# DRAFT Ozone Depleting Substances Initiative Protocol

## Destruction of Ozone Depleting Substances Used as Foam Blowing Agents and Refrigerants

## *Protocol Version*

*[Draft]*

# Table of Contents

# List of Tables

# List of Figures

# List of Equations

# Abbreviations and Acronyms

| | |
|---|---|
| A/C | Air conditioning |
| Aggregation | Grouping together multiple containers of ODS |
| AHRI | Air-Conditioning, Heating and Refrigeration Institute |
| CEMS | Continuous emissions monitoring system |
| COD | Certificate of Destruction |
| CFC | Chlorofluorocarbons |
| $CH_4$ | Methane |
| $CO_2$ | Carbon dioxide |
| DRE | Destruction and removal efficiency |
| GHG | Greenhouse gas |
| GJ/h | Gigajoule per hour |
| GWP | Global Warming Potential |
| HBFC | Hydrobromofluorocarbons |
| HLC | Halocarbon |
| HCFC | Hydrochlorofluorocarbons |
| HFC | Hydrofluorocarbons |
| HWC | Hazardous waste combustor |
| K | Kelvin |
| Kg | Kilogram |
| kPa | Kilopascal |
| L | Litres |
| Mg | Mega gram (1,000,000 grams or one tonne, or “t”) |
| MOECC | Ontario Ministry of Environment and Climate Change |
| MSW | Municipal Solid Waste |
| $m^3$ | Cubic metres |
| ODS | Ozone depleting substances |
| SSR | Source, sink, and reservoir |
| t | Metric ton (or tonne) |

# 1 Introduction

This protocol sets out the requirements that will enable a sponsor to undertake an ozone depleting substances (ODS) greenhouse gas (GHG) reduction initiative for the purpose of registering and receiving offset credits in Ontario's cap and trade program.

The following sections outline the definition of an ODS GHG reduction initiative, the specific eligibility criteria, baseline scenario and initiative calculation methods, monitoring, data management and reporting requirements that apply to ODS GHG reduction initiatives.

# 2 Definitions

**Certificate of Destruction** means an official document provided by the destruction facility certifying the date, quantity, and type of ODS destroyed.

**Commencement of destruction process** means the date when the ODS waste-stream is hooked up to the destruction chamber.

**Commercial refrigeration equipment** means the refrigeration appliances used in the retail food, cold storage warehouse or any other sector that requires cold storage. Retail food includes the refrigeration equipment found in supermarkets, grocery and convenience stores, restaurants, and other food service establishments. Cold storage includes the refrigeration equipment used to house perishable goods or any manufactured product requiring refrigerated storage.

**Container** means an air- and water-tight unit for storing and/or transporting ODS material without leakage or escape of ODS.

**Destruction** means destruction of ODS by qualified destruction, transformation or conversion plants achieving greater than 99.99 percent destruction and removal efficiency, in order to avoid their emissions. Destruction may be performed using any technology, including transformation, that results in the complete breakdown of the ODS into either a waste or usable by-product.

**Destruction facility** means a facility that destroys, transforms or converts ODS using a technology that meets the standards defined by the UN Environment Programme Technology and Economic Assessment Panel Task Force on Destruction Technologies.

**Emission rate** means the rate at which refrigerant is lost to the atmosphere, including emissions from leaks during operation and servicing events.

**Generator** means the facility from which the ODS material on a single Certificate of Destruction departed prior to receipt by the destruction facility. If the material on a single Certificate of Destruction was aggregated as multiple shipments to the destruction facility, then the destruction facility shall be the Generator.

**GHG assessment boundary** means all the GHG sources, sinks and reservoirs (SSRs) that are required to be assessed because they are identified as included in Table 5.1.

**Halocarbon (HLC)** means a chemical compound containing both carbon and one or more halogen atoms, including chlorofluorocarbons, hydrochlorofluorocarbons, and hydrofluorocarbons, among others. Certain HLC have a high ozone depleting potential, and are known as ozone depleting substances. Certain HLC have a high global warming potential, and are considered greenhouse gases. All HLC targeted by this protocol are GHGs, but may or may not be ODS.

**Ozone Depleting Substances (ODS)** means substances known to deplete the stratospheric ozone layer. The ODS controlled under the Montreal Protocol and its Amendments are chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC), halons, methyl bromide (CH3Br), carbon tetrachloride (CCl4), methyl chloroform (CH3CCl3), hydrobromofluorocarbons (HBFC) and bromochloromethane (CHBrCl).

**Pure ODS** means ODS from a single container whose composition includes at least 90% of a single chemical, by mass, excluding moisture and high boiling residue.

**Recharge** means replenishment of refrigerant agent (using reclaimed or virgin material) into equipment that is below its full capacity because of leakage or because it has been evacuated for servicing or other maintenance.

**Reclaim** means reprocessing and upgrading of a recovered ODS through mechanisms such as filtering, drying, distillation and chemical treatment in order to restore the ODS to a specified standard of performance. Chemical analysis is required to determine that appropriate product specifications are met. It often involves processing off-site at a central facility.

**Recovery** means the removal of ODS from machinery, equipment, containment vessels, etc., into an external container during servicing or prior to disposal without necessarily testing or processing it in any way.

**Reuse/recycle** means reuse of a recovered ODS following a basic cleaning process such as filtering and drying. For refrigerants, recycling normally involves recharge back into equipment and it often occurs ‘on-site’.

**Startup, shutdown, and malfunction plan** 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.

**Stockpile** means ODS stored for future use or disposal in bulk quantities at a single location. These quantities may be composed of many small containers or a single large container.

**Substitute refrigerant** means those refrigerants that will be used to fulfill the function that would have been filled by the destroyed ODS refrigerants. These refrigerants may be drop-in replacements used in equipment that previously used the type of ODS destroyed or may be used in new equipment that fulfills the same market function.

**Substitute emissions** means a term used in this protocol to describe the greenhouse gases emitted from the use of substitute refrigerants in technologies that are used to replace the ODS destroyed in an initiative.

**Transportation system** means a term used to encompass the entirety of the system that moves the ODS from the point of aggregation to the destruction facility.

# 3 ODS GHG Reduction Initiative

## 3.1 Initiative Definition

The ODS GHG reduction initiative that has activities specified below and associated with the collection, recovery and destruction of eligible ODS contained in foam or used as refrigerants that are removed from refrigeration, freezer or air-conditioning appliances or commercial installations, or are intended for those uses and that are.

Initiative activities for a foam ODS initiative include the extraction and concentration of ODS blowing agent from recovered appliance foam, as well as the storage, transportation, mixing (where applicable), sampling, analysis, and destruction of the ODS.

Initiative activities for a refrigerant ODS initiative include the handling, transportation, mixing (where applicable), sampling, analysis, and destruction of the ODS.

Activities occurring prior to the ODS collection at the designated Point of Origin are not considered “initiative activities.”

A single ODS initiative may incorporate ODS obtained from one or both of these ODS source categories.

ODS sources not in one of the above categories, such as ODS that were used as or produced for use as solvents, medical aerosols or other applications are not eligible under this protocol.

For all ODS initiatives, the end fate of the ODS must be destruction at any transformation or destruction facility which employs one of the approved destruction technologies under the Montreal Protocol.[1] These facilities must meet or exceed the Montreal Protocol’s Technology and Economic Assessment Panel (TEAP) standards provided in the *Report of the Task Force on Destruction Technologies*.[2] During the ODS destruction process, the facility must operate in conditions that meet all applicable legal requirements. , The Sponsor must demonstrate that the destruction facility achieves destruction and removal efficiency (DRE) of 99.99 percent and emission levels consistent with the guidelines set forth in the aforementioned TEAP report or, if they are more stringent, any applicable legal requirements in respect of destruction and removal efficiency and emission levels.

ODS GHG initiatives must provide one or more Certificates of Destrcution issued by a qualifying destruction facility certifying and documenting the destruction of ODS at a qualifying destruction facility within a 5 year period of collection or recovery.

The entire quantity of ODS destroyed must be documented in a Certificate of Destruction . This quantity may come from a single origin (e.g., one supermarket) or from numerous sources. Multiple Certificates of Destruction may be included for a a single initiative, only if the following conditions are met:

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[1] Based on the most recent list of approved destruction technologies provided by the Ozone Secretariat of the United Nations Environment Programme: http://ozone.unep.org/.

[2] TEAP. (2002). Report of the Task Force on Destruction Technologies. *Volume 3B*.

1. The sponsor of the ODS initiative is the same for all ODS collected and destroyed
2. No Certificate of Destruction is has been issued and included as part of another initiative

# 4 Eligibility

Initiatives must fully satisfy the following eligibility rules in order to receive offset credits. The criteria only apply to initiatives that meet the definition of a GHG reduction initiative (Section **Error! Reference source not found.**).

## 4.1 General Requirements

a) A legal requirement to destroy the ODS must not be applicable.

## 4.2 Location

Recovery of the foam and refrigerants and extraction of the ODS from the foam must be carried out in Canada. Foam, ODS, and appliances recovered outside of Canada are not eligible for the issuance of offset credits under this protocol.

## 4.3 Initiative Start Date, Duration, and Crediting Period

The initiative start date is defined according to the commencement of initiative activities.

- For pure ODS initiatives that are not aggregated at the destruction facility, the initiative start date is the day that the initiative ODS departs the final storage or aggregation facility for transportation to the destruction facility.
- For pure ODS initiatives where eligible material is aggregated at the destruction facility, the initiative start date is the day when destruction commences, as documented by a Certificate of Destruction.
- For non-pure ODS initiatives, the initiative start date is the day that mixing procedures begin.

An initiative may contain multiple destruction events, as long as the final event concludes within 5 years of the start of the earliest event. The crediting period for an ODS initiative is the period of time over which avoided emissions are quantified for the purpose of determining verifiable GHG reductions. ODS initiatives may be eligible to have credits issued for the quantity of ODS that would have been released over a ten-year period following a destruction event. With 5 years of destruction events, and 10 years of crediting following each year of destruction, the total crediting period for an ODS initiative is 14 years. Registered initiatives may be eligible to have offset credits issued for all ODS emissions avoided by an initiative over the 14-year crediting period.

## 4.4 Eligible ODS

Ozone depleting substances contained in foam removed from refrigeration or freezer appliances and ODS used as refrigerants removed from equipment, systems or appliances from industrial, commercial, institutional or residential sources, or ODS stored by such sources for their future use are admissible for the purposes of this protocol. 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 foam source.

Only the following ODS foam blowing agents are eligible to generate reductions under this protocol:

1. CFC-11
2. CFC-12
3. HCFC-22
4. HCFC-141b

Only destruction of the following ODS refrigerants is eligible for crediting under this protocol:

1. CFC-11
2. CFC-12
3. CFC-13
4. CFC-113
5. CFC-114
6. CFC-115

When ODS used as refrigerants targeted by a initiative are removed from refrigeration, freezer or air-conditioning appliances that also contain ODS contained in foam, the initiative must also, for any destruction activity taking place after 22 October 2016, provide for the extraction and destruction of the ODS contained in the foam in accordance with this protocol.

In order for unused or reclaimed ODS refrigerant to be considered eligible, the Sponsor must be able to document that it was not recovered from residential appliances by following the guidance provided in Section 7.3.2.

# 5 GHG Assessment Boundary

a) The following SSRs have been considered in determining the GHG Assessment Boundary

   1. Figure 5.1 and Figure 5.2 show the SSRs that must be taken into account by the Sponsor when calculating the GHG emission reductions attributable to the initiative.
   2. Table 5.1 provides greater detail on each SSR and justification for the inclusion or exclusion of certain SSRs and gases from the GHG Assessment Boundary for all ODS initiatives.

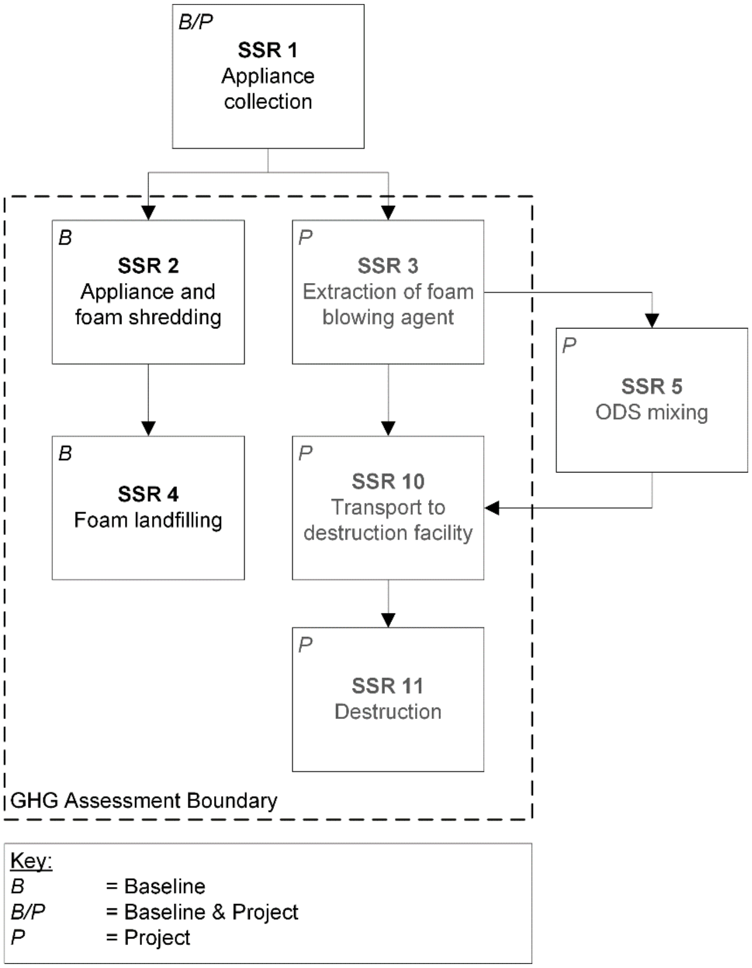

**Figure 5.1.** GHG Assessment Boundary for ODS Contained in Foam

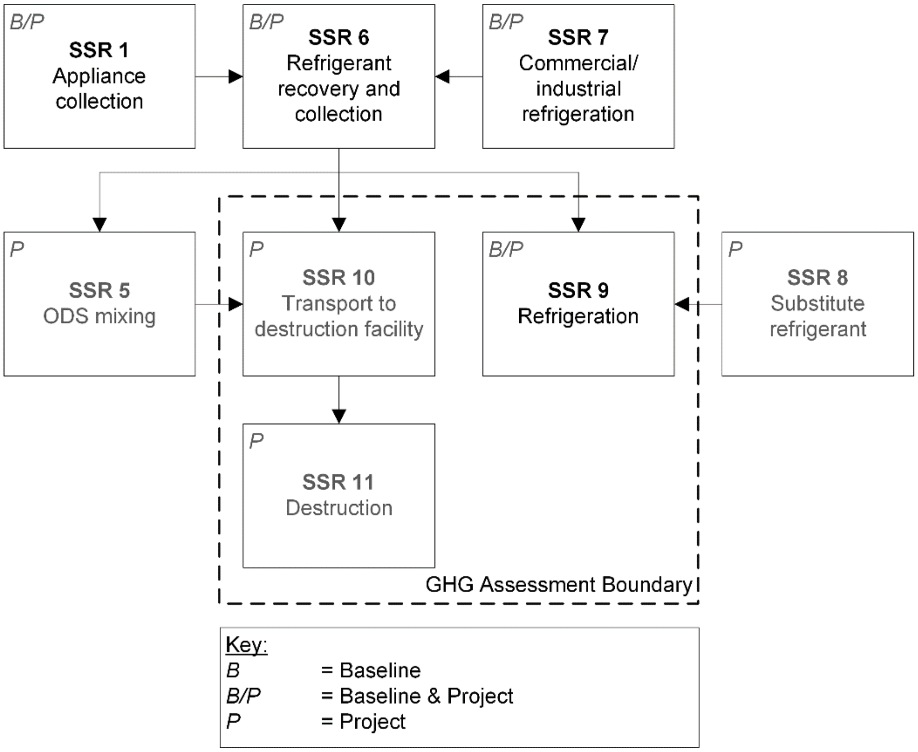

**Figure 5.2.** GHG Assessment Boundary for ODS Used as Refrigerants

**Table 5.1.** Description of all Sources, Sinks, and Reservoirs

| SSR | Source Description | Type of Emission | Included (I) or Excluded (E) | Relevant to Baseline Scenario (B) and/or Project (P) |
|---|---|---|---|---|
| 1 | Fossil fuel emissions attributable to the collection and transportation of end-of-life appliances | $CO_2$ | E | B, P |
| | | $CH_4$ | E | B, P |
| | | $N_2O$ | E | B, P |
| 2 | Emissions of ODS attributable to the shredding of appliances for materials recovery | ODS | I | B |
| 3 | Emissions of ODS attributable to the removal of foam ODS blowing agent from appliances | ODS | I | P |
| 4 | Emissions of ODS attributable to the disposal of foam at a landfill site | ODS | I | B |
| | Emissions of ODS degradation products attributable to foam disposed of at a landfill site | HFC, HCFC | E | B |
| | Fossil fuel emissions attributable to the transportation of shredded foam and disposal at a landfill site | $CO_2$ | E | B |
| | | $CH_4$ | E | B |
| | | $N_2O$ | E | B |

| SSR | Source Description | Type of Emission | Included (I) or Excluded (E) | Relevant to Baseline Scenario (B) and/or Project (P) |
|---|---|---|---|---|
| 5 | Fossil fuel emissions from ODS mixing activities at mixing facility | $CO_2$ | E | P |
| | | $CH_4$ | | |
| | | $N_2O$ | | |
| 6 | Emissions of ODS attributable to the removal of refrigerant from appliances and installations | ODS | E | B, P |
| 7 | ODS emissions attributable to equipment leakage and maintenance | ODS | E | B, P |
| | Fossil fuel emissions attributable to the operation of refrigeration and air conditioning equipment | $CO_2$ | E | B, P |
| | | $CH_4$ | E | B, P |
| | | $N_2O$ | E | B, P |
| 8 | Substitute refrigerant emissions during production | $CO_2e$ | E | P |
| | Fossil fuel emissions during the production of substitute refrigerants | $CO_2$ | E | P |
| | | $CH_4$ | E | P |
| | | $N_2O$ | E | P |
| 9 | Emissions of ODS attributable to leakage and maintenance during the continuous operation of equipment | ODS | I | B |
| | Substitute refrigerant emissions attributable to leakage and maintenance during the continuous operation of equipment | $CO_2e$ | I | P |
| | Indirect emissions attributable to the use of electricity | $CO_2$ | E | B, P |
| | | $CH_4$ | E | B, P |
| | | $N_2O$ | E | B, P |
| 10 | Emissions of fossil fuels attributable to the transportation of ODS from the point of origin to the destruction facility | $CO_2$ | I | P |
| 11 | Emissions of ODS attributable to incomplete destruction at destruction facility | ODS | I | P |
| | Emissions from the oxidation of carbon contained in the destroyed ODS | $CO_2e$ | I | P |
| | Fossil fuel emissions attributable to the destruction of ODS in a destruction facility | $CO_2$ | I | P |
| | | $CH_4$ | E | P |
| | | $N_2O$ | E | P |
| | Indirect emissions attributable to the use of electricity | $CO_2$ | I | P |
| | | $CH_4$ | E | P |
| | | $N_2O$ | E | P |

# 6 Calculation of Emission Reductions

a) *Reductions of GHG emissions from the initiative during a reporting period shall be calculated in accordance with* ***Error! Reference source not found.****.*

1. In calculating the GHG emission reductions attributable to an initiative for the destruction of ODS, the Sponsor must calculate the reductions attributable to the destruction of ODS contained in foam together with from those attributable to the destruction of ODS used as refrigerants.

**Equation 6.1.** Total Emission Reductions

$$\boldsymbol{ER_t = BE_t + \ PE_t}$$

*Where,*

| | | | Units |
|---|---|---|---|
| $ER_t$ | = | Total GHG emission reductions attributable to the initiative during the initiative reporting period | $tCO_2e$ |
| $BE_t$ | = | Total baseline emissions attributable to the destruction of ODS during the initiative reporting period, calculated using Equation 6.2 | $tCO_2e$ |
| $PE_t$ | = | Total initiative emissions attributable to the destruction of ODS, calculated using Equation 6.6 | $tCO_2e$ |

## 6.1 Calculation of Baseline Emissions

Total baseline emissions must be estimated by calculating and summing the calculated baseline emissions for all relevant SSRs (as indicated in Table 5.1) using Equation 6.2 and the supporting equations presented below. Note that emissions shall be quantified in kilograms throughout this section and converted into metric tonnes in Equation 6.2, below.

**Equation 6.2.** Total Baseline Emissions

$$\boldsymbol{BE_t = \frac{BE_R + BE_F}{1000} \times (1 - VR)}$$

*Where,*

| | | | Units |
|---|---|---|---|
| $BE_t$ | = | Total quantity of baseline emissions during the reporting period | $tCO_2e$ |
| $BE_R$ | = | Baseline emissions attributable to the destruction of refrigerant ODS during the reporting period, calculated using Equation 6.5 | $kgCO_2e$ |
| $BE_F$ | = | Baseline emissions attributable to the destruction of foam ODS during the reporting period, calculated using Equation 6.4 | $kgCO_2e$ |
| 1000 | = | Conversion from kilograms to tonnes | kg/t |
| VR | = | Deduction for vapour composition risk (see below) | % |

For any given container of ODS sent for destruction, a portion of the container will be filled with liquid, and the remaining space will be filled with vapour. To address the risk of inaccurate liquid composition sampling, initiatives that destroy containers which contain more than one chemical must use Table 6.2 to determine their risk category and applicable value of *VR* to be applied to the calculation of baseline emissions for that container (Equation 6.2). Table 6.1 classifies the eligible ODS species as low or high pressure. For the purposes of this protocol, any ineligible chemical with a boiling point lower than 0°C at 1 atm is considered high pressure.

The densities of the liquid and vapour phase components of the initiative container will be determined by the testing laboratory at the time that the composition analysis is carried out. The testing laboratory will calculate the densities of the liquid phase and vapour phase contents within the container. To support this calculation, the sponsor shall provide the laboratory with the temperature of the project container (internal temperature if available, otherwise ambient temperature) at the time of sampling, as well as the volumetric capacity of the project container. Once the weight of the contents of the project container is known, the liquid fill level of the container may be determined using Equation 6.3.

**Table 6.1.** Eligible Low Pressure and High Pressure ODS

| Low Pressure ODS | High Pressure ODS |
|---|---|
| CFC-11 | CFC-12 |
| CFC-113 | CFC-13 |
| CFC-114 | CFC-115 |
| HCFC-141b | HCFC-22 |

**Table 6.2.** Determining the Deduction for Vapour Composition Risk

| If the value of $Fill_{liquid}$ is: | AND the concentration of eligible low pressure ODS is: | AND the concentration of ineligible high pressure chemical is: | Then the vapour risk deduction factor (VR) for that container shall be: |
|---|---|---|---|
| > 0.70 | N/A | N/A | 0 |
| 0.50 – 0.70 | > 1% | > 10% | 0.02 |
| < 0.50 | > 1% | > 5% | 0.05 |

The presence of eligible, high pressure ODS may mitigate the risk of over-crediting, so there are two scenarios where a container is exempt from a deduction otherwise required in Table 6.2:

1. The container holds an eligible, high pressure ODS (in any concentration) which has a lower boiling point than the ineligible, high pressure chemical, or
2. The container holds an eligible, high pressure ODS in a concentration greater than that of the ineligible, high pressure chemical.

If the container holds multiple eligible, high pressure ODS, the applicability of the above scenarios will be determined based on the ODS with the highest percent concentration. If the container holds multiple ineligible, high-pressure chemicals, the applicability of the above scenarios will be determined based on the chemical with the highest percent concentration.

This deduction applies to both mixed and non-mixed ODS initiatives. If the initiative includes multiple containers, with different values for VR, the value of VR shall be pro-rated according to the mass of material in each container.

**Equation 6.3.** Determining Liquid Fill Level in Project Container

$$Fill_{liquid} = \frac{M_{destroyed} - (\rho_{vapour} \times V_{container})}{(\rho_{liquid} - \rho_{vapour}) \times V_{container}}$$

*Where,*

| | | | Units |
|---|---|---|---|
| $Fill_{liquid}$ | = | Fill level of the liquid in the project container | fraction |
| $V_{container}$ | = | Total volume of the project container | L |
| $M_{destroyed}$ | = | Total mass of the contents of the project container | kg |
| $\rho_{liquid}$ | = | Modeled density of the liquid material in the project container at the measured temperature | kg/L |
| $\rho_{vapour}$ | = | Modeled density of the vapour material in the project container at the measured temperature | kg/L |

The Sponsor must calculate GHG emissions under the baseline scenario attributable to ODS-containing foam using Equation 6.4.

**Equation 6.4.** Total Baseline Emissions for Foam Initiatives

$$BE_F = \sum_{i=1}^{n} [BA_{init,i} \times EF_{F,i} \times GWP_i]$$

*Where,*

| | | | Units |
|---|---|---|---|
| $BE_F$ | = | Baseline emissions attributable to the destruction of ODS contained in foam during the initiative reporting period | kg $CO_2e$ |
| i | = | Type of ODS | |
| $BA_{init,i}$ | = | Initial quantity of ODS of type *i* entrained in appliance foam prior to processing, determined in accordance with Appendix C | kg ODS |
| $EF_{F,i}$ | = | GHG emission rate for ODS of type *i* contained in foam, as indicated in the appropriate table in Appendix B | % |
| $GWP_i$ | = | Global warming potential of ODS of type *i* as indicated in 0 | kg $CO_2e$/kg ODS |

**Equation 6.5.** Total Baseline Emissions for Refrigerant Initiatives

$$BE_R = \sum_{i} [Q_{R,i} \times EF_{R,i} \times GWP_i]$$

*Where,*

| | | | Units |
|---|---|---|---|
| $BE_R$ | = | Emissions under the baseline scenario attributable to the destruction of ODS used as refrigerants during the reporting period | kg $CO_2e$ |
| *i* | = | Type of ODS | |
| $Q_{R,i}$ | = | Total quantity of ODS of type *i* used as refrigerants recovered and sent for destruction, determined in accordance with Section 7.6 | kg $CO_2e$ |
| $EF_{R,i}$ | = | GHG emission factor for ODS of type *i* used as refrigerants, as indicated in the table in Appendix B | % |
| $GWP_i$ | = | Global warming potential for ODS of type *i*, as indicated in the table in 0 | kg $CO_2e$/kg ODS |

## 6.2 Calculation of Initiative Emissions

The Sponsor must calculate GHG emissions under a initiative for the destruction of ODS using Equation 6.6 to Equation 6.9.

**Equation 6.6.** Calculation of GHG Emissions Attributable to an Initiative for the Destruction of ODS

$$\boldsymbol{PE_t = \frac{BA_{pr} + Sub + TrDest}{1000}}$$

| *Where,* | | | Units |
|---|---|---|---|
| $PE_t$ | = | GHG emissions under a initiative for the destruction of ODS during the initiative reporting period | $tCO_2e$ |
| $BA_{pr}$ | = | Total GHG emissions related to ODS contained in foam that are emitted during extraction, calculated using Equation 6.7 | kg $CO_2e$ |
| Sub | = | Total emissions from substitute refrigerants, calculated using Equation 6.8 | kg $CO_2e$ |
| TrDest | = | GHG emissions attributable to the transportation and destruction of ODS, calculated using Equation 6.9 | kg $CO_2e$ |
| 1000 | = | Conversion from kilograms to tonnes | kg/t |

**Equation 6.7.** Total Emissions Attributable to the Extraction of ODS Contained in Foam

$$\boldsymbol{BA_{pr} = \sum_{i} \left[\left(BA_{init,i} - BA_{final,i}\right) \times GWP_i\right]}$$

| *Where,* | | | Units |
|---|---|---|---|
| $BA_{pr}$ | = | Total emissions attributable to the extraction of ODS contained in foam removed from appliances | kg $CO_2e$ |
| $i$ | = | Type of ODS | |
| n | = | Number of types of ODS | |
| $BA_{init,i}$ | = | Initial quantity of ODS blowing agent of type *i* entrained in appliance foam prior to processing, determined in accordance with Appendix C | kg ODS |
| $BA_{final,i}$ | = | Total quantity of ODS blowing agent of type *i* extracted and sent for destruction, determined in accordance with Section 7.6 | kg ODS |
| $GWP_i$ | = | Global warming potential of ODS of type i as indicated in 0 | kg $CO_2e$/kg ODS |

**Equation 6.8.** Total GHG Emissions Attributable to Substitute Refrigerants

$$\boldsymbol{Sub = \sum_{i} \left(Q_{R,i} \times EFS_i\right)}$$

| *Where,* | | | Units |
|---|---|---|---|
| Sub | = | Total GHG emissions attributable to substitute refrigerants | kg $CO_2e$ |
| $i$ | = | Type of ODS | kg $CO_2e$ |
| $Q_{R,i}$ | = | Total quantity of ODS of type *i* used as refrigerants recovered and sent for destruction, determined in accordance with Section 7.6 | kg ODS |
| $EFS_i$ | = | Emission factor for substitutes for ODS of type *i* as indicated in the table in Appendix B | kg $CO_2e$/kg ODS |

**Equation 6.9.** Initiative Emissions from Transportation and Destruction

$$\boldsymbol{TrDest = Q_{dest} \times 7.5}$$

*Where,* Units

| | | | Units |
|---|---|---|---|
| TrDest | = | GHG emissions attributable to the transportation and destruction of ODS contained in foam | kg $CO_2e$ |
| $Q_{dest}$ | = | Total quantity of material (eligible and ineligible) destroyed during the initiative, as shown on the official weigh tickets | kg ODS |
| 7.5 | = | Default emission factor for ODS transportation and destruction | kg $CO_2e$/kg ODS |

# 7 Data Management and Monitoring

## 7.1 Data Collection

The Sponsor is responsible for collecting the information required for initiative monitoring. The Sponsor must show that the data collected are actual and that rigorous supervision and record-keeping procedures are applied at the initiative site.

The Sponsor must institute a transparent, verifiable methodology for the validation of all initiative data to ensure that any erroneous or unusual data are identified, subject to verifier review and approval.

The Sponsor is required to collect data using this methodology that demonstrates the initiative meets the requirements listed in sections 7.2 and 7.3.

## 7.2 Extraction and Destruction

ODS must be extracted and destroyed as follows:

1. ODS contained in foam must be extracted in concentrated form using a negative pressure process;

2. Refrigerant must be collected and handled by a certified person, as defined in the Federal Halocarbon Regulations, 2003, who has successfully completed training recognized by the Province in which the collection and handling occurs;

3. All ODS must be collected, stored and transported in hermetically sealed containers which are approved by Transport Canada for the particular chemicals and usage;

4. All ODS must be destroyed in concentrated form in an ODS destruction facility meeting the requirements in Section 7.7 of this protocol.

## 7.3 Determining Point of Origin

### 7.3.1 Point of Origin for Concentrated Foam ODS

The point of origin (POO) for concentrated ODS from appliance foam shall be the facility where the blowing agent is extracted from the foam.

### 7.3.2 Point of Origin for Refrigerant ODS

The POO for refrigerant ODS removed from residential appliances shall be the facility where such removal occurred.

The POO for used, unused, or reclaimed commercial or industrial refrigerant ODS shall be the facility where the eligible ODS is aggregated to a quantity greater than 225 kg. In cases where greater than 225 kg of eligible ODS is removed from a single installation or piece of equipment, the POO shall be that specific installation or piece of equipment. For all refrigerant ODS which is not removed from residential appliances, the Sponsor must be able to document that the ODS was removed from or intended for use in commercial or industrial equipment or installations. All refrigerant ODS is assumed to have come from residential appliances unless the Sponsor can document otherwise. It may be necessary to identify a separate POO for quantities less than 225 kg to satisfy this requirement.

## 7.4 Data Management

The sponsor must record the following information in the Monitoring Plan, and include it in any initiative reports required by the Regulation, indicating separately the information pertaining to ODS contained in foam and that pertaining to ODS used as refrigerants:

1. A listing of the facilities and entities involved in any initiative activities (as defined in Section 3.1), from POO to point of destruction of the ODS;

2. Information and data required to demonstrate the requirements in Section 7.2

3. Information on the POO, required in Section 7.3. This information at a minimum must include:
    a. The physical address of each POO;
    b. The name and contact information of each party involved in each stage of the initiative, and the quantity of materials, whether foam or ODS, transferred, sold or handled by each party; and
    c. For initiatives destroying ODS sourced from appliances, the number of appliances recovered and, for each appliance, the type, size, storage capacity and, if available, serial number;
    d. For initiatives destroying ODS sourced from commercial installations, the number, type, size, and, if available, serial number of the equipment from which the ODS was recovered;

4. The serial number or identification number of the containers used for ODS storage and transportation;

5. For appliance-sourced ODS, information on ODS extraction, specifying
    a. The number of appliances containing foam from which ODS has been extracted;

  b. The number of appliances containing refrigerants from which ODS have been extracted;
  c. The name and contact information of the facility where the appliances are recycled, if any; and
  d. Processes, training, and quality assurance, quality control and extraction process management processes;

6. One or more certificates of destruction for all the ODS destroyed under the initiative, issued by the facility that destroyed the ODS, by destruction activity, specifying:
   a. The name of the Sponsor;
   b. The name and contact information of the destruction facilities;
   c. The name and signature of the person responsible for the destruction operations;
   d. The identification number on the certificate of destruction;
   e. The serial, tracking or identification number of all containers for which ODS destruction occurred;
   f. The weight and type of ODS destroyed for each container, in kg, including the weigh tickets generated in accordance with Section 7.6;
   g. The destruction start date and time; and
   h. The destruction end date and time;

7. The monitoring plan referred to in Section 7.5;

8. The certificate of sampling results issued by the laboratory in accordance with Section 7.6.

All required data concerning the point of origin must be obtained at the time of recovery from the point of origin.

## 7.5 Monitoring Parameters

Table 7.1 sets out the monitoring parameters required to be used in the calculations for each reporting period .

**Table 7.1.** Parameters for the Monitoring of an ODS Initiative

| Equation | Parameter | Factor Used in Equations | Measurement Unit | Method |
|---|---|---|---|---|
| Equation 6.1 | Total GHG emission reductions attributable to the initiative during the initiative reporting period | $ER_t$ | $tCO_2e$ | Calculated |
| Equation 6.1<br>Equation 6.2 | Total baseline emissions attributable to the destruction of ODS during the initiative reporting period | $BE_t$ | $tCO_2e$ | Calculated |
| Equation 6.1<br>Equation 6.6 | Total initiative emissions attributable to the destruction of ODS | $PE_t$ | $tCO_2e$ | Calculated |
| Equation 6.2<br>Equation 6.5 | Baseline emissions attributable to the destruction of refrigerant ODS during the reporting period | $BE_R$ | kg $CO_2e$ | Calculated |
| Equation 6.2<br>Equation 6.4 | Initiative emissions attributable to the destruction of foam ODS during the reporting period | $BE_F$ | kg $CO_2e$ | Calculated |
| Equation 6.2 | Deduction for vapour composition risk | VR | % | Referenced |
| Equation 6.3 | Fill level of the liquid in the initiative container | $Fill_{liquid}$ | fraction | Calculated |
| Equation 6.3 | Total volume of the project container | $V_{container}$ | L | Measured |

| Equation | Parameter | Factor Used in Equations | Measurement Unit | Method |
|---|---|---|---|---|
| Equation 6.3 | Total mass of the contents of the project container | $M_{destroyed}$ | kg | Measured |
| Equation 6.3 | Modeled density of the liquid material in the project container at the measured temperature | $\rho_{liquid}$ | kg/l | Measured and Calculated |
| Equation 6.3 | Modeled density of the vapour material in the project container at the measured temperature | $\rho_{vapour}$ | kg/l | Measured and Calculated |
| Equation 6.4<br>Equation 6.5<br>Equation 6.7<br>Equation 6.8 | Type of ODS | *i* | kg $CO_2e$ | Measured |
| Equation 6.4<br>Equation 6.7<br>Equation C.1<br>Equation C.2 | Initial quantity of ODS of type *i* contained in foam appliances prior to removal | $BA_{init,i}$ | kg ODS | Calculated |
| Equation 6.4 | GHG emission rate for ODS of type *i* contained in foam, as indicated in the appropriate table in Appendix B | $EF_{F,i}$ | % | Referenced |
| Equation 6.4<br>Equation 6.5<br>Equation 6.7 | Global warming potential for ODS of type *i*, as indicated in the table in Appendix A | $GWP_i$ | kg $CO_2e$/kg ODS | Referenced |
| Equation 6.5<br>Equation 6.8 | Total quantity of ODS of type *i* used as refrigerants recovered and sent for destruction | $Q_{R,i}$ | kg $CO_2e$ | Calculated |
| Equation 6.5 | GHG emission factor for ODS of type i used as refrigerants, as indicated in the table in Appendix B | $EF_{R,i}$ | % | Referenced |
| Equation 6.6<br>Equation 6.7 | Total emissions attributable to the extraction of ODS from foam removed from appliances | $BA_{pr}$ | kg $CO_2e$ | Calculated |
| Equation 6.6<br>Equation 6.8 | Total quantity of GHG emissions from substitute refrigerants | Sub | kg $CO_2e$ | Calculated |
| Equation 6.6<br>Equation 6.9 | Emissions attributable to the transportation and destruction of ODS | TrDest | kg $CO_2e$ | Calculated |
| Equation 6.7<br>Equation C.1 | Number of items to be summed | n |  | Measured |
| Equation 6.7 | Total quantity of ODS of type *i* contained in foam extracted and sent for destruction | $BA_{final,i}$ | kg ODS | Calculated |
| Equation 6.8 | Emission factor for substitutes for ODS of type *i* as indicated in the table in Appendix B | $EFS_i$ | kg $CO_2e$/kg ODS | Referenced |
| Equation 6.9 | Total quantity of material destroyed during the initiative, as shown on the official weigh tickets | $Q_{dest}$ | kg ODS | Measured |
| Equation C.1 | Number of appliances of type *n* containing ODS of type i | $N_n$ |  | Measured |
| Equation C.1 | Mass of ODS per appliance of type *n* containing ODS of type *i* | $M_n$ | kg | Measured |
| Equation C.2 | Total quantity of foam recovered prior to ODS extraction | $Foam_{rec}$ | kg ODS | Calculated |
| Equation C.2 | Concentration of ODS in foam before extraction from appliances | CBA | kg ODS/kg foam | Calculated |

## 7.6 Concentrated Refrigerant and Blowing Agent Composition and Quantity Analysis Requirements

For each container, this section sets out the method to calculate, on a mass basis, the total quantity of ODS of type *i* sent for destruction under the initiative, namely the factor $BA_{final,i}$ for initiatives for the destruction of ODS contained in foam and the factor $Q_{R,i}$ for initiatives for the destruction of ODS used as refrigerants.

### 7.6.1 Determination of the Quantity of ODS in Each Container

The quantity of ODS to be destroyed in each container must be determined at the destruction facility by an authorized person, by weighing each container when it is full of ODS prior to destruction and after it has been emptied and its contents have been destroyed.

The quantity of ODS is equal to the difference between the mass of the container when full and when empty.

Each ODS container must be weighed at the destruction facility:

1. Using a single scale to generate both full and empty weight tickets;
2. Ensuring that the scale has been calibrated less than 3 months prior to the weighing:
    a. Scale calibration shall be conducted by a measurement Canada inspector or an authorized service provider, to an accuracy standard relevant to that specific type of scale, as specified by Measurement Canada;
3. Weighing the full container not more than 2 days prior to commencing the destruction of the ODS;
4. Weighing the empty container not more than 2 days after the destruction of the ODS.

Despite subparagraph 2 above, scales used prior to 31 December 2012, and subject to the Weights and Measures Act (R.S.C. 1985, c. W-6) may have been calibrated at the frequency specified by Measurement Canada provided that frequency does not exceed 2 years. However, if the first calibration after a weighing indicates that the weight of the ODS destroyed was overestimated, the Sponsor must correct the weight by deducting the error percentage recorded during the calibration.

### 7.6.2 ODS Mixing

For each sample that does not contain over 90% of the same type of eligible ODS, the Sponsor must, in addition to the conditions provided for in Section 7.6.1, also meet the following conditions concerning mixed ODS.

The circulation of the ODS mixture must be conducted at the destruction facility or prior to delivery of the ODS to such a facility, by a person who is independent of the Sponsor and of the destruction facility, and who is properly trained to carry out this task.

Prior to sampling, the ODS mixture must be circulated in a container that meets all of the following conditions:

1. The container has no solid interior obstructions other than mesh baffles or other interior structures that do not impede circulation;
2. The container was fully evacuated prior to filling;
3. The container must have mixing ports to circulate liquid and gas phase ODS;

4. The container has ports to sample liquid and gas phase ODS;
5. The sampling ports are located in the middle third of the container and not at one end or the other;
6. The container and associated equipment can circulate the mixture through a closed loop system from the bottom to top.

If the original mixed ODS container does not meet these requirements, the mixed ODS must be transferred into a compliant temporary container.

The mass of the ODS mixture transferred into the temporary container must be calculated and recorded. In addition, transfers of ODS between containers must be carried out at a pressure that meets the applicable standards for the jurisdiction where the initiative is located and the specific chemicals being handled.

Once the mixed ODS are in a container that meets the above criteria, they must be circulated as follows:

1. Liquid mixtures must be circulated from the liquid port to the vapour port;
2. A volume of the mixture equal to 2 times the volume in the container must be circulated;
3. Circulation must occur at a rate of at least 114 litres per minute unless the liquid mixture has been circulating continuously for at least 8 hours, and has circulated more than twice the volume of the container;
4. The start and end times must be recorded.

### 7.6.3 Sampling

Sampling must be conducted for each ODS container:

1. In the case of pure ODS, one sample must be taken at the destruction facility;
2. In the case of ODS mixtures that have been circulated at the destruction facility, a minimum of two samples must be taken during the last 30 minutes of circulation and the samples must be taken from the bottom liquid port;
3. In the case of ODS mixtures that have been circulated prior to delivery to the destruction facility, a minimum of two samples must be taken in accordance with subparagraph 2, and one additional sample must be taken at the destruction facility.

If more than one sample is taken for a single container, the calculations must use the results from the sample with the weighted ODS concentration with the least global warming potential.

The sampling must be conducted in accordance with the following conditions:

1. The samples must be taken by a person who is independent of the Sponsor and of the destruction facility and has the necessary training to carry out this task;
2. The samples must be taken with a clean, fully evacuated sample bottle with a minimum capacity of 0.45 kg;
3. Each sample must be taken in a liquid state;
4. A minimum sample size of 0.45 kg must be drawn for each sample;
5. Each sample must be individually labeled and tracked according to the container from which it was taken;
6. The following information must be recorded for each sample:
    a. The time and date of the sample;

b. The name of the Sponsor for whom the sampling is conducted;
c. The name and contact information of the technician who took the sample, and of the technician's employer;
d. The volume of the container from which the sample was drawn;
e. The ambient air temperature at the time of sampling;
f. The chain of traceability of each sample, from the point of sampling to the accredited laboratory.

Despite subparagraph 3 of the first paragraph, in the case of ODS mixtures circulated before 31 December 2012, a minimum of one sample must be taken in accordance with subparagraph 2 of the first paragraph and one extra sample must be taken at the destruction facility.

### 7.6.4 Analysis of Samples

The quantity and type of ODS must be determined by having a sample from each container analyzed by one of the following laboratories:

1. A laboratory that is independent of the Sponsor and of the destruction facility, and is accredited for analysis of ODS by the Air-Conditioning, Heating and Refrigeration Institute in accordance with the most recent version of AHRI 700 of that organization.

All the ODS samples for the initiative must be sampled to determine the following:

1. The type of each ODS;
2. The quantity, in kilograms, and concentration, in kg of ODS of type *i* per kg of gas, in each type of ODS in the gas, using gas chromatography;
3. The moisture content of each sample in parts per million;
4. The high boiling residue from the ODS sample, which must be below 10% of the total mass of the sample.

The moisture content determined under subparagraph 3 of the second paragraph must be less than 75 percent of the saturation point for the ODS based on the temperature recorded at the time the sample was taken. For containers that hold mixed ODS, the sample’s saturation point shall be assumed to be that of the ODS species in the mixture with the lowest saturation point that is at least 10 percent of the mixture by mass. If this threshold is exceeded, the Sponsor must dry the ODS mixture, take the sample again and analyze it in accordance with the method in Section 7.6.4.

Note that the threshold for moisture saturation will be difficult to achieve at very low temperatures, and it is recommended that sampling not occur if the ambient air temperature around the ODS container is below 0°C. Sponsors may sample for moisture content and perform any necessary de-watering prior to the sampling and laboratory analysis required by this section.

In the case of ODS mixtures, the analysis must determine the weighted concentrations of the ODS on the basis of their global warming potential for samples taken in accordance with subparagraph 2 of the first paragraph of Section 7.6.4.

A certificate of the sampling results must be issued by the laboratory that conducted the analysis and a copy of the certificate must be included with the initiative report.

### 7.6.5 Determination of the Total Quantity of Foam and Refrigerant ODS Sent for Destruction

Based on the mass of the ODS in each container and the concentration of each sample, the Sponsor must

1. Calculate the quantity of each type of ODS in each container, by deducting the weight of the water and the high boiling residue;
2. Add together the quantities of each type of ODS in each container to obtain the factor $BA_{final,i}$, namely the total quantity of ODS of type *i* contained in the foam, or the factor $Q_{i,R}$, namely the total quantity of ODS of type *i* used as refrigerants extracted and sent for destruction under the initiative.

## 7.7 Destruction Facilities

The Sponsor must demonstrate that the operating parameters for the facility during ODS destruction were monitored and recorded in accordance with the Code of Good Housekeeping approved by the Montréal Protocol.[3] The Sponsor must ensure that the destruction facilities provide third-party certified results indicating that the facility meets all performance criteria set out in the Code of Good Housekeeping. Following the initial performance testing, sponsors must demonstrate that the facility has conducted comprehensive performance testing at least every three years to validate compliance with the TEAP DRE and emissions limits.

The verifier must use the data to show that, during the ODS destruction process, the facility was operating in conditions that met the requirements of any authorization necessary to pursue activities at that facility.

It must be demonstrated that the following parameters were continuously monitored during the entire ODS destruction process::

1. The ODS feed rate;
2. The operating temperature and pressure of the destruction facility during ODS destruction;
3. Effluent discharges measured in terms of water and pH levels;
4. Continuous data on the carbon monoxide emissions.

# 8 Reversals

## 8.1 Reversals Listed for the Purposes of s. 20(1) paragraph 1

There are no reversals listed in this protocol for the purpose of s. 20(1) paragraph 1 of O.Reg. 539/17.

## 8.2 Errors, Omissions or Misstatements

a) In the event that an error, omission or misstatement is discovered after Ontario offset credits have been created and issued for a reporting period, the Sponsor shall determine the total amount of the reversal by:

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[3] TEAP. (2006). Code of Good Housekeeping. *Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, 7th Edition*.

1. Using this protocol to re-calculate the corrected value of the GHG emission reductions from the initiative during the reporting period for each initiative report affected by the reversal.
2. Calculating the total reversal of GHG emission reductions from the initiative using Equation 8.1.

**Equation 8.1. Calculating GHG Emission Reductions Reversed**

$$\boldsymbol{RE = \sum_{r=1}^{n} ERc - ERi}$$

| *Where,* | | | Units |
|---|---|---|---|
| RE | = | GHG emission reductions reversed | $tCO_2e$ |
| n | | Total number of initiative reports affected by the reversal | |
| r | | Initiative reports affected by the reversal | |
| ERc | = | Corrected GHG emission reductions from the initiative during the reporting period calculated in accordance with Subsection 8.1(a)(1) | $tCO_2e$ |
| ERi | = | Initially reported GHG emission reductions from the initiative during the reporting period | $tCO_2e$ |

# 9 Reporting

a) The following information shall be set out in an initiative report or a reversal report in addition to the information required by the Regulation.

- Certificate(s) of Destruction
- Laboratory analysis of ODS composition from sampling at destruction facility
- Laboratory analysis of ODS composition from sampling at mixing facility, if applicable
- Initiative Surveillance Plan
- Verification Report
- Verification Statement

## 9.1 Initiative Report

### 9.1.1 Monitoring Information

a) A description of how the initiative was monitored, including the following:
   1. A statement of whether the monitoring performed meets the requirements set out in Section 7.
   2. Where applicable, an identification of any deviations from the requirements set out in Section 7 and a description of whether these deviations should be considered material.

b) Calibration certificates or verification reports on the calibration accuracy, from either the manufacturer or a qualified third-party certified by the manufacturer for each piece of monitoring equipment.

c) Identification of the measurement frequency used for each monitoring parameter, where multiple frequencies may be used in accordance with Section 7.5**Error! Reference source not found.**.

### 9.1.2 Quantification Information

a) All calculations set out in Section 6, including any supporting calculations set out in Section 7, that were used.
b) The reference temperature and density used.

## 9.2 Reversal Report

### 9.2.1 General

a) Information about the circumstances and causes of the reversal including the number of reporting periods affected.
b) For each initiative report that was affected by the reversal, all information that has changed as a result of the reversal and a description of those changes.
c) In the case of an error, omission or misstatement reversal, a description of the corrective actions taken to address the circumstances and causes of the reversal.
d) Supporting documentation for each of the items in paragraphs (a) through (c) above.

### 9.2.2 Quantification Information

a) All calculations set out in Section 8, including supporting calculations set out in Section 6 and Section 7, that were used to determine the amount of the reversal.
b) Supporting documentation related to the calculations.

# 10 Record Keeping

a) The following records and documents shall be kept in addition to the records that are required to be kept under the Regulation:

1. The name and contact information for any facilities or enterprises that carried out the following activities, as they apply to the initiative;
    a. Extraction of foam and blowing agent, as well as refrigerant, from appliances;
    b. Destruction of eligible ODS;
    c. Mixing of eligible ODS;
    d. Laboratory analysis of ODS samples;
2. All data inputs for the calculation of the initiative emission reductions, including all required sampled data;
3. Copies of all permits, Notices of Violations (NOVs), and any relevant administrative or legal consent orders dating back at least three years prior to the initiative start date;
4. Destruction facility monitor information (CEMS data, DRE documentation, scale readings, calibration procedures, and permits);
5. Verification records and results;
6. Chain of custody and point of origin documentation;
7. ODS composition and quantity lab reports;
8. For appliance foam and refrigerant initiatives, a description of the methods used to remove foam or refrigerants from the appliances, and extract ODS from the foam.

## 10.1 Reporting Period and Verification Cycle

ODS destruction initiatives may be no greater than 5 years in duration, measured from the initiative start date to completion of ODS destruction. Sponsors may choose a shorter time horizon for their initiative (e.g., 12 months or 3 years), but no initiative may be longer than 5 years. ODS initiatives shall report annually, and will thus be verified as many as 5 times during the initiative lifetime.

# Appendix A Global Warming Potential of ODS

**Table A.1.** Global Warming Potential of Eligible ODS

| Type of ODS | Global Warming Potential (mass unit of $CO_2$ equivalent per same unit of ODS) |
|---|---|
| CFC-11 | 4,750 |
| CFC-12 | 10,900 |
| CFC-13 | 14,400 |
| CFC-113 | 6,130 |
| CFC-114 | 10,000 |
| CFC-115 | 7,370 |
| HCFC-22 | 1,810 |
| HCFC-141b | 725 |

# Appendix B Emission Factors

**Table B.1.** Baseline Emission Rates for Foam Blowing Agents

| Type of ODS | Emission Rate for Each Type of ODS Contained in Foam Removed from Appliances ($EF_{F,i}$) |
|---|---|
| CFC-11 | 0.44 |
| CFC-12 | 0.55 |
| HCFC-22 | 0.75 |
| HCFC-141b | 0.50 |

**Table B.2.** Emission Factor for each Type of ODS Used as a Refrigerant

| Type of ODS | Emission Rate for Each Type of ODS Contained in Foam Removed from Appliances ($EF_{F,i}$) |
|---|---|
| CFC-11 | 0.89 |
| CFC-12 | 0.95 |
| CFC-13 | 0.61 |
| CFC-113 | 0.89 |
| CFC-114 | 0.78 |
| CFC-115 | 0.61 |

**Table B.3.** Emission Factors for Substitute Refrigerants

| ODS Used as Refrigerants | Emission Factors for Substitute Refrigerants ($EFS_i$) ($CO_2e$/ODS) |
|---|---|
| CFC-11 | 223 |
| CFC-12 | 686 |
| CFC-13 | 7,144 |
| CFC-113 | 220 |
| CFC-114 | 659 |
| CFC-115 | 1,139 |

# Appendix C Calculations Related to Appliance Foam Blowing Agent Recovery

In order to calculate baseline and initiative emissions related to recovery of foam blowing agent, in accordance with Section 6, the sponsor must first calculate the quantity of ODS contained in foam prior to removal from appliances.

## C.1 Calculation Methods for the Initial Quantity of ODS Contained in Foam

Sponsors shall determine the initial quantity of ODS contained in appliance foam using one of two options:

1. Estimation based on the storage capacity and number of appliances from which the eligible ODS was sourced, in accordance with Section C.2; or,
2. Estimation based on analysis of samples of initiative foam, in accordance with Section C.3.

## C.2 Calculation of the Initial Quantity of ODS Contained in Foam Based on the Storage Capacity of the Appliances

The Sponsor may calculate the initial quantity of ODS contained in foam using Equation C.1 and data from Table C.1.

**Equation C.1.** Initial Quantity of ODS Contained in Foam Prior to Removal (default values)

$$\boldsymbol{BA_{init,i}} = \sum_{\boldsymbol{n=1}}^{\boldsymbol{4}} (\boldsymbol{N_n} \times \boldsymbol{M_n})$$

*Where,*

| | | | Units |
|---|---|---|---|
| $BA_{init,i}$ | = | Initial quantity of ODS of type *i* contained in foam prior to removal from appliances | kg ODS |
| $N_n$ | = | Number of appliances of type *n* containing ODS of type *i* | |
| $M_n$ | = | Mass of ODS per appliance of type *n* containing ODS of type *i* | kg |

**Table C.1.** Quantity of ODS by Type of Appliance

| Type of Appliance | Storage Capacity (SC) | Mass of ODS per Appliance (kg) |
|---|---|---:|
| Type 1 | SC < 180 litres | 0.24 |
| Type 2 | 180 litres ≤ SC < 350 litres | 0.32 |
| Type 3 | 350 litres ≤ SC < 500 litres | 0.4 |
| Type 4 | SC ≥ 500 litres | 0.48 |

## C.3 Calculation of the Initial Quantity of ODS Contained in Foam Based on Samples

Appliance foam initiatives have the option of calculating the initial quantity of blowing agent in appliances by determining an initiative-specific foam blowing agent concentration. This is done once per initiative[4] based on a run of a minimum ten appliances. Basing this analysis on a number of appliances greater than ten will likely result in a higher calculated concentration of blowing agent due to the 90 percent upper confidence limit procedure. A larger sample size will decrease uncertainty and thus lower the estimated blowing agent concentration, reducing the value of $BA_{init,i}$; however, sampling of additional appliances will also increase testing costs. The procedures below shall be used to calculate CBA and $BA_{init,i}$ using analysis of foam samples.

The initial quantity of ODS contained in foam may be calculated using samples from at least 10 appliances and the following method:

1. Have the initial concentration of ODS in the foam determined by a laboratory independent of the Sponsor in accordance with Section 7.6 and in the following manner:
   a. by cutting 4 foam samples from each appliance (left side, right side, top, bottom) using a reciprocating saw, each sample being at least 10 $cm^2$ and the full thickness of the insulation;
   b. by sealing the cut edges of each foam sample using aluminum tape or a similar product that prevents off gassing;
   c. by individually labelling each sample to record appliance model and site of sample (left, right, top, bottom);
   d. by analyzing the samples using the procedure outlined below; the samples may be analyzed individually (4 analyses per appliance) or a single analysis may be done using equal masses of foam from each sample (1 analysis per appliance);
   e. based on the average concentration of ODS in the samples from each appliance, by calculating the 90% upper confidence limit of the ODS concentration in the foam, and using that value as the “CBA” factor in Equation C.2 to calculate initial quantity of ODS contained in foam from appliances;

2. Determine the quantity of foam removed from the appliances processed, namely the factor “$Foam_{rec}$” in Equation C.2 using a default value of 5.85 kg per appliance and multiplying by the number of appliances processed or using the following method:
   a. by separating and collecting all foam residual, which may be in a fluff, powder or pelletized form, and documenting the processing to demonstrate that no significant quantity of foam residual is lost in the air or other waste streams;
   b. by separating non-foam components in the residual (such as metal or plastic);

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[4] The initiative-specific blowing agent concentration may be applied to other initiatives as long as the type of appliances being processed remains consistent.

   c. by weighing the recovered foam residual prior to ODS extraction to calculate the total mass of foam recovered;

3. Calculate the initial quantity of ODS contained in foam prior to removal from appliances ($BA_{init}$) using Equation C.2:

**Equation C.2.** Initial Quantity of ODS Contained in Foam Prior to Removal (site-specific)

$$BA_{init,i} = Foam_{rec} \times CBA$$

*Where,*

| | | | Units |
|---|---|---|---|
| $BA_{init,i}$ | = | Initial quantity of ODS of type *i* contained in foam prior to removal from appliances | kg ODS |
| $Foam_{rec}$ | = | Total quantity of foam recovered prior to ODS extraction | kg ODS |
| CBA | = | Concentration of ODS blowing agent in the foam prior to removal from appliances | kg ODS/kg foam |

Requirements for laboratory analysis of ODS concentration from appliance foam samples:

1. the analysis of the content and mass ratio of the ODS from foam must be done at an independent laboratory in accordance with Section 7.6;
2. the analysis must be done using the heating method to extract ODS from the foam in the foam samples, as described in the article "Release of fluorocarbons from Insulation foam in Home Appliance during Shredding" published by Scheutz, Fredenslund, Kjeldsen and Tant in the Journal of the Air & Waste Management Association (December 2007, Vol. 57, pages 1452-1460), and set out below:
   a. each sample must 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;
   b. to release the ODS, the sample must be incubated in an oven for 48 hours at 140°C;
   c. when cooled to room temperature, gas samples must be redrawn from the headspace and analyzed by gas chromatography in accordance with Section 7.6;
   d. the lids must be removed after analysis, and the headspace must be flushed with atmospheric air for approximately 5 minutes using a compressor; afterwards, the septa and caps must be replaced and the bottles subjected to a second 48-hour heating step to drive out the remaining ODS from the sampled foam;
   e. when cooled down to room temperature after the second heating step, gas samples must be redrawn from the headspace and analyzed by gas chromatography in accordance with Section 7.6;
3. the quantity of each type of ODS recovered must then be divided by the total mass of the initial foam samples prior to analysis to determine the mass ratio of ODS present, in kg of ODS per kg of foam.