration of the cavity. Only Rigid PU injected foam used in the following sub-applications are eligible: • Marine flotation or buoyancy • Heating, Ventilation, Air Conditioning and Air Handling Systems • Refrigerated Transport – Foam used in refrigerated logistics services such as refrigerated cargo boxes and coolers • Industrial Refrigeration Systems – Large, “engineered” systems used in supermarkets, industrial process refrigeration, cold storage, and walk-in freezers applications that employ cold storage panel insulation. • Garage and entry doors
Rigid PUF residential refrigerators and freezers	Appliances used to preserve food and beverages in residential applications.

[1] See Appendix A and Tables 8 and 9 for market penetration analysis for Eligible Foam Applications.

1.3 REPORTING PERIODS

Projects shall have one reporting period which must not exceed 12 months in length. Baseline and project emissions shall be quantified (per Section 4) using the total volume of BA that would have been used in the absence of the Project Activity over a maximum of 12 months (baseline emissions) and the total volume of Eligible BA that was used during the project (project emissions) over the same corresponding time period.

1.4 CREDITING PERIODS

The crediting period shall be ten years. The Methodology's quantification approach is based upon the UNFCCC small system method which includes the manufacturing and use of the foam product. The Methodology excludes any calculation of EOL emissions. EOL emissions may be considered in future versions of this Methodology.

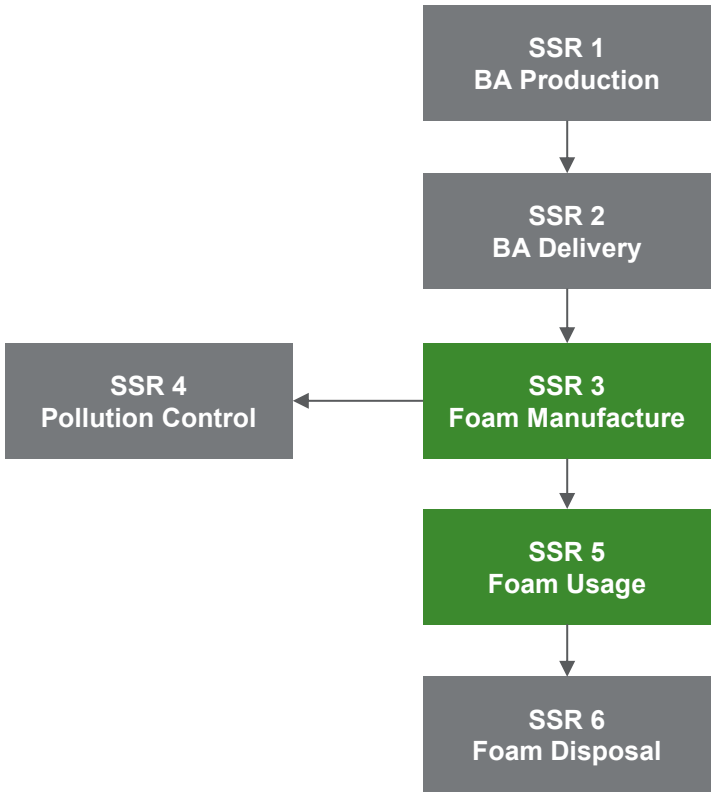
1.5 PERIODIC REVIEWS AND REVISIONS

ACR may require revisions to this Methodology to ensure that monitoring, reporting, and verification systems adequately reflect changes to project activities. This Methodology may also be periodically updated to reflect regulatory changes, emission factor revisions, or expanded applicability criteria. Before beginning a project, the project proponent should ensure that they are using the latest version of the Methodology.

2 PROJECT BOUNDARIES

The project boundary delineates the sources, sinks, and reservoirs (SSRs) that must be included or excluded when quantifying the net changes in emissions associated with the transition to an Eligible BA. Figure 1 illustrates the GHG assessment boundary for a project.

Figure 1: Illustration of the Project Boundary



All SSRs in green are included and must be accounted for under this Methodology. SSRs in gray are not included under this Methodology.

Table 2: List of Identified SSRs

SSR	SOURCE DESCRIPTION	GAS	INCLUDED (I) OR EXCLUDED (E)	QUANTIFICATION METHOD
1. BA Production	Fossil fuel emissions from the production of the BA.	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
	Emissions from the production of the BA.	HFC or Low GWP BA	E	N/A
2. BA Delivery	Emissions from the delivery of the BA to the project site.	HFC or Low GWP BA	E	N/A
	Fossil fuel emissions from the delivery of the BA to the project site.	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
3. Foam Manufacture	Emissions from the manufacture of the foam using a BA in the baseline and project.	HFC or Low GWP BA	I	Equations 1, 2 & 3
4. Pollution Control	Fossil fuel emissions from air pollution control equipment used in the baseline and project.	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
5. Foam Usage	Emissions from the use of the foam in the baseline and project.	HFC or Low GWP BA	I	Equations 1, 2 & 3

SSR	SOURCE DESCRIPTION	GAS	INCLUDED (I) OR EXCLUDED (E)	QUANTIFI-CATION METHOD
6. Foam Disposal	Fossil fuel emissions from the transport of the foam to EOL.	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
	Emissions from the equipment used to destroy the foam at EOL	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
	Emissions from the foam at EOL (e.g. landfill, shredding, incinera-tion, etc.)	HFC or Low GWP BA	E	N/A

3 BASELINE DETERMINATION AND ADDITIONALITY

3.1 BASELINE DETERMINATION

The baseline for a project is calculated using: (1) the GWP of the Baseline BA, (2) data associated with the quantity of Eligible BA used in the project[2], and (3) the emission factor associated with the Eligible Foam Application.

As a reference, Table 3 lists some of the most common BAs currently used in North America.

Table 3: GWP of Common Baseline BAs[3]

BA	GWP[4]
HFC-152a	125
HFC-365mfc	794
HFC-245fa	1030
HFC-134a	1430

[2] This data is used to calculate the amount of baseline BA that would have been used to produce a foam of equivalent thermal performance that is produced with the Eligible BA.

[3] This is not an exhaustive list but rather a guidance table for project proponents.

[4] IPCC, Fourth Assessment Report (100- year GWP time horizon).

Table 4: EPA SNAP Rule Change of Status as of July 2015

FOAM APPLICATION	BAS BEING TRANSITIONED OUT OF SNAP PROGRAM	SNAP TRANSITION DATE
Rigid PUF residential refrigerators and freezers and Rigid PUF injected foam (all eligible sub-applications) as specified in SNAP Table 6, [80 Fed Reg at 42923] 40 CFR 82, Subpart G, Appendix U	HFC-134a HFC-245fa HFC-365mfc (and blends, where applicable) Formacel TI Formacel Z-6	January 1, 2020 generally, and January 1, 2022 for qualifying military, space- and aeronautics applications
XPS boardstock	HFC-134a HFC-245fa HFC-365mfc (and blends, where applicable) Formacel TI Formacel B Formacel Z-6	January 1, 2021 generally, and January 1, 2022 for qualifying military, space- and aeronautics applications
Two-component rigid PU Spray foam	No BAs affected	N/A

3.2 ADDITIONALITY ASSESSMENT

Emission reductions from the project must be additional, or deemed not to occur in the "business-as-usual" scenario. Assessment of the additionality of a project will be made based on passing the two tests cited below. These two tests require the project proponent to demonstrate that the project is surplus to regulations and reduces emissions below the level established in the Methodology.

- Regulatory Surplus Test, and
- Practice-Based Performance Standard

3.2.1 Regulatory Surplus Test

In order to pass the regulatory surplus test a project must not be mandated by existing laws, regulations, statutes, legal rulings, or other regulatory frameworks in effect as of the start date that directly or indirectly affect the credited offsets. The project proponent must demonstrate that there is no existing regulation that mandates the project or effectively requires the GHG emission reductions associated with the transition to an Eligible BA.

3.2.2 Practice-Based Performance Standard

For a project to qualify for offsets under this Methodology it must also be demonstrated that the Eligible Foam Application has a low market adoption rate for Eligible BAs. This Methodology has already completed a market adoption analysis, and hence an additionality demonstration for the foam applications stated in Table 1. Project proponents must only show that their project falls into one of the Eligible Foam Applications found in Table 1.

Market research showing these applications to have low market adoption rates included, but was not limited, to the following: 1) review of the EPA SNAP rule, 2) various CARB and industry research reports, 3) a market characterization study commissioned for the Methodology, and 4) conversations with various regulatory bodies and industry experts. Additional applications may be added through revisions to this Methodology. A discussion of the development of the performance standard is found in Appendix A.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS

Quantification of emission reductions requires the calculation of baseline emissions and project emissions using production data, the GWPs of the Baseline and Eligible BA, and the emission factor associated with the Eligible Foam Application.

The GHG emissions from the BA used in foam production occurs at three phases of the product lifecycle, (i.e. manufacturing, use, and EOL). Only manufacturing and foam use for the first 10 years are considered in this Methodology[5].

Table 5: Emission Factors for HFC-134a and HFC-152a[6]

FOAM APPLICATION	PRODUCT LIFE IN YEARS	FIRST YEAR LOSS (%)[7]	ANNUAL LOSS (%)
XPS – HFC 134a	50	25	0.75
XPS – HFC 152a	50	50	25
Rigid PUF residential refrigerators and freezers	15	7	0.5
Rigid PUF injected foam (all eligible sub-applications)	15	12.5	0.5

[5] All offsets for a project's manufacturing and use over the 10-year crediting period will be issued following verification. For example, a foam production line using HFC-134a with a GWP of 1430 converts to an Eligible BA with a GWP of 1 on March 1, 2017. The reporting period is March 1, 2017 through February 28, 2018. All foam produced on the foam line within that timeframe has the potential to create offsets under this Methodology, provided the required monitoring and recordkeeping is maintained. Assuming the quantity of BA used during that timeframe was 50,000 pounds and the BA ratio is 1:2, the reductions associated with the manufacturing and 10-year use period of that foam line would be 76,180 MT CO_2e or 76,180 offsets issued, following verification.

[6] Source: Table 7.6 and Table 7.7, Page 7.37, Chapter 7: Emissions of fluorinated substitutes for Ozone depleting substances, Volume 3, Industrial Processes and Product Use, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

[7] Includes emissions associated with the foam manufacturing.

Table 6: Emission Factors for HFC-245fa and HFC-365mfc[8]

FOAM APPLICATION	PRODUCT LIFE IN YEARS	FIRST YEAR LOSS (%)[9]	ANNUAL LOSS (%)
Rigid PUF injected foam (all eligible sub-applications)	15	10	0.5
Two-component rigid PU Spray foam	50	15	1.5
Rigid PUF residential refrigerators and freezers	15	4	0.25

4.1 BASELINE EMISSIONS

4.1.1 Baseline emissions associated with the foam manufacturing and first year of foam use

These emissions are calculated as the total quantity of Baseline BA that would have been used for the foam manufacturing in absence of the Project Activity, multiplied by the first-year loss emission factor associated with the foam application (Tables 5 and 6), multiplied by the GWP of the Baseline BA. For foam applications required to transition to a different BA as the result of a regulation, the GWP of a Default BA may be used if it can be demonstrated that the Default BA is the alternative most likely to be used upon transition. Project proponents shall provide documentation, which shall include financial, market and/or technical analyses, to justify the use of the Default BA. This documentation shall be subject to review by the ACR and assessment by the chosen verification body.

[8] Source: Table 7.6 and Table 7.7, Page 7.37, Chapter 7: Emissions of fluorinated substitutes for Ozone depleting substances, Volume 3, Industrial Processes and Product Use, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

[9] Includes emissions associated with the foam manufacturing.

4.1.2 Baseline emissions associated with the remaining years of foam use

These emissions are calculated as the total quantity of Baseline BA that would have been used in the foam manufacturing in the absence of the Project Activity, multiplied by the annual loss emission factor associated with the foam application (Tables 5 and 6) multiplied by the number of years remaining in the project[10], multiplied by the GWP of the Baseline BA.

4.1.3 Calculating Baseline BA Blends

When the BA is a blend, baseline emissions are only calculated for the constituent BA that is being transitioned to the Eligible BA. In the event that each constituent of the Baseline BA is transitioned, each constituent of the Baseline BA is calculated separately.

Equation 1

$$BE_{BBA} = \{[(Q_{BBA} \times FYL_{BBA}) + (Q_{BBA} \times AL_{BBA} \times YR)] \div 2204.62\} \times GWP_{BBA}$$

WHERE

BE_{BBA}	Baseline emissions (MT CO_2e)
Q_{BBA}	The quantity of Baseline BA (in pounds) which would have been used to manufacture the foam in the absence of the project activity, using Equation 2
FYL_{BBA}	The first-year loss emission factor associated with the foam application (See Tables 5 and 6)
AL_{BBA}	The annual loss emission factor associated with the foam application (See Tables 5 and 6)
YR	The number of years remaining in the project (equal to 9 years)
GWP_{BBA}	The GWP of the Baseline BA[11]

[10] Emission reductions are quantified over 10 years. The first-year emissions are accounted for in the first year loss emission factor, therefore, a maximum of 9 years remain to be calculated for usage emissions.

[11] For projects required to transition as a result of a regulation, the GWP of the Default BA will be used.

To calculate the quantity of baseline BA that would have been used in the absence of the project activity, Equation 2 is applied.

Equation 2

$$Q_{BBA} = Q_{EBA} \times BAR$$

WHERE

Q_{BBA}	The quantity of Baseline BA (in pounds) which would have been used to manufacture the foam in the absence of the project activity
Q_{EBA}	The quantity of Eligible BA (in pounds) which is used to manufacture the foam for the project
BAR	Blowing Agent Ratio - The quantity of Eligible BA, as compared to the Baseline BA, that is required to replace the Baseline BA to produce a foam with equivalent thermal performance (%)

4.2 PROJECT EMISSIONS

4.2.1 Project emissions associated with the foam manufacturing and first year of foam use

These emissions are calculated as the total quantity of Eligible BA that is used in the project, multiplied by the first-year loss emission factor associated with the foam application (same as the emission factor used in Equation 1), multiplied by the GWP of the Eligible BA.

4.2.2 Project emissions associated with the remaining years of foam use

These emissions are calculated using the total quantity of Eligible BA used in the project, multiplied by the annual loss emission factor associated with the foam application (same as the emission factor used in Equation 1), multiplied by the number of years remaining in the project, multiplied by the GWP of the Eligible BA.

4.2.3 Calculating Project BA Blends

When the BA is a blend, project emissions are only calculated for the Eligible BA portion of the blend.

Equation 3

$$PE_{EBA} = \{[(Q_{EBA} \times FYL_{EBA}) + (Q_{EBA} \times AL_{EBA} \times YR)] \div 2204.62\} \times GWP_{EBA}$$

WHERE

PE_{EBA}	Project emissions (MT CO_2e)
Q_{EBA}	The quantity of Eligible BA (in pounds), which is used to manufacture the foam for the project
FYL_{EBA}	The first-year loss rate emission factor of the foam application (set equal to emission factor used in Equation 1)
AL_{EBA}	The annual loss rate emission factor of the foam application (set equal to emission factor used in Equation 1)
YR	The number of years remaining in the Project Activity (9 years)
GWP_{EBA}	The GWP of the Eligible BA

4.3 LEAKAGE

4.3.1 Market-shifting leakage emissions

Transition to an Eligible BA does not cause the displaced BA to be used elsewhere. There is no market-shifting leakage and hence is to be disregarded.

4.3.2 Activity-shifting leakage emissions

If the Project Activity results in the equipment used in the baseline being transferred to another location or activity in which a BA with a GWP greater than 30 is used, leakage effects are to be considered. If the baseline equipment is also used in the project or is decommissioned, then leakage is to be disregarded.

- Activity shifting leakage emissions associated with the foam manufacturing and first year of foam use: These emissions are calculated as the total quantity of BA with a GWP greater than 30 that is being used at the new location with the baseline equipment, multiplied by the first year loss emission factor associated with the foam application (Tables 5 and 6), multiplied by the GWP of the BA.

- Activity shifting leakage emissions associated with the remaining years of foam use: These emissions are calculated as the total quantity of BA with a GWP greater than 30 that is being used at the new location with the baseline equipment, multiplied by the annual loss emission factor associated with the foam application (Tables 5 and 6), multiplied by the number of years remaining in the project, multiplied by the GWP of the BA.

Equation 4

$$LE_{LBA} = \{[(Q_{LBA} \times FYL_{LBA}) + (Q_{LBA} \times AL_{LBA} \times YR)] \div 2204.62\} \times GWP_{LBA}$$

WHERE

LE_{LBA}	Activity shifting leakage emissions (MT CO_2e)
Q_{LBA}	The quantity of BA (in pounds) that is used at the new location
FYL_{LBA}	The first-year loss emission factor associated with the foam application of the BA used at the new location (See Tables 5 and 6)
AL_{LBA}	The annual loss emission factor associated with the foam application of the BA used at the new location (See Tables 5 and 6)
YR	The number of remaining years in the project (9 years)
GWP_{LBA}	The GWP of the BA used at the new location

4.4 EMISSION REDUCTIONS

The emission reductions achieved as a result of the transition to an Eligible BA are calculated as the baseline emissions minus the leakage emissions (if applicable) minus the project emissions. Annual losses beyond year ten and EOL emissions shall not be calculated.

Equation 5[12]

$$ER = (BE_{BBA} - LE_{LBA}) - PE_{EBA}$$

WHERE

ER	Emission reductions (MT CO_2e)
BE_{BBA}	Equation 1 - Baseline emissions (MT CO_2e)
PE_{EBA}	Equation 3 - Project emissions (MT CO_2e)
LE_{LBA}	Equation 4 - Leakage emissions (MT CO_2e)

[12] As stated in Sections 4.1 and 4.2, where a BA blend is used, emissions are to be quantified separately for each constituent BA. As a result, a summation of baseline, project, and leakage emissions for the project shall occur to accurately quantify total emission reductions associated with a project.

5 MONITORING AND DATA COLLECTION

Each project shall include a monitoring, reporting and verification plan sufficient to meet the requirements of the ACR Standard. The plan shall describe the collection of all data to be monitored and in a manner which meets the requirements for accuracy and precision of this Methodology.

This Methodology is based on determining the amount of BA that was or would have been used prior to project implementation and the amount of an Eligible BA used during the project. Project proponents are expected to provide data based on production quantity inputs to the manufacturing process (as shown in Figure 1). The Monitoring Plan shall provide inputs for all applicable equations used in this Methodology.

The project proponent is responsible for the collection and maintenance of all required data and monitoring parameters whether the foam blowing agent is mixed at a manufacturing facility (i.e. in scenarios where a Formulator or Systems Supply House has not provided the A side or B side materials) or where a Formulator or a Systems Supply House provides the A side and B side materials.

Individual manufacturing facilities or construction sites may be aggregated into a single project provided each of the facilities/sites meet the Applicability Conditions (1.2) and the project proponent provides the monitoring and recordkeeping as required by this Methodology.

5.1 DESCRIPTION OF THE MONITORING PLAN

The project proponent must prepare a monitoring plan describing the following:

- The location and recordkeeping/retention for all stored data.
- The methods used to generate data.
- Transfer points and methods of non-automated transfer of data.
- If applicable, describe any calibration procedures and the frequency with which calibration and other maintenance requirements are performed.
- Describe the internal audit and other quality assurance/quality control procedures.
- Sampling methods utilized and performed during the reporting period, if applicable.

The rationale of monitoring project implementation is to document all project activities implemented by the project proponent.

5.2 DATA COLLECTION AND PARAMETERS TO BE MONITORED

For all projects, the process for monitoring the project's emission reduction parameters includes:

- Records of the foam application used in the baseline and project.
- For all foam applications, other than projects which will use the Default BA, records of the Baseline BA used in the project showing a minimum of 2 years of usage prior to the Project Activity.
- Ongoing recordkeeping of the Eligible BA used in the project showing quantity of BA consumed.
- Records used in support of the BA ratio for the project including all calculations to derive the BA ratio.
- Equipment log for all equipment used in the project.
- Identification and log of any equipment modified, replaced, or decommissioned as a result of the Project Activity and any equipment moved for use outside of the project boundaries (leakage).
- For project proponents applying a Default BA: financial, market and/or technical analyses to justify the use of the Default BA.

For projects where a Formulator or a Systems Supply House provides the A side and B side materials, the following requirements must also be met:

- Specific identification (such as serial numbers) for tanks, drums, totes or other containers sent to each manufacturing facility or construction site must be documented;
- Pre-shipment weight of tanks, totes, drums or other containers containing A side and B side materials;
  - Pre-shipment weight documentation (such as a weight ticket) must be recorded and maintained;
- Records of shipments to the manufacturing facility or to a construction site documenting the mass of material shipped on appropriate shipping documentation such as bills of lading or other business records provided by the transport company as receipt of shipped material;
- Return weight of tanks, totes or containers sent (identification number must match tank, tote or container sent from the Formulator/Systems Supply House) from the manufacturing facility or construction site;
  - Return (post) weight ticket or equivalent documentation must be recorded and maintained;
- Evidence of calibration of weigh scales used to weigh project materials shall be maintained;
  - Calibration must be conducted on intervals required by the manufacturer and documentation of calibration events shall be recorded and maintained.

- Signed attestation from the end user of the A side and B side materials documenting:
  - Date(s) of foam production;
  - End use of the foam product;
  - Confirmation that all A side and B side materials sent to the manufacturing facility/construction site were consumed on the date(s) and in the end use specified.

5.2.1 Parameters Monitored

PARAMETER	BAR
Units	%
Description	(BA ratio) The quantity of Eligible BA, as compared to the Baseline BA, that is required to replace the Baseline BA to produce a foam with equivalent thermal performance
Relevant Section	4.1
Relevant Equation(s)	2
Source of Data	MSDS sheets, foam production records, meter readings, product or design specifications, engineering calculations
Measurement Frequency	Once, at the beginning of each project

PARAMETER	Q_{EBA}
Units	Pounds
Description	Quantity of Eligible BA used in project
Relevant Section	4.1 and 4.2
Relevant Equation(s)	2 and 3
Source of Data	Operating records, purchase records, usage records, meter readings

Measurement Frequency	Throughout the project

PARAMETER	**Q_{LBA}**
Units	Pounds
Description	Quantity of BA that is shifted to the new location that results in activity shifting leakage
Relevant Section	4.3
Relevant Equation(s)	4
Source of Data	Records associated with moving the equipment to a new location, operating records, purchase records, meter readings, attestations
Measurement Frequency	Throughout the project

APPENDIX A: DEVELOPMENT OF PERFORMANCE STANDARD

In developing the Methodology, information about BA use in the foam industry was gathered and reviewed. This included several studies, reports, and conversations with industry experts, regulatory personnel, and foam manufacturers. Additionally, a market research report was commissioned on the "Global Foam Blowing Agents Market Size, Share, Development, Growth, and Demand Forecast". The ACR peer review process was also relied upon to identify the market penetration of all BAs and then to identify the Eligible Foam Applications, which are shown in Methodology Table 1 and repeated below.

Table 7: Eligible Foam Applications

FOAM APPLICATION	DESCRIPTION
XPS boardstock	Boardstock, block, and billet that is used for insulation in the following applications: roofing, walls, flooring, and pipes. Does not include XPS sheet foam applications.
Two-component rigid PU spray foam	Spray foam is a two-part polyurethane application that when combined forms a solid foam insulation; involves a gun, nozzle or straw and forms foam as the ingredient chemicals are blended together.
Rigid PU injected foam	A manufacturing process for producing component parts by injecting two or more liquid streams into a mold or part. Materials for the component are fed into a mix-head, mixed, and forced into the mold cavity, where they react, foam, cool and harden to the configuration of the cavity. Only Rigid PU injected foam used in the following sub-applications are eligible: • Marine flotation or buoyancy • Heating, Ventilation, Air Conditioning and Air Handling Systems • Refrigerated Transport – Foam used in refrigerated logistics services such as refrigerated cargo boxes and coolers • Industrial Refrigeration Systems – Large, "engineered" systems used in supermarkets, industrial process

FOAM APPLICATION	DESCRIPTION
	refrigeration, cold storage, and walk-in freezers applications that employ cold storage panel insulation. • Garage and entry doors
Rigid PUF residential refrigerators and freezers	Appliances used to preserve food and beverages in residential applications.

To construct the performance standard, it was important to determine which sectors had high penetration rates for low GWP BA. Based on market research, it was determined that the following sectors already had high penetration rates for certain low GWP BA (primarily HC BA which are commonly considered to be lower GWP BA):

- PU Spray, other than two-component PU Spray
- Rigid PUF discontinuous panel
- Rigid PUF continuous laminate/boardstock
- Rigid PUF block for pipe sections
- Rigid PUF discontinuous block for panels
- Rigid PUF pipe-in-pipe
- Rigid PUF discontinuous block for pipe sections
- Rigid PUF continuous block
- XPS sheet

The primary outcome that the Methodology is meant to incentivize (reduced GHG emissions from foam BA consumption) is already being achieved in the above applications at rates that are higher than acceptable for crediting under this Methodology. Further, it was also clear that the use of HC BA should be considered business as usual for foam production. There are many additional concerns with HC BA such as high flammability risks, cost associated with flame proofing and safety measures, status as volatile organic compounds, and the generally lower thermal efficiency of foams produced by HC BA as compared to many alternatives. For these reasons, the Methodology credits only advanced formulation BAs and HC are ineligible for crediting.

Table 8 shows the market penetration rates of Eligible BAs. Table 9 shows the market penetration rates of Eligible BAs with the addition of the percentage of HC BAs consumed in these applications. As is shown, the eligible foam applications have extremely low adoption rates for Eligible BA and are also not achieving high rates of low GWP BA adoption, in general.

Table 8 Market Penetration Rate of Eligible BAs[13]

APPLICATION	2011	2012	2013	2014
Rigid PUF injected foam – Marine flotation and buoyancy	1%	1%	1.2%	1.5%
Rigid PUF injected foam – Heating, Ventilation, Air Conditioning and Air Handling Systems	1.7%	1.8%	2.1%	2.4%
Rigid PUF injected foam – Refrigerated Transport	1.2%	1.2%	1.4%	1.8%
Rigid PUF injected foam – Industrial Refrigeration Systems	1-2%	1-2%	1-2%	1-2%
Rigid PUF injected foam – Garage and Entry Doors	1.2%	1.3%	1.6%	2%
Rigid PUF residential refrigerators and freezers	1%	1%	1.2%	1.5%
XPS (Board, Billet, and Block only)	7-8%	7-8%	7-8%	7-8%
Two-component Rigid PU Spray Foam	5%	5%	5%	5%

[13] Eligible BAs assessed in the market analysis included all known HFOs, Methyl Formate, and inert gases.

Table 9: Market Penetration Rate including HC BAs

APPLICATION	2011	2012	2013	2014
Rigid PUF injected foam – Marine flotation and buoyancy	7.8%	7.7%	8.2%	8.6%
Rigid PUF injected foam – Heating, Ventilation, Air Conditioning and Air Handling Systems	10.7%	10.2%	10.6%	11.1%
Rigid PUF injected foam – Refrigerated Transport	7%	6.5%	7.2%	7.2%
Rigid PUF injected foam – Industrial Refrigeration Systems	7-8%	6-7%	7-8%	7-8%
Rigid PUF injected foam – Garage and Entry Doors	4.6%	4.9%	5.5%	6.6%
Rigid PUF residential refrigerators and freezers	9.2%	8.8%	9.3%	9.7%
XPS (Board, Billet, and Block only)	8-9%	8-9%	8-9%	8-9%
Two-component Rigid PU Spray Foam	5%	5%	5%	5%

APPENDIX B: ELIGIBLE BA GWP

The following is a table of Eligible BAs that are listed as acceptable substitutes under the SNAP program. This list is not exhaustive, it is only the list of substitutes under SNAP that are applicable to this Methodology.

Table 10: GWPs for selected Eligible BAs

ELIGIBLE BA	GWP
Methyl formate	1[14,15]
HFO-1336	2[16]
trans-1-chloro-3,3,3, -trifluoroprop-1-ene (HCFO-1233ze(E))	7[17,18]
CO_2	1[19]
Methylal	3[16,20]
HFO-1234ze	1[15,21]

[14] Federal Register, Volume 65, Number 243. Monday, December 18, 2000

[15] Per the Federal Register, the GWP is stated as “very low or zero” in all Federal Register listings (for Methyl Formate and Ecomate). For purposes of this Methodology, the GWP shall be set equal to 1 in Project emission reduction calculations.

[16] AR5

[17] Federal Register, Volume 79, Number 203. Tuesday, October 21, 2014.

[18] Per the Federal Register, the GWP has been reported as 1 to 7 in various publications. For purposes of this Methodology, the GWP shall be set equal to 7 in Project emission reduction calculations.

[19] AR4

[20] Per the Federal Register, the GWP is reported as less than 3. For purposes of this Methodology, the GWP shall be set equal to 3 in Project emission reduction calculations.

[21] Per AR5, the GWP is less than 1. For purposes of this Methodology, the GWP shall be set equal to 1 in Project emission reduction calculations.

APPENDIX C: REFERENCES AND OTHER INFORMATION

A Review of The CPI End-Use Market Survey 2012 (2013, October). PU Magazine.10 (5).

American Chemistry Council, Center for the Polyurethanes Industry (2013) 2012 End-Use Market Survey on the Polyurethanes Industry in the United States, Canada, & Mexico.

American Chemistry Council, Center for the Polyurethanes Industry (2011). 2010 End Use Market Survey on Polyurethanes Industry in the US, Canada & Mexico.

AB-32 Climate Change Scoping Plan (2008). Retrieved from: https://www.arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm

AB-32 First Update to the Climate Change Scoping Plan (2014). Retrieved from: https://www.arb.ca.gov/cc/scopingplan/document/updatedscopingplan2013.htm

California Air Resources Board Regulation, Article 5. California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms to Allow for the Use of Compliance Instruments Issues by Linked Jurisdictions. Retrieved from: https://www.arb.ca.gov/cc/capandtrade/ctlinkqc.pdf

California Air Resources Board (2014). Compliance Offset Protocol Ozone Depleting Substances Projects (November 14, 2014). Retrieved from: https://www.arb.ca.gov/regact/2014/capandtrade14/ctodsprotocol.pdf

California Air Resources Board (2013). CARB Process for the Review and Approval of Compliance Offset Methodologies in Support of the Cap-and-Trade Regulation. Retrieved from: https://www.arb.ca.gov/cc/capandtrade/compliance-offset-protocol-process.pdf

CDM Methodology III.N. Avoidance of HFC emissions in rigid Poly Urethane Foam (PUF) manufacturing, Version 03. Retrieved from: https://cdm.unfccc.int/methodologies/DB/1P2JT8SH9N4BE14JIL3641BQOB0FCR

CDM (2006). General Guidance on Leakage in biomass projects (Attachment C to Appendix B of 4/CMP.1 Annex II) Retrieved from: https://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid04.pdf

Caleb Management Services Limited (2011). Developing a California Inventory for Ozone Depleting Substances (ODS) and Hydrofluorocarbon (HFC) Foam Banks and Emissions from Foams. Retrieved from: https://www.arb.ca.gov/cc/foam/Foam_GHG_Emissions_CARB_Final_March_2011.pdf

European Commission, DG Climate Action (2013). Carbon Leakage Evidence Project. Retrieved from: https://ec.europa.eu/clima/sites/clima/files/ets/allowances/leakage/docs/cl_evidence_factsheets_en.pdf

EPA (2014). Final Amendments to the Air Toxics Standards for Flexible Polyurethane Foam Production. Retrieved from: https://www.epa.gov/sites/production/files/2015-12/documents/20140730factsheet.pdf

EPA (2016). Fact Sheet for Final Rule - Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes under the Significant New Alternatives Policy Program. Retrieved from: https://www.epa.gov/sites/production/files/2016-12/documents/snap_regulatory_factsheet_july20_2015.pdf

EPA (2010). Transitioning to Low-GWP Alternatives in Building/Construction Foams. Retrieved from: https://www.epa.gov/sites/production/files/2015-07/documents/transitioning_to_low-gwp_alternatives_in_building_and_construction_foams.pdf

EPA (2015). Significant New Alternatives Policy (SNAP) under section 612 of the Clean Air Act Amendments, Rule 20: Prohibition on the use of certain high-GWP HFCs as alternatives. Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2015-07-20/pdf/2015-17066.pdf

Huntsman (2011) Polyurethanes - Blowing agent options for insulation foam after HCFC phase out. Retrieved from: http://www.huntsman.com/polyurethanes/Media%20Library/a_MC1CD1F5AB7BB1738E040EBCD2B6B01F1/Products_MC1CD1F5AB8081738E040EBCD2B6B01F1/Insulation_ME4E93A022E848990E040EBCD2C6B1951/files/Blowing%20agent%20options%20for%20insulation%20foam%20after%20HCFC%20phase%20out.pdf

IPCC (2006). Emissions of Fluorinated Substitutes for Ozone Depleting Substances. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 3 Industrial Processes and Product Use. Retrieved from: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_7_Ch7_ODS_Substitutes.pdf

Mason Knowles. Calculating Yield in Spray Foam. Retrieved from: http://www.masonknowles.com/docs/calculating_yield_in_sprayfoam.pdf

Oko-Institute and Ecofys (2013). Support to the Commission for the Determination of the List of Sectors and Subsectors Deemed to be Exposed to a Significant Risk of Carbon Leakage for the Years 2015-2019 (EU Emission Trading System). Retrieved from: https://ec.europa.eu/clima/sites/clima/files/ets/allowances/leakage/docs/carbon_leakage_list_en.pdf

P & S Market Research (2016) Global Foam Blowing Agents Market Size, Share, Development, Growth, and Demand Forecast to 2020. Retrieved from: https://www.psmarketresearch.com/market-analysis/foam-blowing-agents-market

UNEP (2010). Rigid and Flexible Foams Report (Foam Technical Options Committee): 2010 Assessment. Retrieved from: http://ozone.unep.org/Assessment_Panels/TEAP/Reports/FTOC/FTOC-2010-Assessment-Report.pdf