



The American Carbon Registry™

**EMISSION REDUCTION MEASUREMENT AND  
MONITORING METHODOLOGY FOR  
DESTRUCTION OF OZONE DEPLETING  
SUBSTANCES AND HIGH-GWP FOAM**

**Version 1.0**

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Public Comment Draft

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## Abbreviations and Acronyms

A/C	Air conditioning
AHRI	Air-Conditioning, Heating and Refrigeration Institute
CAA	Clean Air Act
CFC	Chlorofluorocarbons
CH <sub>4</sub>	Methane
CO <sub>2</sub>	Carbon dioxide
CPT	Comprehensive Performance Test
DOT	U.S. Department of Transportation
DRE	Destruction and removal efficiency
EPA	United States Environmental Protection Agency
GWP	Global warming potential
HBFC	Hydrobromofluorocarbons
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
HWC	Hazardous waste combustor
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology
ODS	Ozone depleting substances
PU	Polyurethane
RCRA	Resource Conservation and Recovery Act
SSR	GHG Sources, GHG Sinks, and GHG Reservoirs

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# 1 Introduction

This Methodology is an update to the California Air Resources Board's (CARB) Compliance Offset Protocol for Ozone Depleting Substances Projects, dated November 14, 2014 ("CARB ODS Protocol").<sup>1</sup> For ease in using this updated Methodology, the same format as used in the CARB ODS Protocol will be used in this document.

## 1.1 Purpose and Definitions

### 1.1.1 Purpose

- (a) The purpose of the Methodology is to quantify greenhouse gas (GHG) emission reductions associated with the destruction of: 1) high global warming potential (GWP) ozone depleting substances (ODS) sourced from and destroyed within the U.S. that would have otherwise been released to the atmosphere; 2) high-GWP foam blowing agents that are extracted from insulation foam; and 3) insulation foam that contains blowing agent(s) with high GWP. This Methodology updates the CARB ODS Protocol to include additional sources of ODS used as refrigerant in air conditioning and refrigeration equipment, ODS in medical aerosol applications and fire suppression, and ODS and other high-GWP blowing agents in foam. Additionally, modifications have been made to emission factors and methods used to generate emission reductions for foam projects and to methods used for monitoring destruction events conducted at destruction facilities that are a part of an enclosed equipment de-manufacturing system.

### 1.1.2 Definitions

- (a) For the purposes of this Methodology, the following definitions apply:
- (1) "Aggregation" means the grouping together of multiple containers of ODS, high-GWP foam blowing agents, or high-GWP insulation foam into a single shipment or single container. Aggregation does not require the collected ODS

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<sup>1</sup> California Air Resources Board (2014) Compliance Offset Protocol, Ozone Depleting Substances Projects, Destruction of U.S. Ozone Depleting Substances Banks, November 14, 2014.

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- to be combined into a single container. Multiple containers shipped together are considered an aggregate.
- (2) “Certificate of Destruction” means an official document provided by the destruction facility certifying the date, mass, and species of ODS or high-GWP foam blowing agents destroyed.
  - (3) “Container” means an air-tight and water-tight unit for storing or transporting ODS, high-GWP foam blowing agents, or high-GWP insulation foam material without leakage or escape. Containers used in transporting project material must comply with all applicable U.S. Department of Transportation (DOT) requirements.
  - (4) “Destruction” means the destruction of ODS, high-GWP foam blowing agents, or high-GWP insulation foam by qualified destruction, transformation or conversion plants achieving greater than 99.99% destruction and removal efficiency, so that the destructed ODS, high-GWP foam blowing agents, or high-GWP insulation foam are not emitted to the atmosphere. Destruction may be performed using any technology, including transformation, that results in the complete breakdown of ODS, high-GWP foam blowing agents, or high-GWP insulation foam into a waste product, a usable by-product, or end product.
  - (5) “Destruction facility” means a facility that destroys, transforms, or converts ODS, high-GWP foam blowing agents, or high-GWP insulation foam and conforms with the description in either subchapter 2.1(a)(1) or 2.1(a)(2) in this Methodology.
  - (6) “Disqualified ODS, high-GWP foam blowing agents, or high-GWP insulation foam” means ODS, high-GWP foam blowing agents, or high-GWP insulation foam that does not conform, or cannot be determined to conform, to the point of origin or chain of custody documentation requirements specified in chapter 6 of this Methodology and must be removed from baseline emission calculations pursuant to subchapter 5.3 in this Methodology.

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- (7) “Eligible ODS, high-GWP foam blowing agents, or high-GWP insulation foam” means those ODS, high-GWP foam blowing agents, or high-GWP insulation foam included in subchapter 2.2.1., 2.2.2, 2.2.3 and 2.2.4 in this Methodology.
- (8) “Emission rate” means the rate at which refrigerant or foam blowing agent is lost to the atmosphere, including emissions from leaks during operation and servicing events.
- (9) “Essential Use Exemption” means an exception, granted by the Parties to the Montreal Protocol, for continued production of medical aerosol ODS after the production prohibition for ODS used in other applications.
- (10) “Fire suppression equipment/system” means the equipment or system employed to control and extinguish fires used in any sector (including commercial, industrial, or residential).
- (11) “Halogens” means a class of ODS that are powerful greenhouse gases and that contribute significantly to stratospheric ozone depletion. These substances are used in various fire suppression equipment and systems.
- (12) “High-GWP Foam Blowing Agent” means ODS or HFC entrained in insulation foam that was used in manufacture of the foam to provide insulation, structural and other performance properties. When purified, ODS or HFC blowing agents have identical chemical properties as ODS or HFC refrigerants and may be sold and used as refrigerants.
- (13) “Ineligible ODS” means those ODS, high-GWP foam blowing agents, or high-GWP insulation foam not included in subchapter 2.2.1., 2.2.2, 2.2.3 and 2.2.4 in this Methodology.
- (14) “Medical aerosol” means the propellant used to dispense medication in a metered dose inhaler. Certain ODS species have been used as medical aerosols.
- (15) “Mixed ODS or high-GWP foam blowing agent” means less than or equal to 90% composition of a single ODS or high-GWP foam blowing agent species.
- (16) “Non-mixed ODS or high-GWP foam blowing agent” means greater than 90% composition of a single ODS or high-GWP foam blowing agent species.
- (17) “Ozone Depleting Substances” or “ODS” means substances known to

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- deplete the stratospheric ozone layer. The ODS controlled under the Montreal Protocol and its Amendments are chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC), halons, methyl bromide (CH<sub>3</sub>Br), carbon tetrachloride (CCl<sub>4</sub>), methyl chloroform (CH<sub>3</sub>CCl<sub>3</sub>), hydrobromofluorocarbons (HBFC) and bromochloromethane (CHBrCl).
- (18) “ODS or high-GWP foam blowing agent species” means any individual type of ODS or high-GWP foam blowing agent (e.g., CFC-11, CFC-113, HCFC-22, HFC-134a, etc.).
- (19) “Refrigeration or air conditioning equipment” means a refrigeration or air conditioning appliance or system used in any sector (including commercial, industrial, or residential).
- (20) “Startup, shutdown, and malfunction plan” or “SSMP” means a plan, as specified under 40 CFR 63.1206, that includes a description of potential causes of malfunctions, including releases from emergency safety vents, that may result in significant releases of hazardous air pollutants, and actions the source is taking to minimize the frequency and severity of those malfunctions.
- (21) “Stockpile” means ODS stored for future use or disposal in bulk quantities at a single facility. The ODS may be stored in multiple containers or a single container.
- (22) “Substitute refrigerant, medical aerosol, or fire suppressant” means those refrigerants, medical aerosols, or fire suppressants that will be used to fulfill the function that would have been filled by the destroyed ODS refrigerants, medical aerosols, or fire suppressants. These refrigerants, medical aerosols, or fire suppressants may be drop-in replacements or may be used in new equipment that fulfills the same market function.
- (23) “Substitute emissions” means a term used in this Methodology to describe the GHG emitted from the use of substitute refrigerants, medical aerosols, or fire suppressants in technologies that are used to replace the ODS destroyed in a project.
- (24) “Transformation” or “conversion” means the breakdown of a substance



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into a waste product, a usable by-product, or end-product.

## **2. Eligible Activities – Quantification Methodology**

This Methodology defines a set of activities designed to reduce GHG emissions by the destruction of eligible ODS, high-GWP foam blowing agents, or high-GWP insulation foam at a single qualifying destruction facility.

### **2.1. Eligible Destruction Facilities**

- (a) The end fate of the ODS, high-GWP foam blowing agent, or high-GWP insulation foam must be destruction at either:
  - (1) An approved HWC subject to the RCRA and with a RCRA permit for the ODS destruction facility stating an ODS destruction efficiency of at least 99.99%; or
  - (2) A transformation or destruction facility that meets or exceeds the Montreal Protocol's TEAP standards provided in the *Report of the Task Force on Destruction Technologies*.
    - (A) A facility must demonstrate DRE of 99.99% and emission levels consistent with the guidelines set forth in the TEAP report.
    - (B) A facility must have been certified by a third party no more than three years prior to the offset project start date and must show that it maintains its operational status as stated in the certification.
- (b) A destruction facility must meet all applicable monitoring and operational requirements under CAA and NESHAP standards, as well as all applicable federal, state, and local laws that apply directly to ODS and high-GWP insulation foam destruction activities during the time the ODS, high-GWP foam blowing agent or high-GWP foam destruction occurs.
- (c) At the time of ODS, high-GWP foam blowing agent, or high-GWP insulation foam destruction, the destruction facility must have a valid Title V air permit, if applicable, and any other air or water permits required by local, state or federal law to destroy ODS, high-GWP foam blowing agent, and/or high-GWP insulation foam and document compliance with all monitoring and operational requirements

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that apply to ODS, high-GWP foam blowing agent, and high-GWP insulation foam destruction project activities.

- (d) Any upsets or exceedances must be managed in accordance with an authorized SSMP.

## **2.2. Eligible ODS, High-GWP Foam Blowing Agents and High-GWP Insulation Foam**

- (a) ODS, high-GWP foam blowing agents and high-GWP insulation foam destroyed under this Methodology must be from one or more of the eligible sources listed in subchapters 2.2.1, 2.2.2, 2.2.3, or 2.2.4 of this Methodology.
- (b) Eligible ODS, high-GWP foam blowing agents, or high-GWP insulation foam may not be combined within the same container.
- (c) ODS produced exclusively for use as solvents or other applications not listed in Sections 2.2.1, 2.2.2, 2.2.3, or 2.2.4 are not eligible.
- (d) A single offset project may incorporate ODS, high-GWP foam blowing agents, or high-GWP insulation foam obtained from one or more of the source categories listed in subchapters 2.2.1, 2.2.2, 2.2.3, or 2.2.4 of this Methodology.
- (e) Destruction activity must take place under one or more Certificates of Destruction.
- (f) All of the following conditions must be met for multiple Certificates of Destruction to be eligible as a single project:
  - (1) The project proponent is the same for all ODS, high-GWP foam blowing agents, or high-GWP insulation foam destroyed;
  - (2) All ODS, high-GWP foam blowing agents, or high-GWP insulation foam must be destroyed at the same eligible destruction facility; and
  - (3) The destruction activities must occur during one reporting period.
- (g) A Certificate of Destruction may be used for only one offset project.
- (h) Each Certificate of Destruction must be issued by the qualifying destruction facility and must include the following information:
  - (1) Project Proponent;
  - (2) Destruction facility;
  - (3) Certificate of destruction ID number;

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- (4) If applicable, serial, tracking, or ID number of all containers for which ODS destruction occurred;
  - (5) If applicable, serial, tracking or ID number of all containers for which high-GWP insulation foam destruction occurred;
  - (6) If applicable, serial, tracking or ID number of all appliances from which high-GWP foam blowing agents are extracted and destroyed in an enclosed equipment de-manufacturing system;
  - (7) For ODS and high-GWP insulation foam in containers, weight and type of material destroyed from each container;
  - (8) For high-GWP foam blowing agent extracted and destroyed in an enclosed equipment de-manufacturing system, weight of each high-GWP foam blowing agent destroyed.
  - (9) Start and end destruction dates.
- (i) The ODS destroyed may originate from a single source or from numerous sources.
  - (j) The high-GWP foam blowing agents may originate from a single source or from numerous sources.
  - (k) The high-GWP insulation foam may originate from a single source or from numerous sources.
  - (l) The handling, recovery, and disposal of ODS refrigerants must be performed by technicians certified by the U.S. EPA under CAA, sections 608 and 609, as applicable. Technicians may only service refrigeration or air conditioning equipment they are certified to service. Technician name and certification type(s) must be retained as part of the documentation retention requirements of this Methodology.

#### **2.2.1. Refrigerant Sources**

- (a) Eligible refrigerants must originate from equipment, systems, or other supplies in the United States. Imported refrigerant is not eligible under this Methodology.
- (b) Only destruction of the following ODS refrigerants is eligible to generate ACR Emission Reduction Tonnes (ERTs) under this Methodology:

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- (1) CFC-11;
  - (2) CFC-12;
  - (3) CFC-13;
  - (4) CFC-113;
  - (5) CFC-114;
  - (6) CFC-115;
  - (7) HCFC-22
- (c) Only CFC-12 and HCFC-22 refrigerant can be destroyed in a destruction unit that is part of an enclosed equipment de-manufacturing system, or in a separate destruction facility, to generate ERTs. None of the other ODS refrigerants listed above may be destroyed in a destruction unit that is part of an enclosed equipment de-manufacturing system to generate ERTs.
  - (d) HCFC-22 must be recovered from operating equipment that is subsequently decommissioned or otherwise permanently retired from service.
  - (e) HCFC-22 sourced from stockpiles is not eligible under this Methodology.
  - (f) ODS extracted from a foam source for use in refrigeration equipment is not considered part of this source category, and must instead be considered as a high-GWP insulation foam source.

### **2.2.2. High-GWP Insulation Foam Sources<sup>2</sup>**

- (a) Eligible high-GWP insulation foam must originate from appliances, building materials, walk-in coolers, refrigerated transport trailers, refrigeration cases, pipe-in-pipe/preformed pipe, and marine applications in the United States. Imported foams are not eligible under this Methodology.
- (b) Only the following high-GWP insulation foam blowing agents are eligible under this Methodology:
  - (1) CFC-11;
  - (2) CFC-12;
  - (3) HCFC-22;
  - (4) HCFC-141b;

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<sup>2</sup> Inclusive of high-GWP blowing agents extracted from insulation foam.

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- (5) HFC-134a;
  - (6) HFC-245fa.
- (c) To be eligible, the high-GWP blowing agent must be destroyed in one of three ways:
- (1) If blowing agent is extracted from insulation foam and subsequently destroyed at a separate destruction facility, the blowing agent must be extracted from the insulation foam under negative pressure and collected, stored, and transported in hermetically sealed containers;
  - (2) If blowing agent is extracted from foam and destroyed within an enclosed equipment de-manufacturing system, the blowing agent must be extracted from the foam and destroyed under negative pressure; or
  - (3) If high-GWP insulation foam is destroyed, the intact foam must be separated from the application from which it originated (i.e. those applications cited in subchapter 2.2.2a) and must be stored, transported, and destroyed in sealed containers.

### **2.2.3. Medical Aerosol Sources**

- (a) Eligible medical aerosols must:
  - (1) Originate from domestic U.S. stockpiles of ODS originally produced in the U.S. prior to January 1, 2012 under an essential use exemption; and
  - (2) Be eligible for sale for use in medical products either in the U.S. or in a foreign country.
- (b) Any medical aerosols destroyed prior to January 1, 2012 are not eligible for credits under this Methodology.
- (c) Only destruction of the following ODS medical aerosols is eligible under this Methodology:
  - (1) CFC-11;
  - (2) CFC-12;
  - (3) CFC-113;

### **2.2.4 Fire Suppressant Sources**

- (a) Eligible fire suppressants must originate from equipment or systems in the United

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States. Imported ODS fire suppressants are not eligible under this Methodology.

- (b) Only destruction of the following fire suppressants is eligible under this Methodology:
  - (1) Halon 1211;
  - (2) Halon 1301;
- (c) Halon 1301 originating in stockpiles is not eligible under this Methodology.

### **3. Eligibility**

ODS and high-GWP insulation foam (intact foam or extracted blowing agents) offset projects must adhere to the eligibility requirements below as well as general ACR program requirements found in the ACR Standard.

#### **3.1 General Eligibility Requirements**

- (a) Offset projects that use this Methodology must:
  - (1) Collect and destroy ODS, high-GWP foam blowing agents, or high-GWP insulation foam that would otherwise be emitted to the atmosphere;
  - (2) Destroy the recovered ODS, high-GWP foam blowing agents, or high-GWP insulation foam through an eligible end-use management option pursuant to subchapter 2.1 of this Methodology;
  - (3) Conform with the point of origin documentation requirements, as specified in chapter 6 of this Methodology; and
  - (4) Conform to the chain of custody documentation requirements, as specified in chapter 6 of this Methodology.
- (b) A project proponent that uses this Methodology must:
  - (1) Monitor SSRs within the GHG Assessment Boundary as delineated in chapter 4 pursuant to the requirements of chapter 6 in this Methodology;
  - (2) Quantify GHG emission reductions pursuant to chapter 5 of this Methodology;
  - (3) Prepare and submit a GHG Project Plan in accordance with ACR Standard requirements; and
  - (4) Obtain validation and verification services from an ANSI-accredited offset verification body approved by ACR.

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### **3.2. Location**

- (a) Only projects located in the United States or its territories are eligible under this Methodology.
- (b) All ODS and high-GWP insulation foam must be sourced from equipment, systems, and other eligible supplies in the United States or its territories.
- (c) All ODS, high-GWP foam blowing agents, and high-GWP insulation foam must be destroyed within the United States or its territories.

### **3.3. Additionality**

Offset projects must meet the additionality requirements found below. Eligible offsets must be generated by projects that yield additional GHG reductions that exceed any GHG reductions otherwise required by law or regulation or any GHG reduction that would otherwise occur in a conservative business-as-usual scenario. These requirements are assessed through the Legal Requirement Test in subchapter 3.4.1 and the Performance Standard Evaluation in subchapter 3.4.2 of this Methodology.

#### **3.3.1. Legal Requirement Test**

- (a) Emission reductions achieved by a project using this Methodology must exceed those required by any law, regulation, or legally binding mandate.
- (b) The following legal requirement test applies to all ODS and high-GWP insulation foam projects:
  - (1) If no law, regulation, or legally binding mandate requires the destruction of ODS stocks, high-GWP foam blowing agent, or high-GWP insulation foam, all emission reductions resulting from the recovery and destruction of ODS and high-GWP insulation foam are considered to not be legally required, and therefore eligible for crediting under this Methodology.
  - (2) If any law, regulation, or legally binding mandate requires the destruction of ODS stocks, high-GWP foam blowing agent, or high-GWP insulation foam, only emission reductions resulting from the recovery and destruction of ODS, high-GWP foam blowing agent, and high-GWP insulation foam that are in excess of what is required to comply with those laws,

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regulations, and legally binding mandates are eligible for crediting under this Methodology.

### **3.3.2. Performance Standard Evaluation**

- (a) Emission reductions achieved by a project using this Methodology must exceed those likely to occur in a conservative business-as-usual scenario.
- (b) The destruction of HCFC-22 refrigerant sourced from stockpiles or other sources other than recovered from refrigeration or air conditioning equipment is ineligible for crediting under this Methodology.
- (c) The destruction of halon 1301 sourced from stockpiles or other sources other than recovered from fire suppression equipment is ineligible for crediting under this Methodology.
- (d) The performance standard evaluation is satisfied if the ODS or high-GWP insulation foam project activities meet the project definition and all other eligibility requirements in the Methodology.

### **3.4. Start Date**

- (a) For this Methodology, the project start date is defined as the date on which the earliest destruction activity of a project commences, as documented on a Certificate of Destruction.
- (b) Offset project activities (i.e. collection of ODS or high-GWP insulation foam, transportation of ODS or high-GWP insulation foam, etc.) will occur prior to offset project commencement.
- (c) The project start date is on or after January 1, 2000<sup>3</sup>. However, for projects whose start date is more than 2 years prior to the date of the project being listed with ACR, documentation must be provided to show that GHG mitigation was an objective as of the start date (see ACR Standard).

### **3.5. Reporting Periods**

- (a) An ODS or high-GWP insulation foam project can only have a single reporting

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<sup>3</sup> With the exception of medical aerosols per section 2.2.3(b).



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period.

- (b) Multiple destruction events may be combined within a single reporting period subject to the requirements in subchapter 2.2(e) of this Methodology.
- (c) The reporting period must not exceed 12 consecutive months. The project proponent may choose a reporting period shorter than 12 consecutive months.
- (d) The project reporting period begins on the project start date.

### **3.6. Crediting Periods**

- (a) The project crediting period is the period of time over which emission reductions are quantified for the purpose of determining creditable GHG reductions.
- (b) The project crediting period for this Methodology is ten years.
- (c) The project crediting period begins on the project start date.

### **3.7. Regulatory Compliance**

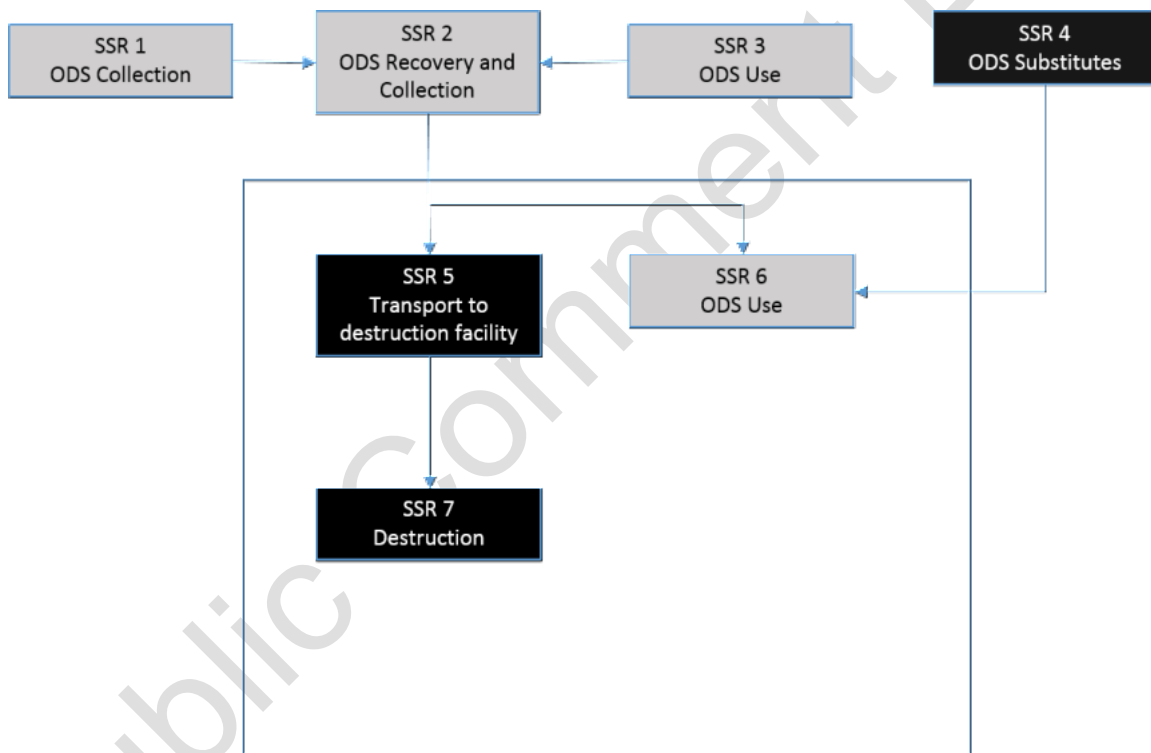
- (a) An offset project must meet the regulatory compliance requirements set forth in the ACR Standard.
- (b) The regulatory compliance requirements for a project apply to the collection, recovery, storage, transportation, mixing, and destruction of ODS or high-GWP insulation foam, including disposal of the post-destruction waste products that are directly applicable to the destruction activities. The regulatory compliance requirements in this section apply to the incinerator and any other unit or operation at the destruction facility, directly related to the destruction activities, during the time destruction occurs.
- (c) Any instances of non-compliance resulting from administrative or other issues not related to the project (those specific activities stated in Section 3.7(b)) shall not be considered in a determination of project-related regulatory compliance.

## **4. Offset Project Boundary – Quantification Methodology**

- (a) The GHG assessment boundary, or offset project boundary, delineates the SSRs that must be included or excluded when quantifying the net changes in emissions associated with the recovery and destruction ODS and high-GWP insulation foam.

- (b) Figure 4.1 illustrates the GHG assessment boundary for refrigerant ODS, medical aerosol ODS, and fire suppressant ODS projects.
- (1) All SSRs within the bold line are included and must be accounted for under this Methodology.
  - (2) SSRs in lightly shaded boxes are relevant to the baseline and project emissions.
  - (3) SSRs in darkly shaded boxes are relevant only to project emissions.

**Figure 4.1: Illustration of the Offset Project Boundary for Refrigerant, Medical Aerosol, and Fire Suppressant ODS Projects**



- (c) Table 4.1 lists the SSRs for refrigerant, medical aerosol, and fire suppressant ODS projects indicating which gases are included or excluded from the offset project boundary.

**Table 4.1. List of Identified SSRs for Refrigerant, Medical Aerosol, and Fire Suppressant ODS Projects**

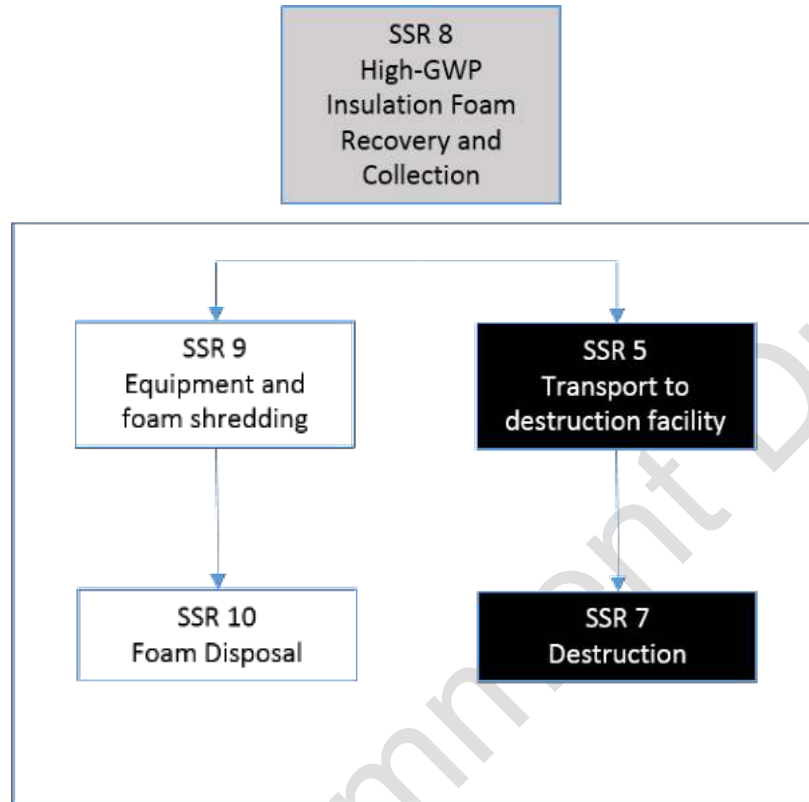
SSR		Source Description	Gas	Included (I) or Excluded (E)
1	ODS Collection	Fossil fuel emissions from the collection and transport of ODS sources	CO <sub>2</sub>	E
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E
2	ODS Recovery and Collection	Emissions of ODS from the recovery and collection of ODS at end-of-life or servicing	ODS	E
		Fossil fuel emissions from the recovery and collection of refrigerant at end-of-life or servicing	CO <sub>2</sub>	E
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E
3	ODS Use	Emissions of ODS from equipment use, leaks, and servicing	ODS	E
		Fossil fuel emissions from the operation of refrigeration and A/C equipment and fire suppressant systems	CO <sub>2</sub>	E
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E
4	Substitute Refrigerant, Medical Aerosol, or Fire Suppressant Production	Emissions of substitute refrigerant, medical aerosols, or fire suppressants occurring during production	CO <sub>2</sub> e	E
		Fossil fuel emissions from the production of substitute refrigerant, medical aerosols, or fire suppressants	CO <sub>2</sub>	E
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E
5	Transport to Destruction Facility	Fossil fuel emissions from the vehicular transport of ODS from aggregation point to final destruction facility	CO <sub>2</sub>	I
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E
6	ODS Use	Emissions of ODS from use, leaks and servicing through continued operation of equipment	ODS	I
		Emissions of substitute from use, leaks and servicing through continued operation of equipment	CO <sub>2</sub> e	I
		Indirect emissions from grid-delivered electricity	CO <sub>2</sub>	E
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E
7	Destruction	Emissions of ODS from incomplete destruction at destruction facility	ODS	I
		Emissions from the oxidation of carbon contained in destroyed ODS	CO <sub>2</sub>	I
			CO <sub>2</sub>	I

SSR		Source Description	Gas	Included (I) or Excluded (E)
		Fossil fuel emissions from the destruction of ODS at destruction facility	CH <sub>4</sub>	E
			N <sub>2</sub> O	E
		Indirect emissions from the use of grid-delivered electricity	CO <sub>2</sub>	I
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E

(d) Figure 4.2 illustrates the GHG assessment boundary for high-GWP insulation foam projects.

- (1) All SSRs within the bold line are included and must be accounted for under this Methodology.
- (2) SSRs in lightly shaded boxes are relevant to the baseline and project emissions.
- (3) SSRs in darkly shaded boxes are relevant only to project emissions.

**Figure 4.2: Illustration of the Offset Project Boundary for High-GWP Insulation Foam Projects**



(e) Table 4.2 lists the SSRs for high-GWP insulation foam projects indicating which gases are included or excluded from the offset project boundary.

**Table 4.2. List of Identified SSRs for High-GWP Insulation Foam Projects**

SSR		Source Description	Gas	Included (I) or Excluded (E)
5	Transport to Destruction Facility	Fossil fuel emissions from the vehicular transport of high-GWP insulation foam or extracted blowing agent from aggregation point to final destruction facility	CO <sub>2</sub>	I
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E
7	Destruction	Emissions from incomplete destruction at destruction facility	ODS/HFC	I
		Emissions from the oxidation of carbon contained in destroyed foam or blowing agent	CO <sub>2</sub>	I
			CO <sub>2</sub>	I

SSR		Source Description	Gas	Included (I) or Excluded (E)
		Fossil fuel emissions from the destruction of foam or blowing agent at destruction facility	CH <sub>4</sub>	E
			N <sub>2</sub> O	E
		Indirect emissions from the use of grid-delivered electricity	CO <sub>2</sub>	I
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E
8	High-GWP Insulation Foam and Recovery	Emissions of ODS/HFC from demolition, deconstruction, or other damage to foam sources	ODS/HFC	E
		Fossil fuel emissions from demolition or deconstruction of foam sources	CO <sub>2</sub>	E
			CH <sub>4</sub>	
			N <sub>2</sub> O	
		Fossil fuel emissions from the collection and transport of high-GWP foam sources	CO <sub>2</sub>	E
			CH <sub>4</sub>	
N <sub>2</sub> O				
9 <sup>4</sup>	Equipment and Foam Shredding	Emissions of ODS/HFC from the shredding of equipment for materials recovery, releasing ODS/HFC from foam	ODS/HFC	I
10	Foam Landfilling	Emissions of ODS/HFC released from foam disposed of in landfills	ODS/HFC	I
		Fossil fuel emissions from the transport and placement of shredded foam waste in landfill	CO <sub>2</sub>	E
			CH <sub>4</sub>	E
			N <sub>2</sub> O	E

<sup>4</sup> SSR 9 is only relevant to projects that extract high-GWP blowing agent. It is not included for projects that destroy intact foam.

## 5. Quantifying GHG Emission Reductions - Quantification Methodology

- (a) GHG emission reductions from an ODS or high-GWP insulation foam<sup>5</sup> project are quantified by comparing actual project emissions to calculated project baseline emissions.
- (b) A project proponent must use the calculation methods provided in this methodology to determine baseline and project GHG emissions.
- (c) GHG emissions must be quantified using the GWP values in Tables A.1- A.4.
- (d) GHG emission reductions (ER) must be quantified by subtracting the project emissions (PE) from the baseline emissions (BE) using Equation 5.1.

### Equation 5.1. Total Emission Reductions

$ER_t = BE_t - PE_t$		
<i>Where,</i>		<u>Units</u>
ER <sub>t</sub>	= Total quantity of GHG emission reductions during the reporting period	tCO <sub>2</sub> e
BE <sub>t</sub>	= Total quantity of project baseline emissions during the reporting period	tCO <sub>2</sub> e
PE <sub>t</sub>	= Total quantity of project emissions during the reporting period	tCO <sub>2</sub> e

### 5.1. Quantifying Baseline Emissions

- (a) Baseline emissions (BE) must be estimated by using Equation 5.2 and by summing the baseline emissions for all SSRs identified as included in the baseline in Tables 4.1 and 4.2.

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<sup>5</sup> Whether intact high-GWP insulation foam or blowing agent extracted from high-GWP insulation foam

## Equation 5.2. Total Baseline Emissions

$$BE_t = BE_{refr} + BE_{foam} + BE_{aer} + BE_{fs}$$

Where,

		<u>Units</u>
$BE_t$	= Total quantity of project baseline emissions	tCO <sub>2</sub> e
$BE_{refr}$	= Total quantity of project baseline emissions from refrigerant ODS	tCO <sub>2</sub> e
$BE_{foam}$	= Total quantity of project baseline emissions from high-GWP blowing agent	tCO <sub>2</sub> e
$BE_{aer}$	= Total quantity of project baseline emissions from medical aerosol ODS	tCO <sub>2</sub> e
$BE_{fs}$	= Total quantity of project baseline emissions from fire suppressant ODS	tCO <sub>2</sub> e

- (b) Baseline emissions from refrigerant ODS ( $BE_{refr}$ ) must be quantified using equation 5.3.
- (c)  $BE_{refr}$  must include the estimated CO<sub>2</sub>e emissions that would have occurred over the ten-year crediting period had the destroyed ODS been used in existing refrigeration or air conditioning equipment.
- (d) The total mass of refrigerant ODS sent for destruction ( $Q_{refr,i}$ ) includes eligible ODS and excludes the mass of HBR, moisture, ineligible ODS, and other ineligible material. Mass and composition of refrigerant ODS are determined per the procedures found in Appendix C.
- (e) The GWP values for refrigerant ODS ( $GWP_i$ ) must be taken from table A.1.
- (f) The 10-year cumulative emission rate for refrigerant ODS ( $ER_{refr,i}$ ) must be taken from table A.1.
- (g) If the project did not destroy any refrigerant ODS, then  $BE_{refr} = 0$ .



### Equation 5.3. Baseline Emissions from Refrigerant ODS

$$BE_{refr} = \sum_i (Q_{refr,i} \times ER_{refr,i} \times GWP_i)$$

Where,

		<u>Units</u>
$BE_{refr}$	= Total quantity of refrigerant project baseline emissions during the reporting period	tCO <sub>2</sub> e
$Q_{refr,i}$	= Total quantity of refrigerant ODS <i>i</i> sent for destruction by the offset project	tODS
$ER_{refr,i}$	= 10-year cumulative emission rate of refrigerant ODS <i>i</i> (see Table A.1)	%
$GWP_i$	= Global warming potential of ODS <i>i</i> (see Table A.1)	tCO <sub>2</sub> e/ tODS

- (h) Baseline emissions from high-GWP foam blowing agents ( $BE_{foam}$ ) (blowing agent extracted from foam or intact foam) must be quantified using Equation 5.4.
- (i)  $BE_{foam}$  must include the estimated CO<sub>2</sub>e emissions that would have occurred over ten years as the result of foam disposal.
- (j) The 10-year cumulative emission rate for high-GWP blowing agents must be taken from Table A.2.
- (k) The mass and composition of extracted blowing agent from high-GWP foam ( $EBA_i$ ) must be calculated according to the procedures in Appendix C.
- (l) The weight of intact high-GWP foam ( $Q_{intf,i}$ ) must be calculated on the scales of the eligible destruction facility as specified in Appendix B.
- (m) The mass fraction of intact high-GWP blowing agent ( $BA\%_{intf,i}$ ) must be calculated according to Appendix B – part (b).
- (n) If the project did not destroy any high-GWP blowing agent, then  $BE_{foam} = 0$

### Equation 5.4. Baseline Emissions from High-GWP Foam

$$BE_{foam} = \sum_{i,j} [(EBA_i + BA_{intf,i}) \times ER_{i,j} \times GWP_i]$$

Where,

	<u>Units</u>
BE <sub>foam</sub> = Total quantity of high-GWP blowing agent project baseline emissions	tCO <sub>2</sub> e
EBA <sub>i</sub> = Total quantity of high-GWP blowing agent <i>i</i> extracted from foam and destroyed (as determined through the procedures found in Appendix C)	tBA
BA <sub>intf,i</sub> = Total quantity of high-GWP blowing agent <i>i</i> in intact foam sent for destruction	tBA
ER <sub>i,j</sub> = 10 year emission rate of high-GWP blowing agent <i>i</i> from application <i>j</i> (see Table A.2)	%
GWP <sub>i</sub> = Global warming potential of high GWP blowing agent <i>i</i> (see Table A.2)	tCO <sub>2</sub> e/ tBA

$$BA_{intf,i} = Q_{intf,i} \times BA\%_{intf,i}$$

Where,

BA <sub>intf,i</sub> = Total quantity of high-GWP blowing agent <i>i</i> from intact foam sent for destruction	tBA
Q <sub>intf,i</sub> = Total weight of intact foam, <i>i</i> , with entrained high-GWP blowing agent sent for destruction (as determined through procedures in Appendix B – part a)	Metric tons
BA% <sub>intf,i</sub> = Mass ratio of high-GWP blowing agent, <i>i</i> , entrained in intact foam (as determined according to the procedures in Appendix B – part b)	% (0-1)

- (o) Baseline emissions from medical aerosol ODS ( $BE_{aer}$ ) must be quantified using Equation 5.5.
- (p)  $BE_{aer}$  must include the estimated CO<sub>2</sub>e emissions that would have occurred over the ten-year crediting period had the destroyed ODS been used in medical aerosols.
- (q) The total mass of medical aerosol ODS sent for destruction ( $Q_{aer,i}$ ) includes eligible ODS and excludes the mass of HBR, moisture, ineligible ODS, and other ineligible material. Mass and composition of medical aerosol ODS are determined per the procedures found in Appendix C.
- (r) The GWP values for medical aerosol ODS ( $GWP_i$ ) must be taken from table A.3.
- (s) The 10-year cumulative emission rate for medical aerosol ODS ( $ER_{aer,i}$ ) must be taken from table A.3.
- (t) If the project did not destroy any medical aerosol ODS, then  $BE_{aer} = 0$ .

**Equation 5.5. Baseline Emissions from Medical Aerosol ODS**

$BE_{aer} = \sum_i (Q_{aer,i} \times ER_{aer,i} \times GWP_i)$		
<i>Where,</i>		<u>Units</u>
$BE_{aer}$	= Total quantity of medical aerosol project baseline emissions during the reporting period	tCO <sub>2</sub> e
$Q_{aer,i}$	= Total quantity of medical aerosol ODS <i>i</i> sent for destruction by the project	tODS
$ER_{aer,i}$	= 10-year cumulative emission rate of medical aerosol ODS <i>i</i> (see Table A.3)	%
$GWP_i$	= Global warming potential of ODS <i>i</i> (see Table A.3)	tCO <sub>2</sub> e/ tODS

- (u) Baseline emissions from fire suppressant ODS ( $BE_{fs}$ ) must be quantified using equation 5.6.

- (v)  $BE_{fs}$  must include the estimated CO<sub>2e</sub> emissions that would have occurred over the ten-year crediting period had the destroyed ODS been used in existing fire suppression equipment or systems.
- (w) The total mass of fire suppressant ODS sent for destruction ( $Q_{fs,i}$ ) includes eligible ODS and excludes the mass of HBR, moisture, ineligible ODS, and other ineligible material. Mass and composition of fire suppressant ODS are determined per the procedures found in Appendix C.
- (x) The GWP values for fire suppressant ODS ( $GWP_i$ ) must be taken from table A.4.
- (y) The 10-year cumulative emission rate for fire suppressant ODS ( $ER_{fs,i}$ ) must be taken from table A.4.
- (z) If the project did not destroy any fire suppressant ODS, then  $BE_{fs} = 0$ .

**Equation 5.6 Baseline Emissions from Fire Suppressant ODS**

$BE_{fs} = \sum_i Q_{fs} \times ER_{fs,i} \times GWP_i$		
<i>Where,</i>		<u>Units</u>
$BE_{fs}$	= Total quantity of fire suppressant project baseline emissions during the reporting period	tCO <sub>2e</sub>
$Q_{fs,i}$	= Total quantity of fire suppressant ODS <i>i</i> sent for destruction by the project	tODS
$ER_{fs,i}$	= 10-year cumulative emission rate of fire suppressant ODS <i>i</i> (see Table A.4)	%
$GWP_i$	= Global warming potential of ODS <i>i</i> (see Table A.4)	tCO <sub>2e</sub> / tODS

**5.2 Quantifying Project Emissions**

- (a) Project emissions (PE) must be quantified by summing the emissions for all SSRs identified as included in the project in tables 4.1 and 4.2 using equation 5.7.

### Equation 5.7. Total Project Emissions

$$PE_t = Sub_{refr} + Sub_{fs} + Sub_{aer} + Tr \& Dest$$

Where,

		<u>Units</u>
PE <sub>t</sub>	= Total quantity of project emissions during the reporting period	tCO <sub>2</sub> e
Sub <sub>refr</sub>	= Total GHG emissions from substitute refrigerant	tCO <sub>2</sub> e
Sub <sub>fs</sub>	= Total GHG emissions from substitute fire suppressant	tCO <sub>2</sub> e
Sub <sub>aer</sub>	= Total GHG emissions from substitute medical aerosol	tCO <sub>2</sub> e
Tr & Dest	= Total GHG emissions from transportation and destruction of ODS and high-GWP insulation foam/blowing agents	tCO <sub>2</sub> e

- (b) Project emissions from substitute refrigerants (Sub<sub>ref</sub>) must be quantified using equation 5.8.
- (c) Sub<sub>ref</sub> must include the estimated CO<sub>2</sub>e emissions over a ten-year period from non-ODS substitute refrigerants that are used. The emission factors for substitute refrigerants in table A.1 must be used.
- (d) The total mass of refrigerant ODS sent for destruction (Q<sub>ref,i</sub>) excludes the mass of HBR, moisture, and ineligible ODS. Mass and composition of refrigerant ODS are determined per the procedures found in Appendix C.
- (e) If the project did not destroy any refrigerant then Sub<sub>ref</sub> = 0.

### Equation 5.8. Project Emissions from the Use of Non-ODS Refrigerants

$$Sub_{refr} = \sum_i (Q_{ref,i} \times SE_i)$$

Where,

		<u>Units</u>
Sub <sub>refr</sub>	= Total quantity of refrigerant substitute emissions	tCO <sub>2</sub> e
Q <sub>ref,i</sub>	= Total quantity of refrigerant <i>i</i> sent for destruction	tODS
SE <sub>i</sub>	= Emission factor for substitute(s) for refrigerant <i>i</i> , per Table A.1	tCO <sub>2</sub> e/ tODS destroyed

- (f) Project emissions from substitute medical aerosols ( $Sub_{aer}$ ) must be quantified using Equation 5.10.
- (g)  $Sub_{aer}$  must include the estimated CO<sub>2</sub>e emissions over a ten-year period from non-ODS substitute medical aerosols that are used. The emission factors for substitute medical aerosols in table A.3 must be used.
- (h) The total mass of medical aerosol ODS sent for destruction ( $Q_{aer,i}$ ) excludes the mass of HBR, moisture, and ineligible ODS. Mass and composition of medical aerosol ODS are determined per the procedures found in Appendix C.
- (i) If the project did not destroy any medical aerosols then  $Sub_{aer} = 0$ .

**Equation 5.9. Project Emissions from the Use of Non-ODS Medical Aerosols**

$Sub_{aer} = \sum_i (Q_{aer,i} \times SE_i)$		
<i>Where,</i>		
$Sub_{aer}$	= Total quantity of medical aerosol substitute emissions	<u>Units</u> tCO <sub>2</sub> e
$Q_{aer,i}$	= Total quantity of medical aerosol <i>i</i> sent for destruction	tODS
$SE_i$	= Emission factor for substitute(s) medical aerosols <i>i</i> , per Table A.3	tCO <sub>2</sub> e/ tODS destroyed

- (k) Project emissions from substitute fire suppressants ( $Sub_{fs}$ ) must be quantified using equation 5.11.
- (l)  $Sub_{fs}$  must include the estimated CO<sub>2</sub>e emissions over a ten-year period from non-ODS substitute fire suppressants that are used. The emission factors for substitute fire suppressants in table A.4 must be used.
- (m) The total mass of fire suppressant ODS sent for destruction ( $Q_{fs,i}$ ) excludes the mass of HBR, moisture, and ineligible ODS. Mass and composition of fire suppressant ODS are determined per the procedures found in Appendix C.
- (n) If the project did not destroy any fire suppressant then  $Sub_{fs} = 0$ .

### Equation 5.10. Project Emissions from the Use of Non-ODS Fire Suppressants

$$Sub_{fs} = \sum_i (Q_{fs,i} \times SE_i)$$

Where,

		Units
Sub <sub>fs</sub>	= Total quantity of fire suppressant substitute emissions	tCO <sub>2</sub> e
Q <sub>fs,i</sub>	= Total quantity of fire suppressant <i>i</i> sent for destruction	tODS
SE <sub>i</sub>	= Emission factor for substitute(s) for fire suppressant <i>i</i> , per Table A.4	tCO <sub>2</sub> e/ tODS destroyed

- (o) Project emission from the transportation and destruction of ODS and high-GWP insulation foam/blowing agent shall be quantified using default emission factors in equation 5.12.
- (1) The default emission factor for ODS transportation and destruction is 7.5 metric tons CO<sub>2</sub>e per metric ton ODS for refrigerant, medical aerosol, fire suppressant or blowing agent extracted from high-GWP foam.
  - (2) The default emission factor for transportation and destruction is 75 metric tons CO<sub>2</sub>e per metric ton of high-GWP foam for intact foam projects.
  - (3) Q<sub>ODS</sub> and Q<sub>BA</sub> include the mass of all eligible and ineligible ODS and high-GWP blowing agent, moisture, HBR, and other accompanying material.

### Equation 5.11. Project Emissions from Transportation and Destruction Using the Default Emission Factors

$$Tr\&Dest = (Q_{ODS} \times EF) + (Q_{BA} \times EF) + (Q_{intf} \times EF)$$

Where,

		Units
Tr&Dest	= Total GHG emissions from ODS and high-GWP insulation foam/blowing agent transportation and destruction, as calculated using default emission factors	tCO <sub>2</sub> e

$Q_{\text{ODS}}$	=	Total quantity of refrigerant, medical aerosol, and/or fire suppressant ODS sent for destruction in the project	tODS
$Q_{\text{BA}}$	=	Total quantity of high-GWP blowing agent extracted from insulation foam and sent for destruction in the project	tBA
$Q_{\text{inf}}$	=	Total weight of intact foam with entrained high-GWP blowing agent sent for destruction	Metric tons
EF	=	Default emission factor for transportation and destruction of ODS or High-GWP Blowing Agent foam (7.5 for refrigerant, medical aerosol, fire suppressant or extracted blowing agent projects, 75 for intact high-GWP foam projects)	tCO <sub>2</sub> e/ tODS/ tBA or t

### 5.3. Accounting for Disqualified ODS Material and High-GWP Foam After Destruction

ERTs may only be generated for the destruction of eligible ODS and high-GWP insulation foam that meet the point of origin and chain of custody requirements specified in chapter 6 of this Methodology. Any disqualified ODS or high-GWP insulation foam must be removed from baseline emission calculations using the following method to determine the weight and species of the disqualified ODS or high-GWP insulation foam:

- (a) The total weight of each container of disqualified ODS (from refrigerant, medical aerosol or fire suppressant ODS or blowing agent extracted from high-GWP insulation foam) or intact high-GWP insulation foam shall be considered as the original container when the ODS or high-GWP foam was acquired. Documentation of the acquired ODS, high-GWP blowing agent, or high-GWP insulation foam must identify the capacity of the disqualified ODS, high-GWP blowing agent or high-GWP insulation foam container or the entire destruction event is not eligible for crediting. If a container's capacity is labelled in volume rather than in weight, the densities in table A.5 must be used to convert the volume to weight.

- (1) For refrigerant, medical aerosol, fire suppressant ODS or high-GWP foam blowing agent: If converting between mass and volume, the ODS or blowing agent must be in a liquid state.



- (b) The species of each disqualified ODS or high-GWP blowing agent shall be the species with the highest GWP of the destruction event.
- (c) The determined weight of disqualified ODS or high-GWP blowing agent shall be subtracted from the total mass of that ODS or high-GWP blowing agent species destroyed in the project.
  - (1) The total mass of refrigerant ODS sent for destruction ( $Q_{\text{refr},i}$ ) shall be adjusted in equation 5.3.
  - (2) The total quantity of blowing agent extracted from high-GWP foam and sent for destruction ( $EBA_{,i}$ ) shall be adjusted in equation 5.4.
  - (3) The total mass of high-GWP blowing agent from intact high-GWP foam sent for destruction ( $BA_{\text{intf},i}$ ) shall be adjusted in equation 5.4.
  - (4) The total mass of medical aerosol ODS sent for destruction ( $Q_{\text{aer},i}$ ) shall be adjusted in equation 5.5.
  - (5) The total mass of fire suppressant ODS sent for destruction ( $Q_{\text{fs},i}$ ) shall be adjusted in equation 5.6.

#### **5.4. Conversion Factors and Rounding Practices**

- (a) For the purpose of this Methodology, 1 pound (lb) equals 0.45359 kilogram (Kg).
- (b) The following rounding practices shall be applied for the purpose of this Methodology:
  - (1) At least five significant figures shall be maintained.
  - (2) There shall be no rounding to the left side of the decimal.

## **6. Monitoring**

### **6.1. General Monitoring Requirements**

- (a) The project proponent is responsible for monitoring all project activities to ensure compliance with this Methodology.
- (b) The point of origin of all ODS and high-GWP foam must be documented. The project proponent must collect and maintain documentation showing regulatory compliance back to all points of origin.

- (c) Documentation of the point of origin must be generated at the time of collection from the point of origin and must include all of the following:
- (1) Facility name and physical address;
  - (2) Point of origin zip code;
  - (3) Identification of any refrigeration or air conditioning equipment by serial number, if available, or description, location, and function, if serial number is unavailable (for refrigerant ODS quantities greater than 500 pounds that originates in equipment that is not processed at an enclosed equipment de-manufacturing facility); and
  - (4) Serial or ID number of containers used for storage and transport.
- (d) For refrigerant ODS, medical aerosol ODS, and fire suppressant ODS, the project proponent must collect and maintain documentation on the chain of custody and ownership of the ODS beginning at the point of origin until destruction, including all of the following:
- (1) Names, addresses, and contact information of all entities buying and selling ODS for destruction; and
  - (2) The mass of ODS including ineligible ODS and contaminants, at each transaction.
- (e) For projects recovering and destroying HCFC-22 refrigerant or Halon 1301 fire suppressant and that meet the point of origin determination requirements in Section 6.2(b)(2)(B), the project proponent must obtain a signed attestation from a representative at the point of origin facility regarding the source of the HCFC-22 or Halon 1301. Specifically, this attestation must state whether the source equipment has been decommissioned or otherwise permanently retired from service and the date of decommissioning or retirement. The attestation shall be supplied to the ACR and to the validation and verification body for assessment.
- (f) For high-GWP foam sources, the project proponent must collect and maintain all of the following information:
- (1) For intact high-GWP building foams:
    - (A) Building address;
    - (B) Date of construction;

- (C) Blowing agent in the foam determined through procedures in Appendix B part (b); and
- (D) Approximate building dimensions.
- (2) For intact non-building high-GWP foams:
  - (A) Numbers of units containing high-GWP foam that are processed;
  - (B) Facility at which equipment de-manufacture occurs and high-GWP foam is removed; and
  - (C) Blowing agent(s) in the foam, determined through the procedures in Appendix B part (b), as applicable.
- (g) For refrigerant ODS, medical aerosol ODS, fire suppressant ODS and extracted high-GWP foam blowing agent that is not destroyed in an enclosed equipment de-manufacturing process, the project proponent must collect and maintain all of the following information from the composition and mass analysis:
  - (1) Time and date of sample;
  - (2) Name of project proponent;
  - (3) Name of technician taking sample;
  - (4) Employer of technician taking sample;
  - (5) Volume of container from which sample was extracted;
  - (6) Ambient air temperature at time of sampling; and
  - (7) Chain of custody for each sample from the point of sampling to the AHRI lab.
- (h) For refrigerant ODS, medical aerosol ODS, and fire suppressant ODS and extracted high-GWP foam blowing agent, the destruction facility must track continuously during the destruction process the following parameters and provide the data about these parameters to the project proponent. The project proponent must collect and maintain all of the following information from the destruction facility:
  - (1) The feed rate;
  - (2) Operating temperature and pressure of the destruction unit during destruction;
  - (3) Effluent discharges measured in terms of water and pH levels;

- (4) CEMS data on the emissions of carbon monoxide during destruction; and
  - (5) If applicable, for an enclosed equipment de-manufacturing system, mass and composition of ODS and high-GWP blowing agent(s) entering the destruction unit, time and date(s) of chemical analyses, number of appliances that are de-manufactured in the system, and date(s) appliances enter equipment de-manufacturing system.
- (i) For intact high-GWP insulation foam, the destruction facility must track during the destruction process the following parameters and provide the data about these parameters to the project proponent. The project proponent must collect and maintain all of the following information from the destruction facility:
- (1) Mass of high-GWP foam fed into the destruction unit;
  - (2) Operating temperature and pressure of the destruction unit during foam destruction;
  - (3) Effluent discharges measured in terms of water and pH levels; and
  - (4) CEMS data on the emissions of carbon monoxide during foam destruction.

## **6.2. Point of Origin Determination**

- (a) The project proponent must collect and maintain data on the point of origin of each quantity of refrigerant ODS, medical aerosol ODS, or fire suppressant ODS, high-GWP foam blowing agent, and high-GWP insulation foam as part of tracking chain of custody. Data must be generated at the time of collection from the point of origin.
- (b) Point of origin is defined as follows:
- (1) For refrigerant ODS, medical aerosol ODS, or fire suppressant ODS which is stored as a stockpile for more than 24 months prior to acquisition by the project proponent:
    - (A) The point of origin for stockpiled refrigerant ODS, medical aerosol ODS, or fire suppressant ODS is the location of the stockpile<sup>6</sup>.

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<sup>6</sup> Per Section 3.4.2, stockpiled HCFC-22 and Halon 1301 is ineligible for crediting.

- (2) For refrigerant ODS, medical aerosol ODS, or fire suppressant ODS which is not part of a stockpile for at least 24 months prior to acquisition by the project proponent:
  - (A) The point of origin for refrigerant ODS, medical aerosol ODS, or fire suppressant ODS with mass less than 500 pounds is the site at which greater than or equal to 500 pounds of ODS is aggregated.
  - (B) The point of origin for refrigerant ODS, medical aerosol ODS, or fire suppressant ODS with mass greater than or equal to 500 pounds is the site where the ODS is removed from service.
  - (C) The point of origin for refrigerant ODS recovered from appliances at an equipment de-manufacturing facility is the equipment de-manufacturing facility.
- (3) For blowing agent extracted from high-GWP foam, the point of origin is the facility where the blowing agent is extracted.
- (4) For blowing agent in intact non-building high-GWP foam, the point of origin is the location at which the foam is removed.
- (5) For blowing agent in intact building high-GWP foam, the point of origin is the location at which the building high-GWP foam was taken.
- (c) For refrigerant ODS, medical aerosol ODS, or fire suppressant ODS, the following provisions also apply to point of origin determination:
  - (1) Any location at which 500 pounds is reached in a single transaction or shipment is a point of origin; the 500 pounds does not need to be in a single container.
  - (2) For each container included within the project, the mass of HBR, moisture, ineligible ODS, and other ineligible material shall be included to determine if the 500 pound threshold is reached.
  - (3) If refrigeration or air conditioning equipment or fire suppression equipment containing at least 500 pounds of ODS is transported prior to the ODS being removed from the equipment, then the point of origin is the site at which the ODS was removed from the equipment.

- (4) When ODS is added to a single container which is part of a stockpile and a portion of the ODS is subsequently removed from the container, the ODS removed must be considered the ODS stored the longest (i.e., first-in, first-out method).

### **6.3. Instrument QA/QC**

- (a) For a destruction facility that is not part of an enclosed equipment de-manufacturing system, the scales used to determine the mass of ODS, high-GWP foam blowing agent, or high-GWP insulation foam used in calculating emission reductions must be:
  - (1) inspected at least quarterly;
  - (2) properly calibrated per the destruction facility's RCRA permit, or for non-RCRA facilities, calibrated at least quarterly to an accuracy of within 5% of reading. RCRA facilities that do not have calibration requirements defined in their RCRA permits must calibrate scales quarterly to an accuracy of within 5% of reading.
- (b) For a destruction facility that is part of an enclosed equipment de-manufacturing system, the following requirements apply:
  - (1) Fourier transform infrared spectroscopy (FTIR) must be used to determine the mass and composition of CFC-12 or HCFC-22 refrigerant, or high-GWP blowing agent and:
    - (A) No more than one day prior to the commencement of the destruction event, conduct a check for calibration accuracy using a gas of known quality:
      - (1) This check must demonstrate that the FTIR is accurate to within +/- 1% relative to the reference gas;
    - (B) Conduct and record a daily zero validation of the FTIR output;
    - (C) No more than one day prior to the end of the destruction event, conduct a check for calibration accuracy using a gas of known quality:

- (1) This check must demonstrate that the FTIR is accurate to within +/- 1% relative to the reference gas
- (D) The FTIR must be calibrated by the manufacturer or a certified calibration service per manufacturer's specifications or every 5 years, whichever is more frequent. Instruments are exempted from calibration requirements if the manufacturer's specifications state that no calibration is required.
  - (E) If a check on the FTIR reveals accuracy beyond a +/- 1% threshold (reading relative to the reference gas), corrective action such as calibration by the manufacturer or a certified service provider is required for the FTIR.
  - (F) If the check on the FTIR reveals accuracy beyond a +/- 1% threshold during the check stipulated in Section 6.3(b)(1)(A), the destruction event may not commence until corrective action is performed and a subsequent check reveals accuracy within a +/- 1% threshold
  - (G) If the check on the FTIR reveals accuracy beyond a +/- 1% threshold during the check stipulated in Section 6.3(b)(1)(C), the mass and composition data from the FTIR must be scaled according to the following procedure. These adjustments must be made for the entire period from the check required in Section 6.3(b)(1)(A) through to the end of the reporting period.
    - (1) the project proponent shall calculate total emission reductions using:
      - (a) The monitored values without correction; and
      - (b) The monitored values adjusted based on the calibration drift recorded at the time of the check as required in Section 6.3(b)(1)(C).
    - (2) The lower of the two emission reduction estimates shall be reported as the emission reductions claimed for the reporting period.

- (2) If a catalyst is used in the destruction process, maintenance procedures related to catalyst replacement, carbon filter cleaning or other system controls needed to insure the required 99.99% destruction efficiency is maintained must be implemented in accordance with manufacturer's guidance and specifications.

#### **6.4. Document Retention**

- (a) The project proponent is required to keep all documentation and information outlined in this methodology.
- (b) Information that must be retained by the project proponent includes:
  - (1) All data inputs for the calculation of the offset project emission reductions, including all required sampled data;
  - (2) Copies of all permits, Notices of Violations (NOVs), and any relevant administrative or legal consent orders dating back at least 3 years prior to the project commencement date;
  - (3) Destruction facility monitoring and maintenance information (CEMS data, DRE documentation, scale readings, calibration procedures, calibration checks and daily zero validations (if applicable), manufacturer guidance pertaining to facility or technology maintenance, and permits);
  - (4) Chain of custody and point of origin documentation; and
  - (5) ODS and high-GWP blowing agent composition and mass determinations (i.e., from lab reports or other procedures found in this Methodology).

#### **6.5. Monitoring Parameters – Quantification Methodology**

The project proponent must monitor the parameters described in Table 6.1.



**Table 6.1. Project Monitoring Parameters – Quantification Methodology**

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
		Legal Requirement Test	N/A	For each offset project		Must be monitored and determined for each project
		Mass of ODS (or ODS mixture) or HFC in each container	mass of mixture	Per container	M	Must be determined for each container
		Concentration of ODS (or ODS mixture) or HFC in each container	mass ODS or HFC/ mass of mixture	Per container	M	Must be determined for each container
		Mass of ODS or HFC destroyed in an enclosed equipment de-manufacturing system	Mass of mixture	Continuous	M	Readings taken and recorded every two minutes
		Concentration of ODS or HFC destroyed in an enclosed equipment de-manufacturing system	Concentration of ODS or HFC	Continuous	M	Readings taken and recorded every two minutes
Equation 5.1	$ER_t$	Total quantity of GHG emission reductions during the reporting period	tCO <sub>2</sub> e	For each offset project	C	
Equation 5.1, Equation 5.2	$BE_t$	Total quantity of baseline emissions during the reporting period	tCO <sub>2</sub> e	For each offset project	C	
Equation 5.1, Equation 5.7	$PE_t$	Total quantity of project emissions during the reporting period	tCO <sub>2</sub> e	For each offset project	C	
Equation 5.2, Equation 5.3	$BE_{refr}$	Total quantity of baseline emissions from refrigerant ODS	tCO <sub>2</sub> e	For each offset project	C	
Equation 5.2, Equation 5.4	$BE_{foam}$	Total quantity of baseline emissions from high-GWP blowing agent	tCO <sub>2</sub> e	For each offset project	C	

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
Equation 5.2, Equation 5.5	BE <sub>aer</sub>	Total quantity of medical aerosol ODS baseline emissions	tCO <sub>2</sub> e	For each offset project	C	
Equation 5.2, Equation 5.6	BE <sub>fs</sub>	Total quantity of fire suppressant ODS baseline emissions	tCO <sub>2</sub> e	For each offset project	C	
Equation 5.3, Equation 5.8	Q <sub>refr,i</sub>	Total quantity of refrigerant ODS <i>i</i> sent for destruction	tODS	For each offset project	M	
Equation 5.3	ER <sub>refr,i</sub>	10-year cumulative emission rate of refrigerant ODS <i>i</i>	0 - 1.0	N/A	R	See Table A.1
Equation 5.3, Equation 5.4, Equation 5.5, Equation 5.6,	GWP <sub>i</sub>	Global warming potential of ODS or HFC <i>i</i>	tCO <sub>2</sub> e/ tODS or tBA	N/A	R	See Tables A.1-A.4
Equation 5.4	EBA <sub>i</sub>	Total quantity of high-GWP blowing agent <i>i</i> extracted from foam and destroyed	tBA	For each offset project	C	
Equation 5.4	BA <sub>intf,i</sub>	Total quantity of high-GWP blowing agent <i>i</i> in intact foam sent for destruction	tBA	For each offset project	C	
Equation 5.4	ER <sub>i,j</sub>	10 year emission rate of high-GWP blowing agent <i>i</i> from application <i>j</i>	% (0-1)	N/A	R	See Table A.2
Equation 5.4	Q <sub>intf,i</sub>	Total weight of intact foam, <i>i</i> , with entrained high-GWP blowing agent sent for destruction	metric tons	For each offset project	M	
Equation 5.4	BA% <sub>intf,i</sub>	Mass ratio of high-GWP blowing agent, <i>i</i> , entrained in intact foam	% (0-1)	For each offset project	M	

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
Equation 5.5, Equation 5.9	$Q_{aer,i}$	Total quantity of medical aerosol ODS, $i$ , sent for destruction	tODS	For each offset project	M	
Equation 5.5	$ER_{aer,i}$	10-year cumulative emission rate of medical aerosol ODS $i$	0 - 1.0	N/A	R	See Table A.3
Equation 5.6, Equation 5.10	$Q_{fs,i}$	Total quantity of fire suppressant ODS, $i$ , sent for destruction	tODS	For each offset project	M	
Equation 5.6	$ER_{fs,i}$	10-year cumulative emission rate of fire suppressant ODS $i$	0 - 1.0	N/A	R	See Table A.4
Equation 5.7, Equation 5.8	$Sub_{refr}$	Total GHG emissions from substitute refrigerant	tCO <sub>2e</sub>	For each offset project	C	
Equation 5.7, Equation 5.9	$Sub_{aer}$	Total GHG emissions from substitute medical aerosols	tCO <sub>2e</sub>	For each offset project	C	
Equation 5.7, Equation 5.10	$Sub_{fs}$	Total GHG emissions from substitute fire suppressant	tCO <sub>2e</sub>	For each offset project	C	
Equation 5.7, Equation 5.11	$Tr\&Dest$	Total GHG emissions from ODS and high-GWP insulation foam/blowing agent transportation and destruction	tCO <sub>2e</sub>	For each offset project	C	
Equation 5.8, Equation 5.9, Equation 5.10	$SE_i$	Emission factor for substitute emissions of refrigerant, medical aerosol, or fire suppressant, $i$ , per Table 5.5	tCO <sub>2e</sub> / tODS destroyed	Per container	R	See Tables A.1, A.3, or A.4
Equation 5.11	$Q_{ODS}$	Total quantity of refrigerant, medical aerosol, and/or fire suppressant ODS sent for destruction	tODS	For each offset project	M/C	

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (c) Measured (m) Reference (r) Operating records (o)	Comment
Equation 5.11	Q <sub>BA</sub>	Total quantity of high-GWP blowing agent extracted from insulation foam and sent for destruction in the project	tBA	For each offset project	M/C	
Equation 5.11	Q <sub>inf</sub>	Total weight of intact foam, <i>i</i> , with entrained high-GWP blowing agent sent for destruction	Metric tons	For each offset project	M/C	
Equation 5.11	EF	Default emission factor for transportation and destruction of ODS or High-GWP Blowing Agent foam	tCO <sub>2</sub> e/ tODS/ tBA or t	N/A	R	-Equal to 7.5 metric tons CO <sub>2</sub> e per metric ton for refrigerant, medical aerosol, or fire suppressant projects and blowing agent extracted from high-GWP foam -Equal to 75 metric tons CO <sub>2</sub> e per metric ton for intact foam projects

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## 6.6. Other Monitoring Requirements – Quantification Methodology

This subchapter provides monitoring requirements in addition to the general requirements in subchapter 6.1.

- (a) When transporting intact high-GWP insulation foam, all recovered foam pieces must be placed in air-tight and water-tight storage until arrival at the destruction facility.
- (b) Projects using this Methodology to quantify emission reductions from extracted high-GWP foam blowing agent must meet all of the following requirements:
  - (1) The blowing agent must be extracted from the foam to a concentrated form prior to destruction.
  - (2) The extraction must occur under negative pressure.
  - (3) If the recovered blowing agent is not destroyed in an enclosed equipment de-manufacturing system, the recovered blowing agent must be collected, stored, and transported in containers meeting DOT standards for refrigerants.
  - (4) The processes, training, QA/QC, and management systems relevant to the collection, storage, and transport of the blowing agent must be documented.
  - (5) If the recovered blowing agent is destroyed in a destruction unit that is within an enclosed equipment de-manufacturing system, the blowing agent must be analyzed prior to destruction as specified in Appendix C.
- (c) Projects destroying high-GWP blowing agent from intact foam must follow the procedures in Appendix B. The project proponent must collect and maintain documentation showing conformance with the procedures in Appendix B.
- (d) Projects destroying refrigerant ODS, medical aerosol ODS, fire suppressant ODS, or extracted high-GWP foam blowing agent must follow the procedures in Appendix C. The project proponent must collect and maintain information showing conformance with the procedures in Appendix C.

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## 7. Verification Requirements

- (a) See the ACR Standard for guidance on project validation and verification requirements.
- (b) An ODS or high-GWP insulation foam offset project requires only one site visit regardless of the number of destruction events within that reporting period.
- (c) For the purpose of this Methodology, the site visit must include a visit to the destruction facility. The site visit may also include a visit to the project proponent's office(s) where all project-related documents and data were produced, managed, and retained. The site visit may also include a visit to any facility in the chain of custody, such as an aggregation facility or other point of origin.

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## Appendix A. Emission Factor Tables – Quantification Methodology

**Table A.1. Parameters for ODS Refrigerants**

ODS	100-yr Global Warming Potential (t CO <sub>2</sub> e/t ODS) (GWP <sub>i</sub> )	10-year Cumulative Emission Rate (%/10 years) ( $ER_{refr}$ )	Substitute Emissions (t CO <sub>2</sub> e/t ODS) ( $SE_i$ )
CFC-11	4,750	89%	223
CFC-12	10,900	95%	686
CFC-13	14,400	61%	7,144
CFC-113	6,130	89%	220
CFC-114	10,000	78%	659
CFC-115	7,370	61%	1,139
HCFC-22	1,810	72%	915

**Table A.2 Parameters for High-GWP Foam**

High-GWP Blowing Agent	100-yr Global Warming Potential (t CO <sub>2</sub> e/t ODS or BA) (GWP <sub>i</sub> )	Non-Building high-GWP blowing agent 10-year emission rate ( $ER_{i,j}$ )	Building high-GWP blowing agent 10-year emission rate ( $ER_{i,j}$ )
CFC-11	4,750	65%	51%
CFC-12	10,900	68%	54%
HCFC-22	1,810	80%	73%
HCFC-141b	725	68%	54%
HFC-134a	1,430	73%	51%
HFC-245fa	1,030	73%	51%

**Table A.3. Parameters for ODS Medical Aerosols**

ODS	100-yr Global Warming Potential (t CO <sub>2</sub> e/t ODS) (GWP <sub>i</sub> )	10-year Cumulative Emission Rate (%/10 years) ( $ER_{aer,i}$ )	Substitute Emissions (t CO <sub>2</sub> e/t ODS) ( $SE_i$ )
CFC-11	4,750	100%	152
CFC-12	10,900	100%	
CFC-113	6,130	100%	

**Table A.4. Parameters for ODS Fire Suppressants**

ODS	100-yr Global Warming Potential (t CO <sub>2</sub> e/t ODS) (GWP <sub>i</sub> )	10-year Cumulative Emission Rate (%/10 years) ( $ER_{fs,i}$ )	Substitute Emissions (t CO <sub>2</sub> e/t ODS) ( $SE_i$ )
Halon 1211	1,890	46%	3
Halon 1301	7,140	26%	89

**Table A.5 ODS Carbon Ratio and Density**

ODS	Carbon Ratio (CR <sub>i</sub> )	Density (g/cm <sup>3</sup> )
CFC-11	12/137	1.494
CFC-12	12/121	1.486
CFC-13	12/104	1.526
CFC-113	24/187	1.560
CFC-114	24/171	1.455
CFC-115	24/154	1.568
HCFC-22	12/87	3.66
HCFC-141b	24/117	1.25
Halon 1211	12/165	1.8



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Halon 1301	12/149	1.54
HFC-134a	12/90	4.25
HFC-245fa	12/134	5.84

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## **Appendix B. High-GWP Mass and Composition from Intact High-GWP Foam Projects – Quantification Methodology**

- (a) High-GWP foam must be destroyed intact following the procedures described in this appendix.
  - (1) The foam's mass shall be determined on scales at the destruction facility. The scales must be calibrated at least quarterly with a demonstrated accuracy of +/- 5% of reading.
  - (2) Prior to determining building foam mass, any construction debris (e.g., wood, metal, glass) or any other non-foam material shall be separated from the foam.
- (b) To determine the composition and mass ratio of the high-GWP foam blowing agent(s) present in the intact foam, the following sampling requirements apply:
  - (1) For foams sourced from buildings, at least two samples per building surface (e.g., wall, roof) must be taken;
  - (2) For foams sourced from walk-in coolers, refrigerated transport trailers, or refrigeration cases, one sample from each unit must be taken;
  - (3) For foams sourced from pipes or marine applications, one sample must be taken from one unit from which foam will be taken for purposes of destruction (i.e. for projects that will aggregate multiple pipe sections or multiple units from marine sources such as buoys, one sample is required for each source type).
  - (4) The samples must conform to all of the following requirements:
    - (A) Each sample must be at least 2 inches in length, 2 inches in width, and 2 inches thick;
    - (B) For storage and transport, each sample must be placed and sealed in a separate air-tight and water-tight container that is at least 2 millimeters thick;
    - (C) The analysis of high-GWP foam blowing agent content and mass ratio shall be performed at an independent laboratory unaffiliated with the project proponent. The analysis shall be done using one of the two following methods: (1) ASTM Method D 7132-05 Standard

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Test Method for Determination of Retained Blowing Agent in Extruded Polystyrene Foam or (2) the heating method to extract ODS blowing agent from the foam samples described in Scheutz *et al.* (2007). The Scheutz method must include all of the following steps:

- (1) Each sample shall be prepared to a thickness no greater than 1 cm, placed in a 1123 mL glass bottle, weighed using a calibrated scale, and sealed with Teflon-coated septa and aluminum caps;
- (2) To release the high-GWP blowing agent from the foam, the samples must be incubated in an oven for 48 hours at 140 degrees C;
- (3) When cooled to room temperature, gas samples must be redrawn from the headspace and analyzed by gas chromatography;
- (4) The lids must be removed after analysis, and the headspace must be flushed with atmospheric air for approximately 5 minutes using a compressor. Afterwards, septa and caps must be replaced and the bottles subjected to a second 48-hr heating step to drive out the remaining high-GWP blowing agent from the sampled foam; and
- (5) When cooled down to room temperature after the second heating step, gas samples must be redrawn from the headspace and analyzed by gas chromatography
- (5) The mass of high-GWP blowing agent(s) recovered shall then be divided by the total mass of the initial foam samples prior to analysis to determine the mass ratio of each high-GWP foam blowing agent present; and
- (6) For foams sourced from buildings, the results from all samples from a single building shall be averaged to determine the mass fraction of blowing agent in foam ( $BA\%_{\text{intf},i}$ ) used in Equation 5.4.

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## **Appendix C. Mass and Composition from Refrigerant, Medical Aerosol, Fire Suppressant and Extracted High-GWP Blowing Agent Projects – Quantification Methodology**

Prior to destruction, the precise mass and composition of ODS refrigerant, ODS medical aerosol, ODS fire suppression agent, and extracted high-GWP blowing agent must be determined.

- (a) For ODS and high-GWP blowing agent extracted into containers prior to destruction, the following analysis must be conducted:
- (1) Mass must be determined by individually measuring the weight of each container first when it is full prior to destruction and then after destruction is complete. The mass of ODS or high-GWP blowing agent and any contaminants is equal to the difference between the full and empty weight, as measured. To be eligible to receive ERTs, all of the following requirements must be met when weighing the containers:
    - (A) A single scale conforming with the requirements in (subchapter 6.3) of this Methodology must be used for generating both the full and empty weight tickets at the destruction facility;
    - (B) The full weight must be measured no more than 48 hours prior to commencement of destruction per the CEMS data, if available, or the Certificate of Destruction;
    - (C) The empty weight must be measured no more than 48 hours after the conclusion of destruction per the CEMS data, if available, or the Certificate of Destruction; and
    - (D) Each single compartment, cylinder, drum, or any other eligible ODS or high-GWP blowing agent container that has been identified and destined for destruction must be weighed separately, sampled separately, and treated as a separate destruction event.
    - (E) Recovery, collection, and aggregation activities may occur until the container has been identified and destined for destruction. After the ODS or high-GWP blowing agent container has been identified and

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destined for destruction, ODS or high-GWP blowing agent must not be added or removed, except for the purpose of sampling and analysis.

- (2) The following procedures must be applied for the full and empty weights required within 48 hours of both the commencement and conclusion of destruction, pursuant to subsections (a)(1)(B) and (a)(1)(C) in Appendix C of this Methodology:
  - (A) For containers permanently affixed to a detachable trailer:
    - (1) The trailer must be detached from its transportation vehicle, and the trailer must be weighed separately from its transportation vehicle;
    - (2) Any accessories, such as spare tires or tire chains, or any part of the trailer's load other than the ODS or high-GWP blowing agent which are included in the trailer's full weight prior to ODS or high-GWP blowing agent destruction must be included in the trailer's empty weight after destruction; and
    - (3) A container with a capacity over 1,000 pounds must be placed on the scale motionless for at least 3 minutes to allow the weight to stabilize before the weight measurement is recorded.
  - (B) For containers not permanently affixed to a truck or detachable trailer:
    - (1) Each container may be weighed by placing it individually on the scale prescribed in subsection (a)(1)(A) in Appendix C of this Methodology; and;
    - (2) A container with a capacity over 1,000 pounds must be placed on the scale motionless for at least 3 minutes to allow the weight to stabilize before the weight measurement is recorded.
  - (C) For containers weighed with the transportation vehicle included:

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- (1) The driver and any other passengers must exit the vehicle such that their weight is not included;
  - (2) Any accessories, such as spare tires or tire chains, or any part of the truck's load other than the ODS or high-GWP blowing agent which are included in the truck's full weight prior to ODS or high-GWP blowing agent destruction must be included in the truck's empty weight after destruction;
  - (3) If more than 1,000 pounds of ODS or high-GWP blowing agent is being transported for destruction, then the truck must be situated motionless on the scale for at least 3 minutes to allow the weight to stabilize before the weight measurement is recorded.
  - (4) The transportation vehicle's weight classification and load rating must be recorded;
  - (5) The transportation vehicle's fuel capacity must be recorded. Its fuel level at the time of each scale recording must also be recorded. Fuel level must be recorded in an increment of one eighth of the fuel tank capacity. If the fuel level is in between two increments, the fuel level prior to ODS or high-GWP blowing agent destruction must be rounded down and the fuel level after ODS or high-GWP blowing agent destruction must be rounded up;
  - (6) If the transportation vehicle's fuel level is lower after destruction than the fuel level before destruction, the difference in fuel weight must be subtracted, as applicable from  $Q_{\text{refr},i}$  in equations 5.3 and 5.6,  $EBA_{,i}$  and  $BA_{\text{intf},i}$  in equation 5.4,  $Q_{\text{aer},i}$  in equations 5.5 and equation 5.9,  $Q_{\text{fs},i}$  in equations 5.6 and equation 5.10, and  $Q_{\text{ODS}}$ ,  $Q_{\text{BA}}$ , and  $Q_{\text{intf}}$  in equation 5.11. The following fuel densities shall be used to adjust for weight:  
7.0851 lb/gal for diesel; or

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6.0023 lb/gal for gasoline; and

- (7) If different transportation vehicles are used to transport containers to a destruction facility and to pick up the empty containers after destruction, each transport vehicle shall be weighed both upon its arrival and departure from the destruction facility. If the vehicle transporting the full ODS containers to the destruction facility weighs more than the vehicle carrying the empty ODS containers from the facility, the weight discrepancy must be subtracted, as applicable from  $Q_{\text{refr},i}$  in equations 5.3 and 5.6,  $EBA_{,i}$  and  $BA_{\text{intf},i}$  in equation 5.4,  $Q_{\text{aer},i}$  in equations 5.5 and equation 5.9,  $Q_{\text{fs},i}$  in equations 5.6 and equation 5.10, and  $Q_{\text{ODS}}$ ,  $Q_{\text{BA}}$ , and  $Q_{\text{intf}}$  in equation 5.11.
- (3) Composition and concentration of ODS or high-GWP blowing agent must be established for each individual container by taking a sample from each container of ODS or high-GWP blowing agent and having it analyzed for composition and concentration at an AHRI-certified laboratory using the AHRI 700-2006 standard. The laboratory performing the composition analysis must not be affiliated with the project proponent. All of the following requirements must be met for each sample:
- (A) The sample must be taken while ODS or high-GWP blowing agent is in the possession of the company that will destroy the ODS or high-GWP blowing agent;
  - (B) Samples must be taken by a technician unaffiliated with the project proponent; if the destruction facility is the project proponent, an outside technician must perform this task;
  - (C) Samples must be taken with a clean, fully evacuated sample bottle that meets applicable DOT requirements with a minimum capacity of one pound;
  - (D) Each sample must be taken in liquid state;

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- (E) A minimum sample size of one pound must be drawn for each sample;
  - (F) Each sample must be individually labeled and tracked according to the container from which it was taken, and all of the following information recorded:
    - (1) Time and date of sample;
    - (2) Name of project proponent;
    - (3) Name of technician taking sample;
    - (4) Employer of technician taking sample;
    - (5) Volume of container from which sample was extracted; and
    - (6) Ambient air temperature at time of sampling; and
    - (7) Chain of custody for each sample from the point of sampling to the AHRI lab must be documented by paper bills of lading or electronic, third-party tracking that includes proof of delivery.
- (4) All project samples shall be analyzed using AHRI 700-2006 to confirm the mass percentage and identity of each component of the sample. The analysis shall provide:
- (A) Identification of the ODS or high-GWP blowing agent;
  - (B) Purity (%) of the ODS or high-GWP blowing agent mixture by weight using gas chromatography;
  - (C) Moisture level in parts per million. The moisture content of each sample must be less than 75% of the saturation point for the ODS or high-GWP blowing agent based on the temperature recorded at the time the sample was taken;
    - (1) For non-mixed ODS or high-GWP blowing agent, the saturation point is the saturation point of the major ODS or high-GWP blowing agent species;
    - (2) For mixed ODS or high-GWP blowing agent, the saturation point is the lowest saturation value of any species that makes up at least 10% of the composition;



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- (D) Analysis of high boiling residue, which must be less than 10% by mass; and
  - (E) Analysis of other ODS or high-GWP blowing agent in the case of mixtures of ODS or high-GWP blowing agent, and their percentage by mass.
- (5) If any of the requirements in sections (a)(1) through (a)(3) of this appendix are not met, no GHG reductions may be verified for ODS or high-GWP blowing agent destruction associated with that container.
  - (6) If a container holds non-mixed ODS or high-GWP blowing agent, no further information or sampling is required to determine the mass and composition of the ODS or high-GWP blowing agent. For non-mixed ODS or high-GWP blowing agent, the analysis conducted for the sample taken at the destruction facility must be used for quantifying GHG emissions.
  - (7) If the container holds mixed ODS or high-GWP blowing agent, the project proponent must meet all of the following additional requirements:
    - (A) The required sampling may be conducted at the final destruction facility or prior to delivery to the destruction facility;
    - (B) Circulation and sampling activities must be conducted by a contracted third-party and by individuals who have been properly trained for the functions they perform;
    - (C) The offset project documentation must specify the procedures by which mixed ODS or high-GWP blowing agent are analyzed;
    - (D) Prior to sampling, the ODS or high-GWP blowing agent mixture must be circulated in a container that meets all of the following criteria:
      - (1) The container has no solid interior obstructions;
      - (2) The container was fully evacuated prior to filling;
      - (3) The container must have sampling ports to sample liquid and gas phase ODS or high-GWP blowing agent;
      - (4) The sampling ports must be located in the middle third of the container (i.e., not at one end or the other); and

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- (5) The container and associated equipment can circulate the mixture via a closed loop system from the bottom to top;
- (E) If the original mixed ODS or high-GWP blowing agent container does not meet these requirements, the mixed ODS or high-GWP blowing agent must be transferred into a temporary holding tank or container that meets all of the above criteria. The weight of the contents placed into the temporary container shall be calculated and recorded. During transfer of ODS or high-GWP blowing agent into and out of the temporary container, ODS or high-GWP blowing agent shall be recovered to the vacuum levels required by the U.S. EPA for that ODS or high-GWP blowing agent (see 40 CFR 82.156);
- (F) Once the mixed ODS or high-GWP blowing agent is in a container or temporary storage unit that meets the criteria above, circulation of mixed ODS or high-GWP blowing agent must be conducted as follows:
- (1) Liquid mixture shall be circulated from the liquid port to the vapor port;
  - (2) A volume of the mixture equal to two times the volume in the container shall be circulated;
  - (3) Calculations converting between mass and volume shall use the densities provided in table A.5; if converting between mass and volume, the mixed ODS or high-GWP blowing agent must be in a liquid state;
  - (4) Circulation must occur at a rate of at least 30 gallons/minute; and
  - (5) Start and end times shall be recorded;
- (G) Within 30 minutes of the completion of circulation, a minimum of two samples shall be taken from the bottom liquid port, and both samples must be analyzed at an AHRI approved laboratory; and

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- (H) The project proponent must calculate the project GHG emission reductions using both sample results, and choose the sample resulting in the lower project emission reductions.
- (b) CFC-12 and HCFC-22 refrigerant and extracted high-GWP blowing agents destroyed in enclosed equipment de-manufacturing systems shall be analyzed using FTIR. FTIR shall be used to determine the mass of each ODS refrigerant and high-GWP blowing agent.

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## **Appendix D. Discussion and Rationale for Updates to CARB ODS Protocol**

The CARB ODS Protocol was first adopted in 2011 and subsequently revised in 2014. The CARB ODS Protocol is essentially a re-formatting of the 2011 CARB ODS Protocol with no major substantive changes. In turn, the 2011 CARB ODS Protocol, with some minor exceptions, is identical to the Climate Action Reserve (CAR) ODS Protocol which was first developed in 2008-2009 and approved in 2010. CAR released Version 2.0 of its Protocol in 2012 that included some minor clarifications, primarily related to point of origin documentation.

Consequently, all of the underlying information relevant to additionality, quantification, and monitoring in the CARB ODS Protocol trace back to data and other information from 2008-2009 or earlier, in sources that are cited in the 2010 CAR Protocol. In the nearly 7 years since, there have been a number of significant changes in underlying regulatory conditions, market dynamics, and baseline scenarios, and new technical data. These changes are summarized here for each of the major updates in this Methodology.

### **I. High-GWP Insulation Foam**

#### **A. Eligibility of High-GWP Blowing Agents**

The CARB ODS Protocol lists several ODS foam blowing agents that are eligible for destruction credits – CFC-11, CFC-12, HCFC-22, and HCFC-141b. These ODS were discontinued from use in foam applications beginning in 1996, and more recently in the case of HCFC-141b and HCFC-22, in 2003 and 2009, respectively. This Methodology adds two HFCs to the list of eligible blowing agents for foam destruction projects – HFC-134a and HFC-245fa.

These HFCs are in production in the U.S. for use in the manufacture of foam products, particularly appliance foam. However, destruction of foam recovered from end-of-life appliances does not trigger additional production of the HFC blowing agents beyond what would be produced anyway.

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At a macro-level, when an appliance reaches end-of-life, demand is created for the manufacture of a new replacement appliance. For example, the decision to purchase a new refrigerator-freezer, in general, is made when the old fridge is discarded. That decision at the consumer level translates to a decision at the manufacturing level to produce a new fridge. Today, the new fridge may be manufactured with insulation foam containing HFC-134a, HFC-245fa, or in some cases, a hydrocarbon-based blowing agent. Regardless of how the foam in the end-of-life appliance is discarded - shredded and landfilled (the baseline scenario), or incinerated in conformance with this Methodology - the same quantity of new blowing agent will be produced for use in a newly manufactured appliance. As is the case for ODS refrigerants and the other eligible ODS categories in this Methodology, destruction of CFC, HCFC, and HFC blowing agents therefore prevents greenhouse gas emissions that would otherwise occur under the baseline scenario (shredding and landfilling of the foam).

### **B. Eligibility of High-GWP Foam Sources**

In addition to the inclusion of new high-GWP foam blowing agents, this Methodology has been expanded to include additional foam sources. The CARB ODS Protocol only allows foam sourced from appliances or buildings. Based on industry communications and research conducted during the development of this Methodology, it was determined that there were no compelling reasons to exclude additional sources of high-GWP foam.

Therefore, the following sources have been added:

- Walk-in coolers,
- Refrigerated transport trailers,
- Refrigeration cases,
- Pipe-in-pipe/preformed pipe, and
- Marine applications.

### **C. Removing Project Disincentives**

Since inception of the ODS destruction protocols, there has not been a single project involving destruction of foam ODS under either the CAR or the ARB programs. The CAR

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and CARB ODS Protocols contain three major disincentives that account for the absence of projects:

1. large “discount” factors to the 10-year baseline emission rates for foam blowing agent,
2. inclusion of a “recovery efficiency” for blowing agents extracted and concentrated, and
3. complex and costly operational requirements for extraction and analysis of ODS blowing agent.

Additionally, any ODS blowing agent that is extracted from foam can be sold and re-used as refrigerant, for which there is substantial market demand.

### **1. Foam Baseline Emission Rates**

For quantification of baseline emissions of ODS from appliance foam, the CARB ODS Protocol relies on assumptions in the CAR ODS Protocol, Version 1 regarding the percentage of blowing agent that is released during: (a) foam shredding, (b) foam compaction, and (c) landfill decomposition.

The estimated release of ODS over the course of landfill decomposition of the remaining foam material was derived from a laboratory study (Scheutz et al., 2007) where pure ODS blowing agent was mixed in test tubes with simulated landfill material, and inoculated with anaerobic bacteria capable of digesting CFCs and HCFCs. As noted by the investigators, and recognized in the CAR ODS Protocol, this study was not intended to reflect real world conditions and yielded extremely high estimates for the amount of ODS that would be decomposed in an actual landfill. The following are some of the issues associated with the application of the Scheutz et al study:

- The idealized anaerobic conditions maintained in the laboratory test tubes would be unlikely in an active landfill;
- The “landfill” material in the study contained only shredder residue, rather than the diverse mix of solid waste in a typical municipal landfill; and,

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- In contrast to the simulated conditions in the experiments, actual landfills would not be biologically pretreated, and there would be larger quantities of landfill gas generated.

Based on a conservative reading of the laboratory study, the CAR ODS Protocol assumed that 35% of the CFC-11 blowing agent remaining in the landfilled material would be released in the landfill, and that 95% of that CFC-11 would undergo anaerobic degradation in landfills. This resulted in an estimate that 1% ( $0.35 * (1-.95)$ ) of the CFC-11 blowing agent in landfilled appliance foam would be released to the atmosphere. When added to the contributions from shredding and compaction (24% + 19%, respectively), the CAR ODS Protocol estimates for the baseline that a total of 44% of CFC-11 in appliance foam would be released to the atmosphere.

In its Protocol, CAR recognized that there is considerable uncertainty regarding the extent of anaerobic degradation of ODS foam blowing agents in U.S. landfills (p.23, CAR, 2010<sup>7</sup>).

More recently, a German research institute (RUK Ingenieurguppe, 2012)<sup>8</sup> subjected the assumptions made by Scheutz et al. to experimental and computational checks and concluded the following:

- Scheutz et al. 2007 assumed that the half-life of the anaerobic degradation of R-11 was ten times longer than that indicated by the laboratory experiments;
- A value of 5% for the percentage of CFC-11 that would not undergo anaerobic degradation is only justified for the kind of “mono-landfill” investigated by Scheutz et al. that generates very small quantities of landfill gas. Only in very rare cases will the type of mono-landfill assumed in the CAR ODS Protocol provide an adequate representation of baseline emissions; and

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<sup>7</sup> Climate Action Reserve, U.S. Ozone Depleting Substances Project Protocol, February 3, 2010.

<sup>8</sup> Landfill behaviour of CFCs in foams recovered from end-of-life refrigeration equipment – Application of results to specific waste disposal scenarios. Ingenieurguppe RUK on behalf of RAL Quality Assurance Association for the Demanufacture of Refrigeration Equipment (March 2012).

- The value assumed for the percent of ODS blowing agent degraded should reflect the particular type of landfill under consideration.

For this Methodology, the 2012 study by RUK Ingenieurguppe is incorporated to update both the release rates and the degradation rates of blowing agents in landfilled foam.

### Release Rates

The Scheutz et al. (2007) study modeled two diffusion rate coefficients to analyze the sensitivity of this factor in predicting the fraction of blowing agent that would be released in landfilled foam. The CAR ODS Protocol, Version 1.0 used only the lower bound result from the Scheutz et al. modeling (35% of R-11 released from landfilled foam). The more recent assessment by RUK Ingenieurguppe indicates that the extreme conditions and assumptions in the Scheutz et al. paper should be adjusted to reflect real-world conditions. Consequently, this Methodology considers the range of diffusion rate coefficients, and the resulting calculations from Scheutz, to be comparably plausible estimates. Thus, the midpoint of the ranges in Table 3 of the Scheutz et al. paper are used, summarized below:

**Table E.1 Summary of results from Table 3 of Scheutz et al. (2007)**

Percentage of blowing agent released from landfilled foam	CFC-11	HCFC-141b	CFC-12	HCFC-22
Lower Bound (%)	35	41	52	100
Upper Bound (%)	83	91	98	100
Mid-Point (%)	59	66	75	100

### Degradation Rates

RUK Ingenieurguppe calculated R-11 landfill degradation rates for a range of solid-waste disposal sites representing a range of climate zones. The re-calculated degradation rates are based on case studies using the landfill gas forecasting model used in CDM and JI projects, approved by the UNFCCC.



**Table E.2 Recalculated degradation rates for solid waste disposal in various climate zones**

Location	Climate Zone	Percent of released CFC-11 blowing agent not degraded in anaerobic landfill conditions
Europe: Central, without biological pre-treatment	Wet temperate	83.6%
Europe: Northern	Wet temperate	64.2%
Asia: South-central	Moist and wet tropical	62.9%
Africa: Southern	Wet temperate	61.9%
America: Central	Dry tropical	55.2%
Asia: Western & Middle East	Dry temperate	48.3%
Minimum: mono-landfill for shredder waste	(no relevant influence)	5.0%

Since the UNFCCC landfill modeling was developed for CDM/JI projects, the RUK Ingenieurguppe analysis does not present factors specific to the United States. However, the range of geographic regions in the U.S. are fairly represented by the range of case study locations used, and therefore it would be reasonable to use the range of factors listed above (48.3-83.6%) to reflect the range in U.S. landfill conditions, with the mid-point of this range (66%) a good estimate for the average U.S. landfill.

The RUK Ingenieurguppe analysis did not calculate degradation rates for the other ODS blowing agents; here we assume the same rate (66%) as calculated for R-11.

Lastly, this Methodology corrects an error in how the original CAR ODS 1.0 Protocol, Version 1.0 derived the total amount of blowing agent released to the atmosphere throughout the end-of-life processing. This error resulted in incorrect blowing agent emission rates that propagated through to the CARB ODS Protocol. The CAR ODS Protocol, Version 1.0 derived the emission rates for the different blowing agents using the following formula:

$$BA_{TE} = BA_S + BA_C + (BA_L * BA_{NDL})$$

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where:

$BA_{TE}$  = Percentage of blowing agent emitted to the atmosphere throughout end-of-life processing of foam

$BA_S$  = Percentage of blowing agent emitted to atmosphere during shredding of appliance foam

$BA_C$  = Percentage of blowing agent emitted to atmosphere during compaction of appliance or building foam

$BA_L$  = Percentage of remaining blowing agent in landfilled foam released into landfill

$BA_{NDL}$  = Percentage of released blowing agent not degraded in anaerobic landfill conditions

Emissions from shredding of appliance foam were factored into the calculations but building foam is not typically shredded prior to being landfilled and therefore shredding was not included for building foam. For R-11 in appliance foam, using the modeling from the Scheutz et al. (2007) paper, the above formula yielded the following calculation:

$$BA_{TR} = 24\% + 19\% + (35\% * 5\%) = 44\%$$

However, the correct formula would be:

$$BA_{TE} = BA_S + BA_C + [(((1 - (BA_S + BA_C)) * BA_L) * BA_{NDL})]$$

where:

$BA_{TE}$  = Percentage of blowing agent emitted to atmosphere from landfilled foam

$BA_S$  = Percentage of blowing agent emitted to atmosphere during shredding

$BA_C$  = Percentage of blowing agent emitted to atmosphere during compaction of appliance or building foam

$BA_L$  = Percentage of remaining blowing agent in landfilled foam released in landfill

$BA_{NDL}$  = Percentage of released blowing agent not degraded in anaerobic landfill conditions

The following illustrates the emission rate calculation for R-11 from appliance foam using

the corrected formula and the updated estimates discussed above for the percentage of remaining blowing agent in landfilled foam that is released into the landfill, and the percentage of the blowing agent released into the landfill that is not degraded:

$$R-11_{TR} = 24\% + 19\% + [(((1 - (24\% + 19\%)) * 59\%) * 66\%)] = 65\%$$

Using the corrected equation and updated release and degradation factors, emissions of all of the eligible blowing agents from landfilled foam are listed below.

Scheutz et al. (2007) did not add HFC-134a or HFC-245fa to the “microcosm” bottles in their experiments and therefore the degradation rates for these appliance foam blowing agents were not modeled. By comparing the Henry Law constant for HFC-134a (2.04) to the other blowing agents (e.g., 3.96 for CFC-11; 14.02 for CFC-12; 0.9 for HCFC-141b; 1.66 for HCFC-22), we can approximate that the percentage released into landfill and the percentage emitted for HFC-134a is approximately mid-way between those of CFC-11 and HCFC-22. For purposes of this Methodology, it will be assumed that the degradation rates and overall emission rates for HFC-134a and HFC-245fa are midway between the range derived for the ODS blowing agents, i.e., 73%.

One additional note is that in the U.S. EPA Vintaging Model, all of the blowing agent in appliance insulation foam is emitted to the atmosphere when the appliances are disposed (Goodwin et al.).

**Table E.3 Emission Rates for Blowing Agents in Non-Building and Building Foam in Baseline Scenario**

High-GWP Blowing Agent	Non-Building high-GWP blowing agent 10-year emission rate (ER <sub>f,i</sub> )	Building high-GWP blowing agent 10-year emission rate (ER <sub>f,i</sub> )
CFC-11	65%	51%
CFC-12	68%	54%
HCFC-22	80%	73%
HCFC-141b	68%	54%

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HFC-134a	73%	51%
HFC-245fa	73%	51%

## **2. High-GWP Foam Emissions Reduction Quantification**

In addition to the changes regarding emission rates discussed above, this Methodology significantly simplifies the process of emission reduction quantification for high-GWP foam projects that extract blowing agents. The CARB ODS Protocol requires the calculation of a recovery efficiency which has been removed as it was unnecessary to accurately determine baseline emissions for blowing agents that are extracted and concentrated. The concept of recovery efficiency was also applied in the determination of foam project emissions. In addition, the deduction for project emissions associated with blowing agent released during processing has been removed as it was highly punitive in nature. The quantification mechanism employed to determine “processing” emissions was highly uncertain and contributed significantly to the disincentives for high-GWP foam destruction projects.

## **3. High-GWP Foam Blowing Agent Concentration and Analysis**

This Methodology preserves the ability of a project proponent to extract high-GWP blowing agents, containerize them, and have the constituents analyzed just as any refrigerant, medical aerosol, or fire suppressant ODS destruction project. However, it is highly unlikely, due to cost and complexity, that this method will be employed in practice. To that end, the Methodology includes provisions for the destruction of extracted blowing agents in enclosed equipment de-manufacturing systems. Recently, new equipment de-manufacturing technologies have been introduced that allow for a closed loop process where blowing agents are extracted and destroyed in enclosed systems. These systems are capable of real time analysis of constituent gases as well as the determination of total volumes destroyed over selected time frames. The Methodology includes requirements for the necessary continuous monitoring and maintenance of these systems.

## II. HCFC-22 Refrigerant (R-22)

The CAR and CARB ODS Protocols excluded R-22 as an eligible refrigerant for destruction credits because when the CAR Protocol was developed in 2008-2009, R-22 production in the U.S. was not controlled.<sup>9</sup> Beginning in 2010, the phaseout of R-22 began in the U.S. under the U.S. Clean Air Act. As of January 1, 2010, production and import of R-22 was banned except for servicing equipment manufactured before January 1, 2010.

Newer equipment manufactured after January 1, 2010 must be serviced with reclaimed R-22 refrigerant. To service older equipment, the U.S. EPA has issued annual production and import consumption<sup>10</sup> allowances, with a declining cap, to 21 companies, including chemical producers and equipment manufacturers. EPA has developed its annual allocations based on precise calculations of the servicing needs of the industry.<sup>11</sup> These allocations will continue through 2019. On January 1, 2020, all production and import of R-22 will end in the U.S.

**Table E.4. EPA's Annual R-22 Consumption Allowances Relative to Baseline<sup>12</sup>**

Year	% of Baseline
2009	100
2010	41.9
2011	32.0
2012	17.7
2013	18.0
2014	14.2
2015	7.0
2016	5.6
2017	4.2

<sup>9</sup> Destruction credits for HCFC-22 foam blowing agent was allowed because its use in the U.S. as a blowing agent ended as of March 1, 2008.

<sup>10</sup> Consumption = (Production + Imports) - Exports

<sup>11</sup> US EPA (2013) "The U.S. Phaseout of HCFCs: Projected Servicing Needs in the U.S. Air-Conditioning, Refrigeration, and Fire Suppression Sectors, Updated for 2015 to 2025. Prepared for US EPA, with support from ICF International.

<sup>12</sup> 40 CFR 82.16

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2018	2.8
2019	1.4
2020	0

### **A. Additionality of R-22 Destruction**

First, as is the case for CFCs, there is no requirement for destruction of R-22 in the U.S.

Second, as also is the case for CFC refrigerants, under business as usual, all R-22 currently in equipment will either leak, or be recovered for re-use in other leaky equipment. As a result, all R-22 that has been produced will ultimately be released to the atmosphere.

The question is whether destruction of R-22 would trigger *new* production and therefore have no net benefit.

This Methodology enables offset credits from destruction of R-22 only under the condition that the R-22 is recovered from refrigeration or air conditioning equipment and that equipment is subsequently de-commissioned as part of the project. Destruction of R-22 stockpiles is not eligible for offset credits. Because of the hard caps established by EPA, destruction of R-22 recovered from retired equipment cannot trigger any additional production or importation:

- Manufacture of new equipment containing R-22 is prohibited; the retired equipment would be replaced with new equipment containing alternative refrigerants such as HFCs, HFOs, hydrocarbons, ammonia, or CO<sub>2</sub>;
- Removal of R-22 from the “national inventory” via destruction could not be replaced by new production or import, but it would increase incentives for recovery and recycling/reclamation of remaining sources of R-22.

There is no expected adverse impact in terms of affecting the market availability of R-22 needed for servicing older equipment. Any destruction would be done on a voluntary basis to accelerate the retirement of older equipment. Companies with annual consumption allowances can be expected to maximize the quantities of R-22 that they produce and/or

import to build up inventories for future needs, regardless of how much R-22 is destroyed.

### B. R-22 Emission Rate

This Methodology uses the same baseline emission rates for CFC refrigerants that were calculated in the CAR ODS Protocol, Version 2.0. Also, the same approach is used here to calculate the baseline emission rate for R-22. Table E.5 summarizes the calculation of the 10-year emission rate for R-22 from refrigeration and air conditioning equipment. Recent data and modeling assumptions from the U.S. EPA and the CARB<sup>13</sup> are incorporated.

**Table E.5 2015 Weighted Average Annual Loss Rate Percent and Market Share for R-22**

Refrigeration and A/C Sector	HCFC-22 Market Share <sup>a</sup>	HCFC-22 Annual Loss Rate <sup>b</sup>
Mobile	-	-
Large Refrigeration	17%	27%
Large A/C	83%	5%
Market-Weighted Annual Loss Rate	12.1%	
10-year Total Loss	72%	

<sup>a</sup> Calculated from U.S. EPA data on average charge sizes for commercial A/C, chillers, retail food refrigeration, cold storage, and industrial process refrigeration systems and U.S. Department of Energy data on commercial buildings in the U.S.

<sup>b</sup> From U.S. EPA Vintaging Model and CARB data on refrigeration and air conditioning leak rates in California facilities.

### C. R-22 Substitute Emissions

For this Methodology, ACR is using the same technique to calculate R-22 project emissions as used by the CAR in establishing project emissions for other ODS refrigerants. The GHG emissions of substitute refrigerants associated with project scenario emissions are estimated using Equation 5.8. The approach is based on the fact

<sup>13</sup> CARB (2009) California Facilities and Greenhouse Gas Emissions Inventory; High-Global Warming Potential Stationary Source Refrigerant Management Program. Research Division, October, 2009.

that by removing ODS refrigerant through destruction projects – including R-22 - from the re-sale market, substitute refrigerants will be required to fulfill demand in the U.S. for refrigeration and air conditioning. The impacts of these substitute refrigerants are calculated for different end-use categories based on leak rates, relative charge sizes, and the proportion of R-22 used, as modeled by the U.S. EPA Vintaging Model.

**Table E.6. Calculation of Substitute Emissions for R-22**

Application	R-22 Market Share of Recharge	R-22 Substitute	Market Share Relative to Subsector (by weight)	Overall R-22 Market Share	GWP	Relative Charge Size (lb Sub/lb ODS)	Sub Used to Replace One lb R-22 (lbs)	Loss Rate of Sub (%/yr)	10-yr lbs CO <sub>2</sub> e/ODS destroyed
Large Refrigeration	0.32	R-404A	35%	11.23%	3922	0.78	0.088	11%	236.35
		R-410A	5%	1.60%	2088	0.88	0.014	5%	11.82
		R-507A	35%	11.23%	3985	0.78	0.088	12%	251.77
		R-407C	8%	2.57%	1774	0.78	0.020	2%	6.50
		HFC-134a	15%	4.81%	1430	1.4	0.067	18%	83.08
		CO <sub>2</sub>	2%	0.64%	1	1	0.006	2%	0.00
Large A/C	0.68	HFC-134a	85%	57.74%	1430	1.4	0.808	3%	303.50
		R-407C	10%	6.79%	1774	0.76	0.052	2%	16.75
		R-410A	5%	3.40%	2088	0.76	0.026	1%	5.15
		<b>R-22-Sub Emissions (lbCO<sub>2</sub>e/lbR-22 destroyed)</b>							

### III. ODS Fire Suppressants

#### A. Atmospheric Impacts and Applications of Halons and Substitutes

Like CFCs and HCFCs, halon fire suppressants are controlled under the Montreal Protocol. Halons contain bromine, which is many more times effective at destroying ozone than chlorine.



**Table E.7 Lifetime, ODP and GWP for various ODS Species**

ODS Species	Atmospheric Lifetime (yrs)	Ozone Depletion Potential <sup>14</sup>	100-year Global Warming Potential <sup>15</sup>
CFC-11	45	1	4,750
CFC-12	100	0.82	10,900
CFC-113	85	0.85	6,130
CFC-114	300	0.58	10,000
CFC-115	1,700	0.5	7,370
HCFC-22	12	0.04	1,810
HCFC-141b	9.3	0.12	725
HCFC-142b	17.9	0.06	2310
Halon-1211	16	7.9	1890
Halon-1301	65	15.9	7140

Because of their high ozone depleting potentials, halons were phased out of production in the U.S. as of January 1, 1994, prior to CFCs. Halons were excluded from the list of eligible ODS from the CAR and CARB ODS Protocols. At the time the CAR ODS Protocol was developed, halon production had not yet been phased out globally. As of January 1, 2010, halon production in developing countries ended.

Halon 1211 is contained in older portable “streaming” fire extinguishers, and halon 1301 is contained in older “total flooding” systems ranging in size from large computer rooms, bank vaults, libraries, oil and gas extraction facilities and submarines, to the engine nacelle on jets. (HTOC, 2006). There are a number of alternative non-ODS fire suppression agents now in wide use, many with significantly lower GWPs (e.g., water mist, CO<sub>2</sub>, nitrogen, fluoroketone) compared to halons, while others have comparable GWPs (HFC-227ea, HFC-236fa).

As of a decade ago, 75% of original halon use had been switched to agents with little or no climate impact; 4% of the original halon applications continued to employ halons. Most of the remaining 21% had been switched to HFCs and to a limited extent, PFCs (IPCC/TEAP, 2006).

<sup>14</sup> Ozone Depletion Potentials from the World Meteorological Organization, Scientific Assessment of Ozone Depletion: 2010, Global Ozone Research and Monitoring Project – Report No. 52, 2011.

<sup>15</sup> Direct GWPs from IPCC Fourth Assessment Report, Working Group I: Chapter 2

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Table E.8 lists the GWPs of ODS fire suppression agents and their substitutes.

**Table E.8:** ODS Fire Suppression Agents and Substitutes

ODS Agent	GWP	Non-ODS Alternative	GWP
Halon 1211	1860	HFC-23	14,310
Halon 1301	7030	HFC-227ea	3,350
HCFC Blend B	650	HFC-125	3,170
		HFC-236fa	9,500
		Dry chemical	1 <sup>16</sup>
		CO <sub>2</sub>	1
		FK-5-1-12	<1
		Inert Gas	0
		Water mist	0

### **B. Conditions for Halon Destruction Credits and Additionality**

This Methodology enables offset credits for destruction of halons recovered from fire suppression equipment under the condition that the equipment is subsequently decommissioned as part of the project. Similar to R-22 refrigerant, destruction of halons recovered from end-of-life equipment will have the following impacts:

- Prevention of the inevitable emissions of halons from the older equipment via leaks, testing, accidental discharges, or release during fire extinguishing; and
- Incentivization of the continued transition to safe and effective halon alternatives, including many with little or no climate impact.

Destruction of halons under the conditions specified in the Methodology meets the additionality criteria because:

- As is the case for refrigerants, halons recovered from end-of-life equipment can be expected to be re-used to recharge other older equipment and systems. While fire suppression equipment is typically well maintained and monitored, releases occur during testing, transfers, and accidental discharges. The intended use of these agents is for release in the event of a fire or explosion. Ultimately, these agents are emitted.

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<sup>16</sup> Dry chemical in some cases releases CO<sub>2</sub>

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- There is no requirement in the U.S. that halons recovered from equipment be destroyed; and
  - Destruction of the halons will not trigger any additional halon production because of the complete phaseout of halons worldwide.

### **C. Halon Stockpiles**

This Methodology does not allow credits for destruction of halon 1301 stockpiles because whatever remaining halon 1301 stockpiles exist likely include strategic reserves that are being maintained for fire suppression systems in aviation, shipping, oil and gas, computer rooms, and other critical applications.<sup>17</sup> Even though all projects under this Methodology would be voluntary activities, there is concern that the potential availability of carbon offset credits would incentivize premature destruction of important halon 1301 stockpiles.

### **D. Emission Rates**

The US EPA Vintaging Model uses data on annual production, import, and export of different ODS along with information on installed equipment in the US to derive emission rates (Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, April 2008, Annex 3.8 Methodology for Estimating HFC and PFC Emissions from Substitution of Ozone Depleting Substances<sup>18</sup>). In the EPA Vintaging Model, streaming systems (portable extinguishers) emissions are assumed to be 2 percent of all chemical in use in each year, while in flooding systems 1.5 percent of the installed base of chemical is assumed to leak annually.<sup>19</sup>

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories cites a study that indicates average annual emissions from installed flooding systems are in the range of 1

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<sup>17</sup> As of a decade ago, stockpiles of halon 1211 for portable fire extinguishers were maintained in lesser quantities (HTOC, 2006).

<sup>18</sup> <http://www.epa.gov/climatechange/emissions/usinventoryreport.html>

<sup>19</sup> Godwin et al. Modeling Emissions of High Global Warming Potential Gases

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to 3% (Verdonik and Robin, 2004)<sup>20</sup>, and cites a range of emissions rates between 2 and 6% per year for halon 1211 portable extinguishers (HTOC, 2003).<sup>21</sup>

Neither of these sources account for the halon losses during accidental releases, system testing, and system deployment for actual fires or explosions. To account for these periodic releases, and without revising the standard approach for GHG methodologies that quantify GHG emission reductions within a 10-year crediting period, this Methodology proposes to use the upper ends from the above ranges, i.e., 3% per year for flooding systems and 6% per year for portable extinguishers. An alternative approach would be to either: 1) use a 10-year GWP to reflect the climate impacts within the 10-year crediting period; or 2) use a 100% emission rate to account for the fact that halons in fire suppression systems will eventually be released under business as usual.

#### **E. Halon Substitute Emissions**

Halon substitute emissions for the halon destruction project scenarios are calculated in Tables E.9 and E.10 using the same approach as used for the ODS refrigerants in the CAR ODS Protocol, Version 2.0 and also used for R-22 substitutes in Section II.C in this Appendix. Substitute emissions for halon 1211 and halon 1301 are based on the average market share of substitutes, their emission rates and relative charge sizes as specified in the EPA Vintaging Model. Market share of HFC-based fire suppressants are adjusted downward to account for proposed restrictions under the U.S. EPA SNAP program that will gradually phase-out use of HFC fire suppressants, as has been done for HFC refrigerants. Similarly, market share of HCFC-based fire suppressants are adjusted to account for the ongoing HCFC phaseout in the United States.

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<sup>20</sup> Verdonik, D.P. and Robin, M.L. (2004). Analysis of Emission Data, Estimates, and Modelling of Fire Protection Agents, Proceedings of the Earth Technology Forum, Washington, DC, 2004.

<sup>21</sup> UNEP-HTOC (2003). Assessment Report of the Halons Technical Options Committee, Report for the United Nations Environment Programme, Ozone Secretariat, Nairobi, Kenya, <http://www.ozonelog.org>

**Table E.9. Calculation of Substitute Emissions for Halon 1211**

HALON 1211 DESTRUCTION PROJECT EMISSIONS									
Application	Halon 1211 Market Share	Halon 1211 Substitute	Market Share Relative to Subsector (by weight)	Overall Halon 1211 Market Share	GWP	Relative Charge Size (lb Sub/lb ODS)*	Sub Used to Replace One lb Halon 1211 (lbs)	Loss Rate of Sub (%/yr)	10-yr lbs CO <sub>2</sub> e/Halon destroyed
Streaming Fire Suppression	5%	HFC-236fa	2%	0.1%	9500	0.5	0.000	6.0%	2.12
		HFC Blend B (Halotron)	5%	0.3%	650	1	0.003	6.0%	0.75
		Non-ODP/GWP	93%	4.7%	0	1	0.047	6.0%	0.00
Halon 1211 Sub Emissions (lb CO <sub>2</sub> e/lb Halon 1211 destroyed)									2.87

**Table E.10 Calculation of Substitute Emissions for Halon 1301**

HALON 1301 DESTRUCTION PROJECT EMISSIONS									
Application	Halon 1301 Market Share	Halon 1301 Substitute	Market Share Relative to Subsector (by weight)	Overall Halon 1301 Market Share	GWP	Relative Charge Size (lb Sub/lb ODS)*	Sub Used to Replace One lb Halon 1301 (lbs)	Loss Rate of Sub (%/yr)	10-yr lbs CO <sub>2</sub> e/Halon destroyed
Total Flooding Fire Suppression	4%	HFC-23	0.10%	0.00%	14,310	1.3	0.001	3.0%	4.91
		HFC-227ea	9%	0.36%	3350	0.6	0.053	3.0%	46.33
		FK-5-1-12	7%	0.28%	1	1.0	0.070	3.0%	0.02
		HFC-125	5%	0.20%	3170	0.8	0.039	3.0%	32.63
		C4F10	1%	0.02%	8860	0.4	0.002	3.0%	4.89
		Non-ODP/GWP	78%	3.14%	0	1.0	0.784	3.0%	0.00
Halon 1301 Sub Emissions (lb CO <sub>2</sub> e/lb Halon 1301 destroyed)									88.78

**IV. Medical Aerosol ODS**

**A. CFC Phaseout**

Under the Montreal Protocol “essential use nominations” program, limited production of CFCs was authorized in the U.S. and other countries for use as the propellant in metered dose inhalers (MDIs), which are relied upon by asthmatics. Essential use production in the U.S. was gradually phased out as the Food and Drug Administration approved CFC-free products, including HFC-propelled MDIs, dry powder inhalers, and oral medications. As of January 1, 2012, all production and import of CFCs in the U.S. for MDIs ended, and on January 1, 2013, sale of CFC-based inhalers ended in the United States. With the exception of Russia and China, the rest of the world has also ended production and consumption of CFC MDIs.

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## **B. Additionality of Destruction of U.S. Inventories**

Some of the CFCs that had been produced under the essential use nominations in the U.S. before 2012 have never been used. The resulting stockpile is eligible for export and sale for use in MDIs in countries that have been granted essential use exemptions from the Parties to the Montreal Protocol. According to the Montreal Protocol Medical Technical Options Committee of the Technology and Economics Assessment Panel, there will be no additional import or production of CFCs in other countries beginning in 2016 (TEAP, 2015<sup>22</sup>) but there may be continuing essential use allocations for import or limited production of CFCs for MDIs in China, pending approval by the Parties to the Montreal Protocol (TEAP, 2015).

The essential use nominations and production allocations are fixed quantities based on projected demand and the status of the transition to CFC-free alternatives (TEAP, 2014). Even if CFC production is approved for China in 2016, Chinese companies can be expected to maximize the quantities of pharmaceutical grade CFC that it produces and/or imports to build up inventories, regardless of any CFCs that are destroyed. In other words, if some of the existing CFC stockpiles are destroyed, there would be no new, compensatory CFC production.

If essential use exemptions continue to be granted, under business as usual, the U.S. CFC stockpile will be sold for use, and eventually released to the atmosphere. In contrast, under the alternative “project” scenario, the CFCs would be destroyed. Under this baseline, the destruction would prevent direct GHG emissions, and result in increased use of CFC-free alternative products including HFCs and dry powdered aerosols.

Medical aerosols destroyed before 2012 when the U.S. phased out all essential use exemptions would not be eligible for offset credits.

## **C. Emission Rates**

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<sup>22</sup> Progress Report of the Technology and Economic Assessment Panel, UNEP, June 2015.

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The CFC and HFC propellants in MDIs provide the chemical energy to deliver medication into patients' airways. With each discharge, the propellant is emitted and eventually reaches the atmosphere. MDIs typically are discarded with a remaining "heel" of propellant, but these spent inhalers are typically crushed at the landfill releasing whatever heel is left. The EPA Ventaging Model assumes that for aerosol propellants, all emissions occur when the product is used. For purposes of this Methodology, it is assumed that 100% of the CFC (baseline scenario) and HFC (project scenario) propellants used as medical aerosols are emitted to the atmosphere within the 10-year crediting period.

#### **D. CFC Substitute Emissions**

In response to the Montreal Protocol phaseout of CFCs, the pharmaceutical industry, with oversight from the U.S. Food and Drug Administration, developed CFC-free formulations to serve asthmatics and other patients with chronic respiratory disease. Following extensive safety studies and engineering innovations, two HFC propellants were approved – HFC-134a and HFC-227ea – for use in MDIs in the United States. The ban on CFCs has also spurred new dry powder technology and other classes of specialty inhalers.

If remaining stockpiles of medical aerosol CFCs are destroyed in the U.S., there would be commensurate additional production and use of alternative propellants to meet overall patient needs. China is the only country that is still authorized to produce CFCs for CUEs; it can therefore be assumed that the additional production of substitute propellants and resulting emissions would occur in China.

For purposes of this Methodology, it is assumed that additional production of propellants, and atmospheric emissions, will be divided amongst HFC-134a and HFC-227ea according to their current market share in the United States for use in MDIs. Table E.12 provides the calculations of emissions of the CFC substitutes associated with destruction

of CFC medical aerosols. U.S. market shares for CFC-substitute propellants used in MDIs along with their GWPs are derived from Tope (2015)<sup>23</sup>.

**Table E.12 Medical Aerosol Substitute Emissions**

Application	CFC Market Share	CFC Substitute	Market Share Relative to Subsector (by weight)	Overall CFC Market Share	GWP	Relative Charge Size (lb Sub/lb ODS)	Sub Used to Replace One lb CFC (lbs)	Loss Rate of Sub (%/yr)	10-yr lbs CO <sub>2</sub> e/ODS destroyed
Asthma Inhalers	10%	HFC-134a	95%	9.50%	1430	1	0.095	100%	135.85
		HFC-227ea	5%	0.5%	3320	1	0.005	100%	16.60
		<b>CFC-Sub Emissions (lb CO<sub>2</sub>e/lb CFC destroyed)</b>							

<sup>23</sup> Tope (2015) Montreal Protocol Technology and Economics Assessment Panel, Workshop on HFC Management, Technical Issues, April 21, 2015