Mexico Halocarbon Protocol

Destruction of Mexican Halocarbons in Mexico

Draft Version 1.0
for Public Comment

April 14, 2021

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Financial Support

The process to develop this protocol was supported by a financial contribution from the Comission for Private Sector Studies for Sustainable Development, CESPEDES.

Previous Protocol Versions

This protocol is a partial adaptation of the Reserve U.S. Ozone Depleting Substances Protocols, Article 5 Ozone Depleting Substances Protocols, and the Mexico Ozone Depleting Substances Protocol V1.0.

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Table of Contents

Abbreviations and Acronyms 1
1 Introduction 3
2 The GHG Reduction Project 4
2.1 Background 4
2.1.1 The Montreal Protocol 4
2.1.2 The Kigali Amendment 6
2.2 Project Definition 7
2.3 Eligible Halocarbons 8
2.4 Eligible Halocarbon Sources 8
2.4.1 Chlorofluorocarbon Eligible Sources 8
2.4.2 Hydrochlorofluorocarbon Eligible Sources 9
2.4.3 Hydrofluorocarbon Eligible Sources 10
2.5 The Project Developer 11
3 Eligibility Rules 12
3.1 Location 12
3.2 Project Start Date 12
3.3 Project Crediting Period 13
3.4 Additionality 13
3.4.1 The Legal Requirement Test 13
3.4.2 The Performance Standard Test 13
3.5 Regulatory Compliance 14
4 The GHG Assessment Boundary 16
5 Quantifying GHG Emission Reductions 22
5.1 Quantifying Baseline Emissions 22
5.2 Quantifying Project Emissions 27
5.2.1 Calculating Project Emissions from the Use of Halocarbon Substitutes 28
5.2.2 Calculating Default Project Emissions from Halocarbon Destruction and Transportation 30
5.3 Deduction for Vapor Composition Risk 30
6 Project Monitoring and Operations 33
6.1 Reserve Halocarbons Tracking 33
6.2 Point of Origin Documentation Requirements 34
6.3 Custody and Ownership Documentation Requirements 36
6.4 Halocarbon Composition and Quantity Analysis Requirements 37
6.4.1 Halocarbon Quantity Analysis 37
6.4.2 Halocarbon Composition and Concentration Analysis 38
6.4.3 Requirements for the Import/Export of Halocarbon Samples 42
6.5 Destruction Facility Requirements 43
6.6 Monitoring Parameters 45
7 Reporting Parameters 48
7.1 Project Documentation 48
7.2 Record Keeping 48

7.3 Reporting Period and Verification Cycle 49
8 Verification Guidance 50
8.1 Standard of Verification..50
8.2 Monitoring and Operations Plan...50
8.3 Verifying Project Eligibility 50
8.4 Core Verification Activities 52
8.5 Verification Site Visits 52
8.6 Halocarbon Verification Items 53
8.6.1 Project Eligibility and CRT Issuance 53
8.6.2 Conformance with Operational Requirements and Halocarbon Eligibility 55
8.6.3 Quantification of GHG Emission Reductions...56
8.6.4 Risk Assessment 57
8.6.5 Completing Verification 57
9 Glossary of Terms 58
10 References..61
Appendix A Summary of Legal Requirement Test Development 65
Appendix B Summary of Performance Standard Development..69
Appendix C Rules Governing Halocarbon Destruction...74
Appendix D Mexican Regulations Relevant to Halocarbon Management.............................80
Appendix E Default Emission Factors for Calculating Halocarbon Transportation and Destruction Emissions 81
Appendix F Halocarbon Project Diagram Sample...86

List of Tables

Table 2.1. Production Phase-Out Schedule of the Montreal Protocol for Article 5 Countries 4
Table 2.2. Accelerated Production Phase-Out Schedule of the Montreal Protocol for Mexico 5
Table 2.3. Implementation Stages of Mexico’s HCFC Phase-Out Plan 6
Table 4.1. Description of all Sources, Sinks, and Reservoirs...17
Table 5.1. Refrigerant Baseline Scenarios 23
Table 5.2. Global Warming Potential of Eligible Halocarbon Refrigerants 25
Table 5.3. Halocarbon Substitute Refrigerant and Leak Rate Assumptions...............................29
Table 5.4. Eligible Low Pressure and High-Pressure Halocarbons..31
Table 5.5. Determining Site-Specific Deduction for Vapor Composition Risk 31
Table 6.1. Identification of Point of Origin for halocarbon projects 34
Table 6.2. Project Quantitative Monitoring Parameters 45
Table 6.3. Qualitative Monitoring Parameters for Halocarbon Projects......................................47
Table 8.1. Summary of Eligibility Criteria for a Mexico Halocarbon Destruction Project.............51
Table 8.2. Eligibility Verification Items 54
Table 8.3. Operational Requirement and Halocarbon Eligibility Verification Items.....................55
Table 8.4. Quantification Verification Items 56
Table 8.5. Risk Assessment Verification Items..57
Table A.1. Authorizations for Hazardous Waste Management 68
Table B.1. Destruction of ODS in Mexico (1990 to 2008) 70
Table B.2. Destruction of ODS in Mexico (2005 to 2008) 70
Table B.3. Halocarbon Destruction Relative to HCFC-22 and HFC at EOL in Mexico 72
Table E.1. Assumptions Used for Project Emissions from Transportation and Destruction of Halocarbons..84
Table E.2. Project Emissions (Excluding Substitutes) 85

List of Figures

Figure 4.1. Illustration of the GHG Assessment Boundary 16

List of Equations

Equation 5.1. Calculating GHG Emission Reductions 22
Equation 5.2. Calculating Site-Specific Emission Rate 24
Equation 5.3. Baseline Emissions 24
Equation 5.4. Total Project Emissions...28
Equation 5.5. Calculating Project Emissions from the Use of Substitute Refrigerants 29
Equation 5.6. Project Emissions from Transportation and Destruction Using the Default Emission Factors 30
Equation 5.7. Determining Liquid Fill Level in Project Container 32
Equation E.1. Project Emissions from the Destruction of Halocarbons......................................82
Equation E.2. Fossil Fuel Emissions from the Destruction of Halocarbons................................82
Equation E.3. Electricity Emissions from the Destruction of Halocarbons..................................83
Equation E.4. Calculating Project Emissions from Halocarbon Not Destroyed 83
Equation E.5. Calculating Project Emissions of CO_2 from the Oxidation of Halocarbons...........83
Equation E.6. Calculating Project Emissions from the Transportation of Halocarbons...............84

Abbreviations and Acronyms

A/C	Air conditioning
AHRI	Air Conditioning, Heating, & Refrigeration Institute
CBP	U.S. Customs and Border Protection
CEMS	Continuous emissions monitoring system
CESPEDES	Commission for Private Sector Studies for Sustainable Development
CFC	Chlorofluorocarbon
CH_4	Methane
CO_2	Carbon dioxide
CPT	Comprehensive performance test
CRT	Climate Reserve Tonne
DRE	Destruction and removal efficiency
EMA	Entidad Mexicana de Acreditación (Mexican Accreditation Entity)
EOL	End-of-life
EPA	U.S. Environmental Protection Agency
FIDE	Fideicomiso para el Ahorro de Energía Eléctrica (Trust for Electric Energy Saving, a branch of SENER)
GHG	Greenhouse gas
GWP	Global warming potential
HBR	High boiling residue
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin
IPANL	Instituto para la Protección al Ambiente de Nuevo León
ISO	International Organization for Standardization
kg	Kilogram
L	Liter
lb	Pound
LGPGIR	Ley General para la Prevención y Gestión Integral de los Residuos (General Law for Waste Prevention and Integrated Waste Management)
NIST	National Institute for Standards and Technology
NOM	Norma Oficial Mexicana (Mexican Official Standard)
N_2O	Nitrous oxide
ODS	Ozone depleting substance(s)
PCDD	Polychlorinated dibenzo-paradioxin
PCDF	Polychlorinated dibenzofuran

PIC	Product of incomplete combustion
PROFECO	Procuraduria Federal del Consumidor (Federal Attorney's Office of Consumer Protection)
PSEE	Programa de Sustitución de Equipos
REFPROP	NIST Reference Fluid Thermodynamic and Transport Properties Database
Reserve	Climate Action Reserve
RFC	Corporate registration number
RTOC	Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC), a committee within TEAP
SCFI	Secretaría de Comercio y Fomento Industrial (Secretariat of Commerce and Industrial Development, now known as Secretariat of Economy, or Secretaría de Economía)
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales (Secretariat of Environment and Natural Resources)
SENER	Secretaría de Energía (Secretariat of Energy)
SSMP	Startup, shutdown, and malfunction plan
SSR	Source, sink, and reservoir
t	Metric ton (or tonne)
TEAP	Technology and Economic Assessment Panel of the Montreal Protocol (a part of UNEP's Ozone Secretariat)
UNEP	United Nations Environment Programme
CINAM	Colegio de Ingenieros Ambientales de México, A.C.
UPO	Unit for National Ozone Protection (Mexico's National Ozone Unit)
WRI/WBCSD	World Resources Institute/World Business Council for Sustainable Development

1 Introduction

The Climate Action Reserve (Reserve) Halocarbon Protocol provides guidance to account for, report, and verify greenhouse gas (GHG) emission reductions associated with the destruction of Mexican-sourced halocarbons at facilities in Mexico.

The Reserve is an offset registry serving the California cap-and-trade program and the voluntary carbon market. The Reserve encourages actions to reduce GHG emissions and works to ensure environmental benefit, integrity, and transparency in market-based solutions to address global climate change. It operates the largest accredited registry for the California compliance market and has played an integral role in the development and administration of the state's GHG offset program. For the voluntary market, the Reserve establishes high quality standards for carbon offset projects, oversees independent third-party verification bodies, and issues and tracks the transaction of carbon credits (Climate Reserve Tonnes or CRTs) generated from such projects in a transparent, publicly-accessible system. The Reserve is a private 501(c)(3) nonprofit organization based in Los Angeles, California.

This protocol is an update to the Reserve's Mexico Ozone Depleting Substances Protocol Version 1.0 (MX ODS V1.0). Given that some of the refrigerants in this protocol have a null impact on the ozone layer, the protocol name was changed to Mexico Halocarbon Protocol Version 1.0 (MXH V1.0)

Project developers that initiate halocarbon destruction projects use this document to quantify and register GHG reductions with the Reserve. The protocol provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the Reserve. Additionally, all project reports receive independent verification by ISO-accredited and Reserve-approved verification bodies. Guidance for verification bodies to verify reductions is provided in the Reserve Verification Program Manual and Section 8 of this protocol.

This protocol is designed to ensure the complete, consistent, transparent, accurate, and conservative quantification and verification of GHG emission reductions associated with halocarbon destruction project.[1]

[1] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG reduction project accounting principles.

2 The GHG Reduction Project

2.1 Background

The term “halocarbon” refers to chemical compounds containing carbon atoms, and one or more atoms of chlorine, fluorine, bromine or iodine. Halocarbons are greenhouse gases and therefore contribute to climate change. The halocarbon subgroup that releases chlorine, bromide or iodine to the stratosphere cause ozone depletion, such as chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFC) (also called ozone depleting substances or ODS). Hydrofluorocarbons (HFC) do not affect stratospheric ozone and thus are not considered ODS. Halocarbons are used in a wide variety of applications including refrigerants, foam blowing agents, solvents, and fire suppressants. The GWP of these halocarbons range from several hundred to several thousand times that of carbon dioxide (see Table 5.2).

2.1.1 The Montreal Protocol

The adoption of the Montreal Protocol on Substances that Deplete the Ozone Layer[2] in 1987 laid out a global framework for the phase-out of the production of certain known ODS. The Montreal Protocol differentiated two separate phase-out schedules: one for the developing Article 5 countries, such as Mexico,[3] and a more rapid phase-out for the developed Non-Article 5 countries.[4] The phase-out schedule for Article 5 countries, including Mexico, is presented in Table 2.1 below.

Table 2.1. Production Phase-Out Schedule of the Montreal Protocol for Article 5 Countries[5]

Ozone Depleting Substance	Article 5 Countries
CFC (chlorofluorocarbons)	January 1, 2010
Halons	January 1, 2010
Carbon tetrachloride	January 1, 2010
Methyl chloroform	January 1, 2015
Methyl bromide	January 1, 2015
HBFC (Hydrobromofluorocarbons)	January 1, 1996
HCFC (hydrochlorofluorocarbons)	January 1, 2013: freeze at baseline (average 2009/2010)
	January 1, 2015:10% below baseline
	January 1, 2020: 35% below baseline
	January 1, 2025: 67.5% below baseline
	January 1, 2030-December 31, 2039: total of 2.5 % of baseline during the entire period
	January 1, 2040: full phase-out

[2] UNEP, Ozone Secretariat. (1987 and subsequent amendments). The Montreal Protocol on Substances that Deplete the Ozone Layer.
[3] UNEP, Ozone Secretariat. List of Parties categorized as operating under Article 5 paragraph 1 of the Montreal Protocol. Retrieved September 24, 2009, from http://ozone.unep.org/Ratification_status/list_of_article_5_parties.shtml.
[4] See http://ozone.unep.org/Ratification_status/ for a list of all countries that have ratified the Montreal Protocol.
[5] UNEP, Ozone Secretariat. (1987 and subsequent amendments). The Montreal Protocol on Substances that Deplete the Ozone Layer.

For CFC, this protocol is limited to the destruction of phased-out CFC refrigerants sourced in Mexico and destroyed at a destruction facility in Mexico. ODS sourced from other Article 5 countries or from within the U.S. are covered in the Article 5 and U.S. Ozone Depleting Substances Protocols, respectively.

Mexico has been a committed leader on addressing stratospheric ozone protection and the phasing out of ozone-depleting substances. Mexico signed the Montreal Protocol in 1987 and in 1988, became the first Article 5 country to ratify it.[6,7] The Unit for National Ozone Protection (UPO) was set up under Mexico's Secretariat of Environment and Natural Resources (SEMARNAT) to help implement and comply with the Montreal Protocol. SEMARNAT drafted a National CFC Phase-Out Plan in 1989. In ratifying the Montreal Protocol, Article 5 countries agreed to stop all production and imports of CFC ODS, with the exception of certain critical use exemptions, by January 1, 2010. However, Mexico went further in its National CFC Phase-Out Plan with a commitment to phase out all domestic production of CFCs, produced at three domestic facilities, by January 1, 2006, and halt the import of refrigeration equipment and appliances containing CFCs by January 1, 2010. By September 2005, all three domestic CFC production facilities transitioned to produce HCFC-22[8] with the assistance of funding from the Multilateral Fund (MLF) for the Implementation of the Montreal Protocol.[9] Mexico's accelerated phase-out schedules for CFCs and HCFCs are presented in Table 2.2 below.

Table 2.2. Accelerated Production Phase-Out Schedule of the Montreal Protocol for Mexico

Ozone Depleting Substance	Mexico
CFC (chlorofluorocarbons) [10]	January 1, 2006
HCFC (hydrochlorofluorocarbons)	January 1, 2018: 35% below baseline
	January 1, 2020: 50% below baseline
	January 1, 2022: 67.5% of all HCFCs below baseline, and total production phase-out and import ban of HCFC-141b
	January 1, 2030-December 31, 2039: total of 2.5 % of baseline during the entire period[a]
	January 1, 2040: full phase-out[a]

[a] Phase-Out targets for 2030 and 2040 represent Article 5 targets, as opposed to accelerated Mexico commitments.[12]

To implement the phaseout of HCFC, Mexico set out three implementation stages divided by halocarbon subsector reflected inTable 2.3. To this date, Stage 1 has been completed, which

[6] UNEP, Ozone Secretariat. Montreal Protocol on Substances that Deplete the Ozone Layer. "Status of Treaties." Retrieved 9 February 2015 from http://montreal-protocol.org/en/treaties.php.
[7] GIZ GmbH, Programme Proklima, Consumption and emission inventory of fluorinated greenhouse gases (CFC, HCFC and HFC) in Mexico: Final Report, www.giz.de/proklima.
[8] *Ibid.*
[9] UNEP, Ozone Secretariat, Multilateral Fund for the Implementation of the Montreal Protocol, National Phase-out Plans and Projects (as at November 2014).
[10] *Ibid.*
[11] UNEP, Ozone Secretariat, Project Proposals: Mexico, Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, 14 October 2014, UNEP/OzL.Pro/ExCom/73/43, available at: http://www.multilateralfund.org/73/pages/English.aspx.
[12] UNEP, Ozone Secretariat. (1987 and subsequent amendments). The Montreal Protocol on Substances that Deplete the Ozone Layer.

means that there is no more consumption of HCFC for the manufacturing of domestic and commercial refrigeration.

Table 2.3. Implementation Stages of Mexico's HCFC Phase-Out Plan[13]

Stage 1, 2018 35% phase-out	Stage 2, 2020 Up to 50% of phaseout in 2020	Stage 3[14]
▪ Phase-out of foam sector and domestic and commercial refrigeration ▪ Flushing services for refrigeration systems ▪ Aerosol sector	▪ Phase-out of remaining foam and aerosol sector ▪ Remaining flushing services ▪ Extruded Polystyrene (XPS) sector	▪ Servicing sector ▪ Remaining manufacturing sectors ▪ New HCFC production sector

2.1.2 The Kigali Amendment

Through the Kigali Amendment to the Montreal Protocol, all countries have committed to legally binding targets that require gradual reductions in HFC consumption and production. For Mexico, the agreement specifies that a licensing system for the import and export of HFCs should enter into force no later than January 1, 2021. Under this agreement, Mexico will have to freeze its consumption in 2024, taking as a baseline the average of HFC consumption in the period from 2020 to 2022. The goals that Mexico must meet to phase-down 80% of the baseline before 2045, by year are:

- 2020-2022: Average of consumption to set the baseline
- 2024: Consumption freeze
- By 2029: 10% consumption below baseline
- By 2035: 35% consumption below baseline
- By 2040: 50% consumption below baseline
- By 2045: 80% consumption below baseline

Though the Mexican General Law for Waste Prevention and Integrated Waste Management (Ley General para la Prevención y Gestión Integral de los Residuos – LGPGIR)[15] establishes some regulations as to how and by whom halocarbons are managed, neither Mexican domestic law nor the Montreal Protocol requires the destruction of extant stocks of halocarbons. Rather, virgin stockpiles may be sold for use, and installed banks may be recovered, recycled, reclaimed, and reused indefinitely, often in equipment with very high leak rates. Because neither the Montreal Protocol nor Mexican law prevents the use of existing or recycled controlled substances beyond the phase-out dates, even properly managed halocarbon banks will eventually be released to the atmosphere during equipment servicing, use, ongoing storage, and end-of-life.

[13] Multilateral Fund for the Implementation of the Montreal Protocol, May 2019. HCFC Phase-Out Management Plans and HCFC-Production Phase-Out Management Plans. Available at: http://www.multilateralfund.org/Our%20Work/policy/Shared%20Documents/Policy83HPMP-HPPMP.pdf
[14] Based on the last HCFC- Phase-Out Management Plans and HCFC Production Phase-Out Management Plans, dated in May 2019. Mexico has not signed a Phase III halocarbon management plan.
[15] Mexican Official Standard 52, Published Oct 2003, SEMARNAT. Retrieved from http://www.diputados.gob.mx/LeyesBiblio/ref/lgpgir/LGPGIR_orig_08oct03.pdf.

Prior to the production phase-out of CFC in Mexico, equipment utilizing CFC refrigerants was preferred in a wide variety of applications. These applications included industrial and commercial refrigeration, cold storage, comfort cooling equipment (i.e., air conditioning), and various consumer applications. Programs such as the Domestic Appliances Replacement Program (Programa de Sustitución de Equipos, PSEE), which was implemented by the Mexican Trust for Electrical Energy Savings (Fideicomiso para el Ahorro de Energía Eléctrica, FIDE) from 2002 to 2012, have helped reduce the use of CFC by incentivizing the replacement of old refrigerators and other appliances using CFCs with new appliances using alternative refrigerants.[16,17] Even so, use of these CFC is still widespread in older equipment in Mexico, and can be found everywhere from vehicle air conditioners to industrial chillers. These substances continue to be released from equipment through operation, servicing, and end-of-life. However, as new appliances with alternative refrigerants make up an ever-increasing proportion of the refrigeration and air conditioning appliances in Mexico, and fewer old appliances with CFCs are in use, demand for both virgin and used CFC has declined. Increasingly, refrigerants that are reclaimed through programs like PSEE are recovered and stored indefinitely, due to the lack of incentives or regulations to drive destruction.

In the case of HCFC-22 and HFC, a high proportion of these refrigerants are leaked to the atmosphere due to the low levels of recovery, reclamation and recycling. A maximum of six percent of HCFC-22, only from the commercial subsector and at end-of-life (EOL), are recovered before reaching a landfill or a junkyard. In the case of HFC, there is practically no reclamation but if there is any, it is stockpiled indefinitely because there is no demand for its reuse. All stockpiles will eventually leak to the atmosphere. As new HFC continues to come into the market, halocarbon emissions continue to increase each year. Under the context of this protocol, any stockpiles recovered prior to the commencement of this protocol, from non-commercial EOL HCFC-22 equipment, from any EOL HFC equipment, and from servicing cylinders would not drive virgin refrigerant demand. That is because the market does not substitute refrigerants from those sources. Therefore, any destruction of non-commercial used HCFC-22 and eligible HFCs from end-of-life equipment would derive in a benefit to the atmosphere by preventing the release of the refrigerants in a landfill.

2.2 Project Definition

For the purposes of this protocol, a project is defined as any set of activities undertaken by a single project developer resulting in the destruction of eligible halocarbons at a single qualifying destruction facility within a 12-month period. Destruction may take place under one or more Certificates of Destruction. Each Certificate of Destruction must document the halocarbon destroyed. The halocarbon destroyed may come from a single origin (e.g., one supermarket) or from numerous sources. However, the entire quantity of eligible halocarbon destroyed must be documented on one or more Certificates of Destruction issued by a qualifying destruction facility.

[16] Funded by UNIDO and the World Bank through the Multilateral Fund for Implementation of the Montreal Protocol (MLF) and the Mexican government, FIDE's successful appliance recycling program incentivized the purchasing of new, energy efficient, non-CFC appliances by providing consumers direct support, financing support or both, in exchange for recycling the old appliance. Under this program, over 2.3 million refrigerators and air conditioners were recycled, significantly reducing the stock of old refrigeration and air conditioning equipment that uses CFCs. For more information, refer to Appendix B.

[17] "Study on Disposal of ODS Collected from Refrigerators and Air Conditioners under the Mexican Efficient Lighting and Appliances Program," Submitted by the World Bank to the Executive Committee of the Multilateral Fund for Implementation of the Montreal Protocol, March 2012, UNEP/OzL.Pro/ExCom/66/Inf.2.

Although project developers may engage in ongoing recovery, aggregation and destruction activities, destruction events that fall outside of the 12-month window designated for a project may only be counted as part of a separately registered project. Project developers may choose a shorter time horizon for a single project (e.g., three months or six months), but no project may run longer than 12 months.

In order for multiple Certificates of Destruction to be included under a single project, all of the following conditions must be met:

- The project developer and owner of emission reductions are the same for all halocarbon destroyed
- The qualifying destruction facility is the same for all Certificates of Destruction
- Project activities span a timeframe of no more than 12 months from the project's start date to completion of the last halocarbon destruction event
- No Certificate of Destruction is included as part of another project

For all projects, the end fate of the halocarbon must be destruction at a destruction facility in Mexico that is permitted under NOM-098-SEMARNAT-2002[18] or NOM-040-SEMARNAT-2002[19] to destroy hazardous waste, and whose permit explicitly includes the destruction of halocarbons. The destruction facility must meet or exceed the Montreal Protocol's Technology and Economic Assessment Panel (TEAP) guidelines provided in the Report of the Task Force on Destruction Technologies.[20]

2.3 Eligible Halocarbons

Eligible halocarbons used in refrigeration applications and eligible for crediting under this protocol are:

- CFC-11
- CFC-12
- CFC-113
- CFC-114
- HCFC-22
- HFC-32
- HFC-125
- HFC-134a
- HFC-143a

Halocarbon blowing agent extracted from appliance foams is not eligible under this protocol.

2.4 Eligible Halocarbon Sources

2.4.1 Chlorofluorocarbon Eligible Sources

Eligible CFC sources are defined as halocarbon material sourced from Mexico. For the purposes of this protocol, "sourced from Mexico" refers to CFC produced domestically in Mexico

[18] SEMARNAT, Norma Oficial Mexicana NOM-098-SEMARNAT-2002, http://www.profepa.gob.mx/innovaportal/file/1309/1/nom-098-semarnat-2002.pdf.
[19] SEMARNAT, Norma Oficial Mexicana NOM-040-SEMARNAT-2002, http://www.profepa.gob.mx/innovaportal/file/1236/1/nom-040-semarnat-2002.pdf.
[20] UNEP TEAP. (2002). Report of the Task Force on Destruction Technologies.

prior to January 1, 2006,[21] CFC imported to Mexico for domestic consumption prior to January 1, 2010 that could legally be sold into the Mexican refrigerant market, as well as CFC originating from refrigerators and other appliances imported to Mexico for domestic use prior to January 1, 2010.[22]

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

1. Privately held stockpiles of used CFC refrigerant that can legally be sold to the market.
2. Privately held stockpiles of virgin CFC refrigerant that can legally be sold to the market. (See additional eligibility restrictions in Section 3.2)
3. Mexican government stockpiles of seized CFC refrigerant that can legally be sold to the market.
4. Mexican government stockpiles of seized CFC that cannot be legally sold to the market.
5. Used CFC refrigerant recovered from industrial, commercial, or residential equipment at servicing or end-of-life.

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

2.4.2 Hydrochlorofluorocarbon Eligible Sources

Eligible HCFC sources are defined as HCFC-22 material sourced from Mexico. For the purposes of this protocol, “sourced from Mexico” refers to HCFC-22 produced domestically in Mexico, HCFC-22 imported to Mexico for domestic consumption and that could legally be sold into the refrigerant market, as well as HCFC-22 originating from refrigerators and other appliances imported and/or manufactured in Mexico for domestic refrigeration use.

Accelerated removal of HCFC-22 or HFC by stockpiling refrigerant that could have been used for a longer period of time can cause higher emissions to the atmosphere if the refrigerant is not substituted with a lower GWP refrigerant[23]. For HCFC-22 and HFC stockpiles, any stockpile in storage prior to protocol adoption is eligible because it is assumed that the recovery was not motivated by the carbon market and therefore there would be a low risk of accelerated removal of HCFC-22 or HFC. HCFC-22 and HFC stockpiles recovered after protocol adoption and up to one year after protocol adoption are eligible. To prevent higher emissions to the atmosphere, the GWP of substitute refrigerants assumed in Table 5.3 are conservatively high.

In the scoping paper that informed this protocol update, Reserve staff determined that eligibility of used HCFC-22 refrigerant should be limited to those that are recovered from commercial refrigeration equipment at end-of-life *and* that would not have been recovered in the baseline or that was substituted with a lower GWP refrigerant. However, during protocol development, the workgroup concluded that the total amount of commercial HCFC-22 that is recovered in Mexico on a yearly basis was overestimated. Reserve staff determined that it is reasonable to assume that up to 2% of HCFC in Mexico was recovered on a yearly basis *across all sectors*. Thus, it is no longer necessary to exclude commercial HCFC-22 from eligibility.

[21] UNEP, Ozone Secretariat, Multilateral Fund for the Implementation of the Montreal Protocol, National Phase-out Plans and Projects (as of November 2014).
[22] Any halocarbon produced in association with a critical use or as by-product is ineligible.
[23] See scoping paper at https://www.climateactionreserve.org/how/protocols/mexico-halocarbon/.

Eligible sources of hydrochlorofluorocarbons are those that meet the following criteria:

1. Stockpiles of used HCFC-22 refrigerant recovered up to one year after the date of adoption of the protocol.
2. Used HCFC-22 refrigerant recovered from industrial, commercial, residential, transportation, stationary or mobile refrigeration and/or air conditioning equipment at end-of-life.
3. Used HCFC-22 refrigerant recovered from industrial, commercial, residential, transportation, stationary or mobile refrigeration and/or air conditioning equipment that was retrofitted to use zero or low GWP refrigerants.[24]
4. Remnants of virgin HCFC-22 in servicing cylinders. For this halocarbon source to be eligible, the project developer must demonstrate that the quantity obtained from each servicing cylinder was not higher than 1 kg.

2.4.3 Hydrofluorocarbon Eligible Sources

Eligible HFC sources are defined as HFC-134a, HFC-125, HFC-32 and HFC-143a material sourced from Mexico. For the purposes of this protocol, “sourced from Mexico” refers to HFC imported to Mexico for domestic manufacture and use, as well as HFC originating from refrigerators and other appliances imported to Mexico for domestic refrigeration use.

The following HFC-134a, HFC-125, HFC-32 and HFC-143a sources are eligible:

1. Stockpiles of used HFC refrigerant recovered up to one year after the date of adoption of the protocol.
2. Used HFC refrigerant recovered from industrial, commercial, residential, transportation, stationary or mobile refrigeration and/or air conditioning equipment at end-of-life.
3. Used HFC refrigerant recovered from industrial, commercial, residential, transportation, stationary or mobile refrigeration and/or air conditioning equipment retrofitted to use zero or low GWP refrigerants.
4. Remnants of virgin HFC in servicing cylinders. For this halocarbon source to be eligible, the project developer must demonstrate that the quantity obtained from each servicing cylinder was not higher than 1 kg.

For projects destroying refrigerant recovered from equipment at end-of-life, the project developer must demonstrate the equipment was at end-of-life, was sent to a landfill or destroyed.

Projects destroying refrigerants from retrofitted equipment must provide documentation to prove that there is no technical or legal barrier for the continued use of the baseline refrigerant for 10 years. In other words, the project developer should prove that the retrofitted system could reasonably have been expected to continue operating for the entire project crediting period using the baseline refrigerant, or could have been repaired or refurbished such that the operating life using the destroyed refrigerant would be extended through the entire project crediting period.

[24] Organic refrigerants hydrofluoroolefins or other refrigerants with a GWP of 13 or less. The list includes Propane, N-butane, Isobutane, N-pentane, Isopentane, Propylene, CO_2, Ammonia, water, HFE-7500, Dimethyl Ether, 1,2-Dichloroethane, HFO-1233zd, HFO-1234ze, HFO-1233yf and HFO-1336mzz.

Project developers seeking to register projects involving the destruction of refrigerant from other Article 5 countries must use the Reserve's Article 5 Ozone Depleting Substances Protocol.

2.5 The Project Developer

The "project developer" is an entity that has an active account on the Reserve, submits a project for listing and registration with the Reserve, and is ultimately responsible for all project reporting and verification. Project developers may be halocarbon aggregators, facility owners, facility operators or GHG project financiers. The project developer must have clear ownership of the project's GHG reductions. Ownership of the GHG reductions must be established by clear and explicit title and the project developer must attest to such ownership prior to commencement of verification activities each time a project is verified by signing the Reserve's Attestation of Title form.[25]

[25] Attestation of Title form available at http://www.climateactionreserve.org/how/program/documents/. Verification activities not related to confirming the Attestation of Title (such as site visits or project material eligibility confirmation) may commence prior to this form being uploaded to the Reserve.

3 Eligibility Rules

Projects must fully satisfy the following eligibility rules in order to register with the Reserve. The criteria only apply to projects that meet the definition of a GHG reduction project (Section 2.2).

Eligibility Rule I:	Location	⟶	*Mexico*
Eligibility Rule II:	Project Start Date	⟶	*No more than six months prior to project submission*
Eligibility Rule III:	Additionality	⟶	*Meet performance standard*
		⟶	*Exceed legal requirements*
Eligibility Rule IV:	Regulatory Compliance	⟶	*Compliance with all applicable laws*

3.1 Location

For halocarbon destruction to be eligible as a project under this protocol, all halocarbons must be sourced from stocks in Mexico, as described in Section 2.4, and destroyed within Mexico. Project halocarbon samples taken to meet halocarbon composition analysis requirements outlined in Section 6.4.2 may be sent to the U.S., as needed.[26]

Project developers seeking to register projects involving the destruction of halocarbons from the U.S. or other Article 5 countries must use the Reserve's U.S. and Article 5 Ozone Depleting Substances Protocols, respectively.

3.2 Project Start Date

The project start date is defined as the date on which destruction activities commence, as documented on a Certificate of Destruction.

To be eligible, the project must be submitted to the Reserve no more than six months after the project start date, unless the project is submitted during the first 12 months following the date of adoption of this protocol by the Reserve Board (the Effective Date, expected June 16, 2021).[27] For a period of 12 months from the Effective Date of this protocol (Version 1.0), projects with start dates no more than 24 months prior to the Effective Date of this protocol are eligible. Specifically, projects with start dates on or after June 16, 2019 are eligible to register with the Reserve if submitted by June 16, 2022. Projects with start dates prior to June 16, 2019 are not eligible under this protocol. Projects may always be submitted for listing by the Reserve prior to their start date.

Privately held and saleable virgin halocarbon refrigerants are not eligible under this protocol.

[26] Notably, any halocarbon remaining upon completion of the laboratory analysis does not need to be returned to Mexico for destruction, but may be destroyed according to the lab's normal waste disposal protocols.
[27] Projects are considered submitted when the project developer has fully completed and filed the appropriate Project Submittal Form, available at http://www.climateactionreserve.org/how/program/documents/.

3.3 Project Crediting Period

A halocarbon project includes a discrete series of destruction events over a period of up to 12 months, beginning on the project start date. No destruction events may occur more than 12 months after the project start date. For the purposes of this protocol, it is assumed that, absent the project, the avoided halocarbon emissions would have occurred over a longer time-horizon.

Under this protocol, the project crediting period is the period of time over which avoided emissions are quantified for the purpose of determining creditable GHG reductions. Specifically, halocarbon projects are issued CRTs for the quantity of halocarbon that would have been released over a ten-year period following a destruction event. At the time the project is verified, CRTs are issued for all halocarbon emissions avoided by the project over the 10-year crediting period.

3.4 Additionality

The Reserve strives to register only projects that yield surplus GHG reductions that are additional to what would have occurred in the absence of a carbon offset market.

Projects must satisfy the following tests to be considered additional:

1. Legal requirement test
2. Performance standard test

3.4.1 The Legal Requirement Test

All projects are subject to a legal requirement test to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to federal, state, or local regulations, or other legally binding mandates. A project passes the legal requirement test when there are no laws, statutes, regulations, court orders, environmental mitigation agreements, permitting conditions or other legally binding mandates requiring the destruction of halocarbons.[28]

To satisfy the legal requirement test, project developers must submit a signed Attestation of Voluntary Implementation form[29] prior to the commencement of verification activities each time the project is verified (see Section 8).[30] In addition, the project's Monitoring and Operations Plan (Section 6) must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the legal requirement test.

3.4.2 The Performance Standard Test

Projects pass the performance standard test by meeting a performance threshold, i.e., a standard of performance applicable to all halocarbon destruction projects, established on an *ex ante* basis by this protocol.[31]

For this protocol, the Reserve uses a performance standard test based on an evaluation of Mexican "common practice" for managing halocarbons. As detailed in Appendix B, minimal

[28] A summary of the study reviewing Mexican regulatory requirements and which establishes the legal requirement test and its update is provided in Appendix A.
[29] Attestation forms are available at http://www.climateactionreserve.org/how/program/documents/.
[30] Verification activities not related to confirming the Attestation of Voluntary Implementation (such as site visits or project material eligibility confirmation) may commence prior to this form being uploaded to the Reserve.
[31] A summary of the study to establish the performance standard test is provided in Appendix B.

destruction of halocarbon has taken place in Mexico, and the destruction of halocarbons sourced from Mexico rarely occurs. Because the Reserve has determined that destruction of CFC, HCFC-22 and HFC refrigerants from Mexico (see full list in Section 2.3) is not common practice, projects that meet the project definition and other eligibility requirements of this protocol pass the performance standard test.

The Reserve will periodically re-evaluate the appropriateness of the performance standard test, and if necessary, amend this protocol accordingly. Projects that meet the performance standard test and other requirements of the version of this protocol in effect at the time of their submission are eligible to generate CRTs.

3.5 Regulatory Compliance

Projects must be in material compliance with all applicable laws (e.g., air, water quality, and safety) at all times during each reporting period, as defined in Section 5. The regulatory compliance requirement extends to the operations of destruction facilities where the halocarbon is destroyed, as well as the facilities where mixed halocarbon projects are mixed and sampled, the transportation of the halocarbon to the destruction facility, and the export/import of the project halocarbon samples for laboratory analysis. These facilities and transportation events must secure the required authorizations and permits to meet applicable regulatory requirements during implementation of project activities, as well as remain in compliance with those permits at all times during each reporting period.[32] For example, any upsets or exceedances of permitted emission limits at a destruction facility must be recorded in its daily log and managed in keeping with its Risk Prevention Plan (Programa de Prevencion de Riesgo).[33]

Project developers must attest that project activities do not cause material violations of applicable laws (e.g., air, water quality, safety, etc.). To satisfy this requirement, project developers must submit a signed Attestation of Regulatory Compliance form[34] prior to the commencement of verification activities each time the project is verified. Project developers are also required to disclose in writing to the verifier any and all instances of legal violations – material or otherwise – caused by the project activities.

A violation should be considered to be “caused” by project activities if it can be reasonably argued that the violation would not have occurred in the absence of the project activities. If there is any question of causality, the project developer shall disclose the violation to the verifier.

If a verifier finds that project activities have caused one or more material violation leading up to and including a destruction event, then no CRTs will be issued for GHG reductions from that destruction event. Verifiers shall use professional judgment to assess such violations, but are

[32] In addition to the destruction facility’s permits allowing halocarbon destruction (either NOM-098-SEMARNAT-2002 or NOM-040-SEMARNAT-2002), there are a number of regulations related to halocarbon management that are applicable to project activities. The LPGIR states that generators of hazardous waste, such as halocarbons, must register with SEMARNAT (SEMARNAT-07-017). Generators and owners of hazardous waste may also hire authorized service providers to collect and store, reuse, recycle or co-process, treat, dispose of, and/or transport the waste. These authorizations are codified by SEMARNAT-07-033-A, B, C, D, F, H, and I, respectively. Additional regulations and complete citations for each are provided in Appendix D.

[33] The Risk Prevention Plan and environmental contingencies for emergencies and accidents is a requirement of permission to incinerate hazardous waste (SEMARNAT-07-033-F) and is similar to the startup, shutdown, and malfunction plan (SSMP) required at U.S. destruction facilities. http://tramites.semarnat.gob.mx/index.php/residuos-peligrosos/autorizaciones/151-semarnat-07-033-f-incineracion-de-residuos-peligrosos.

[34] Attestation forms are available at http://www.climateactionreserve.org/how/program/documents/.

also encouraged to consult with the Reserve in making a determination as to whether or not the violation(s) were material and were caused by project activities. In these circumstances, the Reserve will assess the violation(s) and make a project-specific determination. Individual violations due to administrative or reporting issues, or due to “acts of nature,” are not considered material and will not affect CRT crediting. However, recurrent administrative violations directly related to project activities may affect crediting. Verifiers must determine if recurrent violations rise to the level of materiality. If the verifier is unable to assess the materiality of the violation, then the verifier shall consult with the Reserve.

The project developer may choose to send lab samples for analysis in the United states, which is optional under this protocol. All import/export activities necessary for halocarbon Composition Analysis (see Section 6.4.2) must be conducted in full compliance with import/export rules of the U.S. and Mexico. In particular, project activities must be in compliance with the rules promulgated by the U.S. EPA per the authority granted by Title VI of the Clean Air Act,[35] U.S. Customs, and Article 26, Subarticle IV of the Mexican LGPGIR,[36] in which SEMARNAT-07-029 authorizes export, and Mexican customs or the most recent halocarbon regulations at time of project implementation.[37] Both Mexico and the U.S. allow for *de minimis* quantities of halocarbons to be exported/imported under an exemption for laboratory and analytical uses. Full documentation of this process, including all petition and record-keeping documents, must be retained and provided for verification. For projects exporting halocarbons to the U.S. for lab analysis, any halocarbon that does not have a complete import record into the U.S. is ineligible (see section 6.4.3).

[35] U.S. 40 CFR 82 (b) specifically allows for the exemption of halocarbon samples to be imported for the laboratory and analytical use exemption.
[36] SEMARNAT, Ley General para la Prevención y Gestión Integral de los Residuos, http://www.diputados.gob.mx/LeyesBiblio/ref/lgpgir/LGPGIR_orig_08oct03.pdf.
[37] SEMARNAT, Tramites y Servicios. Residuos peligrosos: Importacion/Exportacion, http://tramites.semarnat.gob.mx/index.php/residuos-peligrosos/importacion-exportacion.

4 The GHG Assessment Boundary

The GHG Assessment Boundary delineates the GHG sources, sinks, and reservoirs (SSRs) that must be assessed by project developers in order to determine the net change in emissions caused by a halocarbon project.[38]

Figure 4.1 illustrates all relevant GHG SSRs associated with halocarbon project activities and delineates the GHG Assessment Boundary.

Table 4.1 provides greater detail on each SSR and justification for the inclusion or exclusion of certain SSRs and gases from the GHG Assessment Boundary.

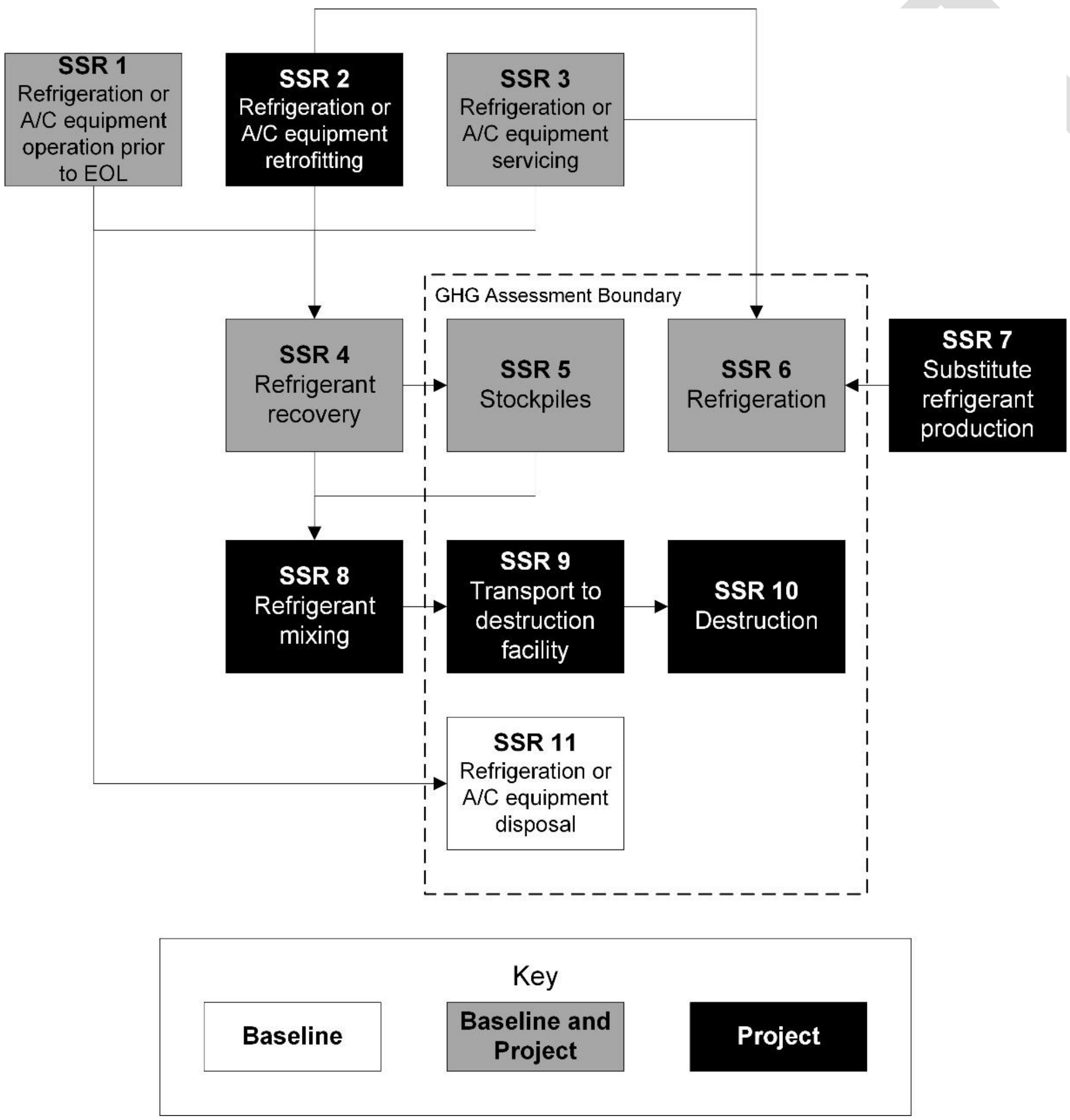

Figure 4.1. Illustration of the GHG Assessment Boundary

38 The definition and assessment of SSRs is consistent with ISO 14064-2 guidance.

Table 4.1. Description of all Sources, Sinks, and Reservoirs

SSR		Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
1	Refrigeration and A/C equipment operation prior to end-of-life (EOL)	Halocarbon emissions from leaks from origin equipment prior to end-of-life	Halocarbons	E	N/A	Excluded, as project activity is unlikely to affect emissions relative to baseline activity
2	Refrigeration and A/C equipment retrofitting	Fossil fuel and electricity emissions from retrofitting refrigeration equipment to use low or zero GWP refrigerants	CO_2	E	N/A	Excluded, as this emission source is assumed to be very small
			CH_4	E	N/A	Excluded, as this emission source is assumed to be very small
			N_2O	E	N/A	Excluded, as this emission source is assumed to be very small
3	Refrigeration and A/C equipment servicing	Fossil fuel and electricity emissions from recharging refrigeration equipment with virgin halocarbon	CO_2	E	N/A	Excluded, as this emission source is assumed to be very small
			CH_4	E	N/A	Excluded, as this emission source is assumed to be very small
			N_2O	E	N/A	Excluded, as this emission source is assumed to be very small
4	Refrigerant recovery	Fossil fuel and electricity emissions from recovering used or remnant refrigerants from servicing, retrofitting and EOL equipment	CO_2	E	N/A	Excluded, as this emission source is assumed to be very small
			CH_4	E	N/A	Excluded, as this emission source is assumed to be very small
			N_2O	E	N/A	Excluded, as this emission source is assumed to be very small

SSR		Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
5	Stockpiles	Halocarbon emissions occurring from long-term storage of halocarbons	Halocarbons	I	**Baseline**: Estimated based on site-specific emission rates **Project**: N/A	Baseline emissions may be significant
6	Refrigeration	Emissions of halocarbon from leaks and servicing through continued operation of equipment	Halocarbons	I	**Baseline**: Estimated according to appropriate baseline scenario **Project**: N/A	Baseline equipment emissions may be significant
		Emissions of substitute from leaks and servicing through continued operation of equipment	Low or zero GWP refrigerant	I	**Baseline:** N/A **Project:** Estimated based on default emission rate	Project equipment emissions may be significant
		Indirect emissions from grid-delivered electricity	CO_2	E	N/A	Excluded, as project activity is unlikely to affect emissions relative to baseline activity
			CH_4	E	N/A	Excluded, as project activity is unlikely to affect emissions relative to baseline activity
			N_2O	E	N/A	Excluded, as project activity is unlikely to affect emissions relative to baseline activity
7	Substitute refrigerant production	Emissions of substitute refrigerant occurring during production	Halocarbon	E	N/A	Excluded, as this emission source is assumed to be very small
		Fossil fuel emissions from the production of	CO_2	E	N/A	Excluded, as this emission source is assumed to be very small

SSR		Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
		substitute refrigerants	CH_4	E	N/A	Excluded, as this emission source is assumed to be very small
			N_2O	E	N/A	Excluded, as this emission source is assumed to be very small
8	Refrigerant mixing	Fossil fuel emissions from halocarbon mixing activities at mixing facility	CO_2	E	N/A	Excluded, as these emission sources are assumed to be very small
			CH_4			
			N_2O			
9	Transport to destruction facility	Fossil fuel emissions from the vehicular and ocean transport of halocarbons from aggregation point to final destruction facility	CO_2	I	**Baseline:** N/A **Project:** Estimated based on distance and weight transported using a default deduction	Project emissions will be small and are calculated using the default factor provided
			CH_4	E	N/A	Excluded, as this emission source is assumed to be very small
			N_2O	E	N/A	Excluded, as this emission source is assumed to be very small
10	Destruction	Emissions of halocarbons from incomplete destruction at destruction facility	Halocarbons	I	**Baseline:** N/A **Project:** Estimated based on weight of halocarbons destroyed, using a default deduction	Project emissions will be small and are calculated using the default factor provided

SSR		Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
		Emissions from the oxidation of carbon contained in destroyed halocarbons	CO_2	I	**Baseline:** N/A **Project:** Estimated based on weight of halocarbons destroyed, using a default deduction	Project emissions will be small and are calculated using the default factor provided
		Fossil fuel emissions from the destruction of halocarbons at destruction facility	CO_2	I	**Baseline:** N/A **Project:** Estimated based on weight of halocarbons destroyed, using a default deduction	Project emissions will be small and are calculated using the default factor provided
			CH_4	E	N/A	Excluded, as this emission source is assumed to be very small
			N_2O	E	N/A	Excluded, as this emission source is assumed to be very small
		Indirect emissions from the use of grid-delivered electricity	CO_2	I	**Baseline:** N/A **Project:** Estimated based on weight of halocarbons destroyed, using a default deduction	Project emissions will be small and are calculated using the default factor provided
			CH_4	E	N/A	Excluded, as this emission source is assumed to be very small
			N_2O	E	N/A	Excluded, as this emission source is assumed to be very small

SSR		Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
11	Refrigeration and A/C equipment disposal	Emissions of halocarbons from the release of refrigerant at end-of-life	Halocarbons	I	**Baseline**: Estimated as 100% immediate release **Project**: N/A	Baseline emissions may be significant
		Fossil fuel emissions from the recovery and aggregation of refrigerant at end-of-life	CO_2	E	N/A	Excluded, as this emission source is assumed to be very small
			CH_4	E	N/A	Excluded, as this emission source is assumed to be very small
			N_2O	E	N/A	Excluded, as this emission source is assumed to be very small

5 Quantifying GHG Emission Reductions

GHG emission reductions from a halocarbon project are quantified by comparing actual project emissions to the calculated baseline emissions. Baseline emissions are an estimate of the GHG emissions from sources within the GHG Assessment Boundary (see Section 4) that would have occurred in the absence of the halocarbon destruction project. Project emissions are actual GHG emissions that occur at sources within the GHG Assessment Boundary. Project emissions must be subtracted from the baseline emissions to quantify the project's total net GHG emission reductions (Equation 5.1.).

The length of time over which GHG emission reductions are quantified and verified is called a "reporting period." A project may not span more than 12 months, and GHG emission reductions must be quantified and verified once for each reporting period. Project developers may choose to have multiple destruction events within 12 months, if desired. The quantification methods presented below are specified for a single reporting period.

Equation 5.1. Calculating GHG Emission Reductions

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

Where,

			Units
ER_t	=	Total emission reductions during the reporting period	tCO_2e
BE_t	=	Total baseline emissions during the reporting period, from all SSRs in the GHG Assessment Boundary (as calculated in Section 5.1)	tCO_2e
PE_t	=	Total project emissions during the reporting period, from all SSRs in the GHG Assessment Boundary (as calculated in Section 5.2)	tCO_2e

5.1 Quantifying Baseline Emissions

Total baseline emissions for the reporting period must be estimated by calculating and summing the emissions from all relevant baseline SSRs that are included in the GHG Assessment Boundary (as indicated in Table 4.1) using Equation 5.3. This includes emissions from stockpiled refrigerants, end-of-life refrigerants, refrigerants from retrofitted equipment and from servicing cylinders that would have occurred over the ten-year crediting period. Note that emissions shall be quantified in kilograms throughout this section and converted into metric tons in Equation 5.3 below.

The Reserve has defined 11 different default baselines for refrigerants in Mexico. Table 5.1 identifies the refrigerant categories, and the associated applicable default baseline scenario selected to provide a conservative estimation of baseline emissions in Mexico. Project developers may use a project-specific Annual Emission Rate based on available evidence or data and subject to Reserve approval. Project-specific emission rates will be needed for any *retrofitted* refrigeration equipment that does not meet any of the refrigeration system types in scenarios 7 to 10 in Table 5.1.

Table 5.1. Refrigerant Baseline Scenarios

Refrigerant Origin	Baseline Scenario	Applicable Default Annual Emission Rate	Default 10-year Cumulative Emissions (%)[39] (ER_{refr})
1. Privately held stockpiles of used CFC refrigerant that can legally be sold to the market	Continued storage[40]	10%[41]	65%
2. Privately held stockpiles of virgin CFC refrigerant that can legally be sold to the market	Continued storage	10%	65%
3. Government stockpiles of CFC refrigerant that can legally be sold into the refrigerant market	Continued storage	10%	65%
4. Government stockpiles of CFC refrigerants that cannot legally be sold into the refrigerant market	Continued storage	See $ER_{stock,i}$ in Equation 5.2	See *ERrefr* in Equation 5.3
5. Stockpiles of used HCFC-22 and HFC refrigerant recovered up to one year after protocol adoption	Continued storage	10%	65%
6. Used CFC, HCFC-22 and HFC refrigerant recovered from end-of-life equipment	End-of-life release to the atmosphere	100%[42]	100%
7. HCFC-22 and HFC refrigerant recovered from retrofitted standalone equipment	Gradual release to the atmosphere	4.5%[43]	37%
8. HCFC-22 and HFC refrigerant recovered from retrofitted centralized commercial equipment and condensing units	Gradual release to the atmosphere	16.25%[43]	83%
9. HCFC-22 and HFC refrigerant recovered from retrofitted centralized industrial equipment	Gradual release to the atmosphere	11.5%[43]	70%
10. HCFC-22 and HFC refrigerant recovered from retrofitted chillers	Gradual release to the atmosphere	5.25%[43]	22%

[39] 10-year cumulative emissions = $1-(1-\text{emission rate})^{10}$, or the percent of a given substance which will be released over ten years at a constant emission rate.

[40] Due to the success of the CFC Phase-out program in Mexico and incentives for new non-CFC appliances, there is very little ongoing demand for virgin or used CFCs. As such, virgin and reclaimed CFCs are assumed to remain in continued storage for the duration of the crediting period. See Appendix A for more information.

[41] The 10% leak rate for continued storage is taken from the 2012 World Bank “Study on Disposal of Halocarbons Collected from Refrigerators and Air Conditioners under the Mexican Efficient Lighting and Appliances Program.” This assumption was further confirmed by a 2006 Report of UNEP TEAP’s Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC), which cites a global CFC leakage from A5 countries of approximately 18%. RTOC reports in 2010 and 2014 did not cite leak rate figures for Article 5 countries, but referred to non-Article 5 leak rates as typically 10-25% but possibly as low as 3.5%, simply noting that the leak rate in Article 5 countries is higher. For conservativeness, the Reserve chose the lower 10% leak rate cited in the World Bank report. Full citations for all four resources can be found in Section 10.

[42] It is assumed that the refrigerant will be fully released to the atmosphere when disposed in a landfill during the crediting period.

[43] Lower quartile from leak rate range given for refrigeration equipment subsectors in IPCC 2006. 2006 IPCC guidelines for national greenhouse gas inventories. 2013-04-28. http://www. ipcc-nggip. iges. or. jp./public/2006gl/index. html.

Refrigerant Origin	Baseline Scenario	Applicable Default Annual Emission Rate	Default 10-year Cumulative Emissions (%)[39] (*ER_{refr}*)
11. Remnants of virgin HCFC-22 and HFC cylinders	End-of-life release to the atmosphere	100%[43]	100%

The site-specific emission rate for stockpiles shall be calculated according to Equation 5.2. For all origins except government stockpiles of CFC refrigerants that cannot legally be sold into the refrigerant market, the use of a site-specific annual emission rate is subject to Reserve approval. To define a project-specific emission rate, project developers can provide site-specific refrigerant leakage studies or use Equation 5.2. To use equation 5.2. the project developer must demonstrate that the refrigerant container was sealed (for example with a shrinking film) after the container was filled with the refrigerant, and that no further refrigerant was added or removed after the initial refrigerant volume (*Qstart* in Equation 5.2) was registered.

Equation 5.2. Calculating Site-Specific Emission Rate

$$\boldsymbol{ER_{stock,i}} = \left(\mathbf{1} - \frac{\boldsymbol{Q_{end}}}{\boldsymbol{Q_{start}}}\right)^{\frac{1}{y}}$$

Where,

			Units
$ER_{stock,i}$	=	Average annual emission rate of refrigerant *i*	%
Q_{end}	=	Total quantity of refrigerant *i* in stockpile at time of destruction	kg of halocarbons
Q_{start}	=	Total quantity of refrigerant *i* in stockpile at time of seizure or at time of collecting the stockpile prior to sealing the container	kg of halocarbons
y	=	Time from seizure to destruction of halocarbon stockpile	years

Equation 5.3 shall be used to calculate the baseline emissions that would have occurred over a ten-year horizon in the absence of the project activity, per the project crediting period limit (see Section 3.3). This equation requires the use of the applicable emission rate provided in Table 5.1 or calculated using Equation 5.2, and the halocarbon-specific GWP provided in Table 5.2.

Equation 5.3. Baseline Emissions

$$\boldsymbol{BE_t} = \left[\frac{\sum_i \left(\boldsymbol{Q_{refr,i}} \times \boldsymbol{ER_{refr,i}} \times \boldsymbol{GWP_{refr,i}}\right)}{\mathbf{1000}}\right] \times (\mathbf{1} - \boldsymbol{VR})$$

Where,

			Units
BE_t	=	Total quantity of refrigerant baseline emissions during the reporting period	tCO_2e
$Q_{refr,i}$	=	Total quantity of pure refrigerant halocarbon *i* sent for destruction by the project	kg halocarbons
$ER_{refr,i}$	=	10-year cumulative emission rate of refrigerant halocarbon *i* (see Table 5.1)	%
$GWP_{refr,i}$	=	Global warming potential of refrigerant halocarbon *i* (see Table 5.2)	kg CO_2e/ kg halocarbons
1000	=	Conversion from kilograms to metric tons	kg/t
VR	=	Deduction for vapor composition risk (see Section 5.3)	%

Table 5.2. Global Warming Potential of Eligible Halocarbon Refrigerants

Halocarbon Species	Global Warming Potential[44] (CO_2e)
CFC-11	4,660
CFC-12	10,200
CFC-113	5,820
CFC-114	8,590
HCFC-22	1,760
HFC-32	677
HFC-125	3,170
HFC-134a	1,300
HFC-143a	4,800

To calculate $Q_{refr,i}$ (total quantify of pure refrigerant halocarbon sent for destruction), the total weight of material destroyed by the project shall be adjusted to exclude the weight of ineligible material, including high boiling residue, as determined by the laboratory analysis required in Section 6.4.2. In the case of multiple laboratory analyses, the highest reported value for HBR shall be used. In any case where the composition of the single halocarbon species is less than 100%, the value of this term must be adjusted to reflect the weight of pure halocarbon for each eligible chemical. See Box 5.1 for an example calculation.

While water is also considered ineligible material, the moisture content requirement in Section 6.4.2 of the protocol (i.e., that the moisture content must be less than 75% of the saturation point for the halocarbon) already ensures that the weight of any moisture present will not have a material impact on the quantification of emission reductions. Thus, the weight does not need to be adjusted to reflect the weight of moisture present in the sample.

Box 5.1. Quantifying High Boiling Residue

As the total weight of material destroyed by the project must be adjusted for ineligible material, high boiling residue (HBR) must be quantified and deducted.

Example:

A project destroys 1,000 kilograms of material in a tank. The laboratory reports that the sample contains 5% high boiling residue and 95% eligible halocarbon_i.

$Q_{refr,i}$ = (1,000 kg x 0.95 x 0.95)

The value of $Q_{refr,i}$ equals 902.5 kilograms.

If, during verification, the verification body cannot confirm that a portion of the halocarbon that was sent for destruction was eligible, this portion of the material shall be considered ineligible. This ineligible halocarbon shall be excluded from baseline emission calculations. The quantity of ineligible halocarbon sent for destruction shall be subtracted from $Q_{refr,i}$ prior to the calculation of Equation 5.3 in order to calculate baseline emissions only for halocarbon that was confirmed to

[44] Appendix 8.A: Lifetimes, Radiative Efficiencies and Metric Values (page 732) in Anthropogenic and Natural Radiative Focing. In: IPCC. 2013. Climate Change: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

be eligible by the verification body. This quantity shall be determined by one of the following methods:

Option A: Confirmed weight and composition

If the project developer can produce data that, based on the verifier's professional judgment, confirm the weight and composition for the specific halocarbon(s) that is deemed to be ineligible (or whose eligibility cannot be confirmed), these data shall be used to adjust the value of $Q_{refr,i}$ accordingly.

Option B: Default values

If sufficient data are not available to satisfy the Option A requirements, then the most conservative estimate of the weight and composition of the ineligible container of halocarbon shall be used. Specifically, the composition of the ineligible container of halocarbons shall be assumed to be 100 percent of the halocarbon species with the highest GWP based on the composition analysis, and the relevant container that was deemed ineligible shall be assumed to have been full. If the project developer has only some of the data required for Option A (i.e., weight or composition, but not both), this may be used in place of the conservative assumptions above, as long as the data can be confirmed by the verification body. The resulting estimate of the weight of ineligible halocarbon shall be subtracted from the total weight of that halocarbon species destroyed in the project, not to exceed the actual amount of that halocarbon species destroyed. See Box 5.2 for an example of Option B.

Box 5.2. Applying Option B to Adjust for Ineligible Halocarbon After Destruction

This option shall be applied when multiple containers of halocarbons are combined into a single container for destruction, but the eligibility of the halocarbons in one or more of the original containers cannot be verified.

Example:

A refrigerant aggregator receives shipments of three different containers (A, B, and C), which are combined into one project container (Z) for destruction. During verification, the project developer is unable to produce documentation to verify the eligibility of container C.

Original Containers from Point of Origin	Maximum Container Volume	Composition
A	1000 L	unknown
B	500 L	unknown
C	500 L	unknown
Project container	**Weight**	**Composition**
Z	2268 kg	50% CFC-11 50% CFC-12

Based on Option B above, the project developer must assume that the composition of container C was 100 percent CFC-12 and that the container was completely full. Using the temperature recorded on the composition analysis (16.67°C for this example), the maximum amount of halocarbons would be equal to the volume of the container (500 L) multiplied by the density of CFC-12 at 16.67°C (1.34 kg/L), or 670 kg. This amount is subtracted from the total amount of eligible halocarbons prior to quantification of emission reductions.

Resulting eligible halocarbons:

CFC-11: 1134 kg
CFC-12: 1134 – 670 = 464 kg

5.2 Quantifying Project Emissions

Project emissions are actual GHG emissions that occur within the GHG Assessment Boundary as a result of project activities. Project emissions must be quantified every reporting period on an *ex-post* basis.

As shown in Equation 5.4, project emissions equal:

- Emissions from substitute refrigerants, plus
- Emissions from the transportation of halocarbons, plus
- Emissions from the destruction of halocarbons

Note that emissions shall be quantified in kilograms throughout this section and converted into metric tons in Equation 5.4.

Equation 5.4. Total Project Emissions

$$\boldsymbol{PE_t = \frac{Sub_{refr} + (Tr + Dest)}{1000}}$$

Where,

			Units
PE_t	=	Total quantity of project emissions during the reporting period	tCO_2e
Sub_{refr}	=	Total emissions from substitute refrigerant	kg CO_2e
Tr	=	Total emissions from transportation of halocarbons (calculated using Equation 5.6)	kg CO_2e
Dest	=	Total emissions from the destruction process associated with destruction of halocarbons (calculated using Equation 5.6)	kg CO_2e
1000	=	Conversion from kilograms to metric tons	kg/t

5.2.1 Calculating Project Emissions from the Use of Halocarbon Substitutes

When refrigerant halocarbons are destroyed, continued demand for refrigeration will lead to the production and consumption of other refrigerant chemicals. Projects that destroy CFC from stockpiles that can legally be sold to market must estimate the emissions associated with the newer generation refrigerant substitute that are assumed to be used in their place. Projects that destroy refrigerants recovered from equipment that was retrofitted to use newer generation refrigerants may use the default substitute GWP values from Table 5.3 or may use project-specific substitute data, as long as sufficient evidence is available. Projects that destroy used refrigerant recovered from end-of-life equipment do not need to account for substitutes, as the destruction of these halocarbons does not increase the demand for substitute refrigerants. Similarly, projects that destroy government stockpiles that cannot legally be sold to the refrigerant market do not need to account for substitutes, as the destruction is not expected to increase use of substitute refrigerants. Finally, projects that destroy the remnant refrigerant from virgin servicing cylinders are not assumed to drive substitute refrigerant consumption, and thus substitute emissions do not need to be accounted for.

The point of origin of the halocarbons must be documented to support the selected baseline per Section 6.2. The only scenarios in this protocol where substitute refrigerant emissions need to be accounted for are privately held stockpiles of CFC that can legally be sold to the market and refrigerants obtained from equipment that were retrofitted. If the verifier can confirm that the point of origin is either end-of-life equipment tracked to location of halocarbon recovery, government stockpiles or servicing cylinders, then $Sub_{refr} = 0$, see Table 5.3.

Equation 5.5 accounts for the emissions associated with the substitute refrigerants that will be used in place of destroyed halocarbon refrigerants. Like the destroyed halocarbon calculations in the baseline, substitute emissions shall also be estimated based on the projected emissions over the ten-year crediting period. Project-specific substitute GWP and leak rate may be used for retrofitted equipment provided that evidence is available.

Table 5.3. Halocarbon Substitute Refrigerant and Leak Rate Assumptions

Origin	Gas	Default Substitute	Default Substitute GWP	Default Leak Rate
Stockpiles sealable to the market	CFC	HFC-134a	1,300	13.7% per year[45]
Government stockpiles	CFC	Assumed to not be substituted	Not applicable	Not applicable
Stockpiles recovered before protocol adoption	HCFC-22 and/or HFC-32, HFC-125, HFC-134a, HFC-143a	Assumed to not be substituted	Not applicable	Not applicable
Stockpiles recovered after protocol adoption and up to one year after protocol adoption	HCFC-22	R-404A, R-410A, R407C, R-507A	2,858[46]	13.7% per year[45]
Stockpiles recovered after protocol adoption and up to one year after protocol adoption	HFC-32, HFC-125, HFC-134a, HFC-143a	The same gas as what was destroyed	GWP of destroyed gas	13.7% per year[45]
Equipment at end-of-life	CFC, HCFC-22 and/or HFC-32, HFC-125, HFC-134a, HFC-143a	Assumed to not be substituted	Not applicable	Not applicable
Equipment retrofitted to use Low or zero GWP refrigerants	HCFC-22 or HFC-32, HFC-125, HFC-134a, HFC-143a	Low or zero GWP refrigerants	12[47]	To use leak rate selected in Table 5.1 or approved project-specific leak rate
Remnants of virgin refrigerant in servicing cylinders	CFC, HCFC-22 y/o HFC-32, HFC-125, HFC-134a, HFC-143a	Assumed to not be substituted	Not applicable	Not applicable

Equation 5.5. Calculating Project Emissions from the Use of Substitute Refrigerants

$$\boldsymbol{Sub_{refr}} = \sum_{i} \left(\boldsymbol{Q_{refr,i}} \times \boldsymbol{Leak} \times \boldsymbol{GWP} \right)$$

Where, Units

Sub_{refr}	=	Total quantity of project refrigerant substitute emissions	kg CO_2e
$Q_{refr,i}$	=	Total quantity of eligible, pure refrigerant *i* destroyed	kg
Leak	=	Leak rate of substitute refrigerant	% (0-1)
GWP	=	Global warming potential of refrigerant substitute (Table 5.3 or project-specific value)	kg CO_2e/ kg sub

[45] UNEP TEAP, Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, https://ozone.unep.org/sites/default/files/2019-05/rtoc_assessment_report06.pdf
[46] Blended GWP based on refrigerant market shares. See Table 3.2 in scoping paper for details.
[47] Highest GWP of 4th generation refrigerants for conservativeness, HFE-7500.

5.2.2 Calculating Default Project Emissions from Halocarbon Destruction and Transportation

Projects must account for emissions that result from the transportation and destruction of halocarbons using Equation 5.6. Because these emission sources are both individually and in aggregate very small, the Reserve has developed a standard deduction for halocarbon projects based on conservative assumptions and the SSRs outlined in Table 4.1. Appendix E outlines the underlying methodology and assumptions of this standard deduction to account for project emissions from the transportation and destruction of halocarbons.

The emission factor for the standard deduction aggregates both transportation and destruction emissions and shall be equal to 7.5 kilograms CO_2e per kilogram of halocarbon refrigerant destroyed. The emission factor is applied, using Equation 5.6.

Equation 5.6. Project Emissions from Transportation and Destruction Using the Default Emission Factors

$$\boldsymbol{Tr + Dest = Q_i \times 7.5}$$

Where,

			Units
Tr + Dest	=	Total emissions from halocarbon transportation and destruction, as calculated using default emission factors	kg CO_2e
Q_i	=	Total quantity of refrigerant *i* sent for destruction, including eligible and ineligible material	kg halocarbon
7.5	=	Default emission factor for transportation and destruction of halocarbons	kg CO_2e/ kg halocarbon

5.3 Deduction for Vapor Composition Risk

For any given container of halocarbon, a portion of the container will be filled with liquid, and the remaining space will be filled with vapor. This protocol only requires that a liquid sample be taken for composition analysis. For containers that hold a mixture of halocarbon, the composition of halocarbon in the vapor may be different from the composition of halocarbon in the liquid due to differences in the thermodynamic properties of the chemicals. If the container holds chemicals that are not eligible for crediting, the quantification of emission reductions based on the analysis of liquid sample could overstate the actual reductions from the destruction of the material.

To address this risk, projects that destroy containers which contain more than one chemical must use a value of 5% for *VR* by default or use Table 5.5 to determine their risk category and applicable value of *VR* to be applied to the calculation of baseline emissions for that container (Equation 5.3). In Mexico it is not common practice for labs to use the database that is required to quantify VR. Because of that, projects must take a 5% default discount, the highest possible on Table 5.5, in lieu of following the process required to quantify VR. If project developers wish to forego the 5% discount, they may do so following the requirements in section 5.3.

Table 5.4 classifies the eligible halocarbon species as low or high pressure. For the purposes of this protocol, any ineligible chemical with a boiling point less than 0°C at 1 atm is considered high pressure.

If using site-specific *VR* determination, the densities of the liquid and vapor phase components of the project container will be determined by the testing laboratory at the time that the composition analysis is carried out. The densities are determined by the testing laboratory using REFPROP, a fluid properties database developed and maintained by the National Institute for Standards and Technology (NIST). This Software is widely used in testing laboratories and is also publicly available.

The testing laboratory will calculate the densities of the liquid phase and vapor phase contents within the container. More specifically, the laboratory should provide the following information to the project developer:

- Measured composition of the liquid phase (as % by mass at the temperature in the tank at the time the sample was taken)
- Modeled density of the liquid phase
- Modeled composition of the vapor phase (as % by mass at the temperature in the tank at the time the sample was taken)
- Modeled density of the vapor phase

To support this calculation, the project developer shall provide the laboratory with the temperature of the project container at the time of sampling (internal temperature if available, otherwise ambient temperature), 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 shall be determined using Equation 5.7.

Table 5.4. Eligible Low Pressure and High-Pressure Halocarbons

Low Pressure Halocarbons	High Pressure Halocarbons
CFC-11	CFC-12
CFC-113	HCFC-22
CFC-114	HFC-32
	HFC-125
	HFC-134a
	HFC-143a

Table 5.5. Determining Site-Specific Deduction for Vapor Composition Risk

IF the value of $Fill_{liquid}$ (Equation 5.7) is:	AND the concentration of eligible low-pressure halocarbons is:	AND the concentration of ineligible high-pressure chemical is:	THEN the vapor 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 halocarbon may mitigate the risk of over-crediting, so there are two scenarios where a container is exempt from a deduction otherwise required in Table 5.5:

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

If the container holds multiple eligible, high-pressure halocarbons, the applicability of the above scenarios will be determined based on the halocarbons 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 halocarbons projects as defined in Section 6.6.

Equation 5.7. Determining Liquid Fill Level in Project Container

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

Where,

			Units
$Fill_{liquid}$	=	Fill level of the liquid in the project container	fraction
$M_{destroyed}$	=	Total mass of the contents of the project container	kg
ρ_{vapor}	=	Modeled density of the vapor material in the project container at the measured temperature (from REFPROP)	kg/L
$V_{container}$	=	Total volume of the project container	L
ρ_{liquid}	=	Modeled density of the liquid material in the project container at the measured temperature (from REFPROP)	kg/L

6 Project Monitoring and Operations

The Reserve requires a Monitoring and Operations Plan to be established and implemented for all monitoring, operations, and reporting activities associated with the halocarbon destruction project. The Monitoring and Operations Plan will serve as the basis for verifiers to confirm that the monitoring, operations, and reporting requirements in this section and Section 7 have been and will continue to be met, and that consistent, rigorous monitoring and record keeping is ongoing for the project. The Monitoring and Operations Plan must cover all aspects of monitoring and reporting contained in this protocol and must specify how data for all relevant parameters in Section 6.2 will be collected and recorded.

At a minimum, the Monitoring and Operations Plan shall stipulate the frequency of data acquisition; a record keeping plan (see Section 7.2 for minimum record keeping requirements); and the role of individuals performing each specific monitoring activity; and a detailed project diagram. The Monitoring and Operations Plan shall contain a project diagram that illustrates the project halocarbon(s) point(s) of origin, any reclamation facilities used, information on halocarbon transportation mode and transportation companies, mixing/sampling facilities, testing laboratories, and the destruction facility (see Appendix F for a sample project diagram). The Monitoring and Operations Plan should also include QA/QC provisions to ensure that operations, data acquisition and halocarbon analyses are carried out consistently and with precision. In addition, the Monitoring and Operations Plan must stipulate data management systems and coordination of data between halocarbon aggregators, project developers, and destruction facilities.

Project developers are responsible for monitoring the performance of the project and ensuring that there is no double-counting of GHG reductions associated with halocarbon destruction. To achieve this, the Monitoring and Operations Plan must also include a description of how data will be provided to the Reserve halocarbon tracking system (see Section 6.1), the Reserve Software.

Finally, the Monitoring and Operations Plan must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the legal requirement test and is in material compliance with all applicable laws (Section 3.4.1 and 3.5, respectively).

6.1 Reserve Halocarbons Tracking

For the purposes of ensuring the integrity of halocarbon destruction projects, the Reserve maintains records of all destruction activities for which CRTs are registered and issued in the Reserve Software. Entries into the Reserve software must be made by the project developer prior to the beginning of verification activities relating to confirming that reductions have not been claimed by other parties for the destruction activity in question.[48]

All projects are required to have one or more Certificate(s) of Destruction accounting for all eligible halocarbons destroyed as part of the project. The following information shall be entered by the project developer into the Reserve software from the Certificate(s) of Destruction issued by the destruction facility, and a copy of the certificate(s) must be provided to the project verifier:

[48] Other verification activities (such as site visits) may commence prior to submission of information into the halocarbon tracking system.

1. Project developer (project account holder)
2. Destruction Facility
3. Certificate of Destruction ID number
4. Start destruction date
5. End destruction date
6. Total weight of material destroyed (including eligible and ineligible material)

6.2 Point of Origin Documentation Requirements

Project developers are responsible for collecting data on the point of origin for each quantity of halocarbons, as defined in Table 6.1. The project developer must maintain detailed acquisition records of all quantities of halocarbons destroyed by the project.

Table 6.1. Identification of Point of Origin for halocarbon projects

Halocarbon	Point of Origin	10-year Cumulative Emissions (%)[1]
1. Government stockpiles of virgin CFC	Location of stockpile	65% or site-specific emission rate (see Section 5.1)
2. Used halocarbons stockpiled prior to June 16, 2021 (expected date of adoption of the protocol)	Location of stockpile	65% or site-specific emission rate (see Section 5.1)
3. Privately held virgin CFC stockpiled up to June 16, 2021	Location of stockpile	65%
4. Used halocarbons in quantities less than 227 kg recovered up to June 16,2022 (one year after protocol adoption)	Location where halocarbon is first aggregated to greater than 227 kg	65%
5. Used halocarbons in quantities greater than 227 kg up to June 16,2022	Site of installation from which halocarbon is removed	65%
6. Used halocarbon of any quantity recovered from end-of-life equipment	Location where halocarbon is recovered from end-of-life equipment	100%
7. Used halocarbon of any quantity recovered from retrofitted equipment	Location where halocarbon is recovered from retrofitted equipment	See Table 5.1
8. Virgin halocarbon remnants aggregated from used servicing cylinders	Location where halocarbon is recovered from servicing cylinders	100%

[1] This information is provided to illustrate the connection between point of origin and the cumulative emission rate used to calculate baseline emissions. See Table 5.1 for more details on these emission rates and related baseline scenarios.

Project developers must be able to document the point of origin for all halocarbons that will be included in the project as defined in the table above. For destroyed halocarbons where the point of origin is a reservoir-style stockpile (i.e., it was not sealed), the date on which the halocarbon was stockpiled is established using "first-in/first-out" accounting. Specifically, the date on which a quantity of halocarbon was "stockpiled" is defined as the furthest date in the past on which the quantity of halocarbon contained in the reservoir was greater than or equal to the total quantity of all halocarbons removed from the reservoir since that date (including any halocarbon removed and destroyed as part of the project). The date must be established using management systems and logs that verify the quantities of halocarbon placed into and removed from the reservoir throughout the relevant period. Provided these elements are met, and the stockpile follows the “first-in/first-out” accounting, the date on which a quantity of halocarbon was stockpiled may be established.

For government-held virgin stockpiles, documentation of the point of origin must be generated at the time material is placed at the stockpile location and every time material is added to the stockpile.

For privately-held virgin CFC stockpiles, in addition to point of origin documentation, project developers must provide documentation that the virgin CFC was produced or imported prior to the production and importation phase-outs for CFC in Mexico, and that it has not been produced illegally. This documentation may be in the form of an audit conducted by or for the government agency that identifies the stockpile and entity holding it, or correspondence regarding the stockpile from, or submitted to, the government agency. Verifiers may request independent confirmation of the asserted documentation from government officials or their representatives. Privately held and saleable virgin CFC refrigerants are eligible under this protocol only if destruction is completed within 12 months of the Effective Date of this protocol (i.e., by June 16, 2022).

For stockpiles of used HCFC-22 and HFC recovered prior to June 16, 2022, documentation must confirm that the stockpile was recovered up to that date and that it has been stored at the point of origin prior to June 16, 2022.

For halocarbon recovered by service technicians in individual quantities less than 500 pounds, the point of origin is defined as the facility where two or more containers were combined and exceeded 227 kilograms in a single container. Those handling quantities less than 227 kilograms in a single container need not provide the documentation required below. However, once smaller quantities are aggregated and exceed 227 kilograms in a single container, tracking is required at that location and point in time forward.

For containers of halocarbons greater than 227 kilograms (determined as the weight of eligible halocarbon within a single container), the project developer must provide documentation as to the origin of the halocarbon within that container and when it was recovered. If it is shown that, prior to aggregation in the project container, the halocarbon was contained as a quantity greater than 227 kilograms, then the documentation must extend back to this previous container and its point of origin. The project developer must provide documentation tracking the halocarbon back to a point in time and location where it was either a) contained or recovered as a quantity of less than 227 kilograms, or b) recovered by a service technician as a quantity of greater than 227 kilograms.

For halocarbons recovered from end-of-life equipment, the project developer must provide documentation to confirm that the halocarbon was recovered at the point of origin and that the equipment was disposed of, or decommissioned. It may not be possible to document the exact time the halocarbon was recovered from all equipment (e.g., at a reclamation facility processing large numbers of appliances), but the verifier must confirm that the inventory and activity logs support the quantity of halocarbon being destroyed for that reporting period.

For halocarbons recovered from retrofitted equipment, the project developer must provide documentation to confirm that the halocarbon was recovered at the point of origin and that the equipment was modified to use low or zero GWP refrigerants. As an option, the project developer may document the substitute refrigerant to use that particular substitute PCG. It may not be possible to document the exact time the halocarbon was recovered from all equipment (e.g., at a reclamation facility processing large numbers of appliances), but the verifier must confirm that the inventory and activity logs support the quantity of halocarbon being destroyed for that reporting period.

For halocarbons recovered from servicing cylinders the project developer must provide documentation to confirm that the halocarbon was recovered at the point of origin and that the volume recovered per cylinder was not higher than 1 kg. The verifier must confirm at a minimum that the inventory and activity logs support the quantity of halocarbon being destroyed for that reporting period.

All data must be generated at the point of origin. Documentation of the point of origin of halocarbons shall include the following:

- Facility name and physical address
- For quantities greater than 227 kilograms, identification of the system by serial number, if available, or description, location, and function, if serial number is unavailable
- Serial or ID number of containers used for storage and transport

6.3 Custody and Ownership Documentation Requirements

In conjunction with establishing the point of origin for each quantity of halocarbon, project developers must also document the custody and ownership of halocarbons. These records shall include names, addresses, and contact information of persons buying/selling the material for destruction and the quantity of the material (the combined mass of refrigerant and contaminants) bought or sold. Such records may include Purchase Orders, Purchase Agreements, packing lists, bills of lading, manifests, lab test results, transfer container information, receiving inspections, freight bills, transactional payment information, and any other type of information that will support previous ownership of the material and the transfer of that ownership to the project developer. The verification body will review these records and will perform other tests necessary to authenticate the previous owners of the material and the physical transfer of the product and the title transfer of ownership rights of all emissions and emission reductions associated with destroyed halocarbon to the project developer, as documented through contracts, agreements, or other legal documents.

No GHG credits may be issued under this protocol for halocarbons where ownership cannot be established.

The transfer of custody may be established using the following documentation, as appropriate:

- Tax ID, or other applicable identifier, of transferor and transferee
- Bill of lading (where appropriate)
- Manifest
- Date of transfer of custody
- Serial or ID numbers of all containers containing halocarbons (received and delivered)
- Weight of all containers containing halocarbons (received and delivered)
- Distance and mode of transportation used to move halocarbons (truck, rail, or air)

6.4 Halocarbon Composition and Quantity Analysis Requirements

The requirements of this section must be followed to determine the quantities of halocarbon refrigerants. Prior to destruction, the precise mass and composition of halocarbons to be destroyed must be determined. For projects where the destruction facility is also the project developer, these analyses must be performed by an independent third party as specified further below.

6.4.1 Halocarbon Quantity Analysis

Mass shall be determined by individually measuring the weight of each container of halocarbon: (1) when it is full prior to destruction; and (2) after it has been emptied and the contents have been fully purged and destroyed. The mass of halocarbons and any contaminants destroyed shall be considered equal to the difference between the full and empty weights of the containers, as measured by the scale at the destruction facility and recorded by the destruction facility on the weight tickets and the Certificate of Destruction. No adjustments shall be made by the project developer to the weights as measured and recorded by the destruction facility in calculating the mass of halocarbons and contaminants.

The following requirements must be met for the measurement of each container:

1. A single scale must be used for generating both the full and empty weight tickets at the destruction facility
2. The scale used must have its calibration verified by PROFECO (Mexico's Federal Attorney's Office of Consumer Protection or Procuraduria Federal del Consumidor) or by a third party authorized by EMA (the Mexican Accreditation Entity or Entidad Mexicana de Acreditación) to perform calibration verifications no more than 3 months prior to or after a project destruction event.[49] Verification must be performed according to NOM-010-SCFI-1994[50] using test weights certified to NOM-038-SCFI-2000. A scale is considered calibrated if it is within the maintenance tolerance of the relevant NOM-010-SCFI-1994[51] accuracy class. If a scale is found to be outside of this tolerance, it must be re-calibrated and re-verified.
3. The full weight must be measured no more than 48 hours prior to commencement of destruction per the Certificate of Destruction, and the empty weight must be measured no more than 48 hours after the conclusion of destruction per the Certificate of Destruction.[52]

Verifiers shall confirm that the weights recorded on the weight tickets and the Certificate of Destruction by the destruction facility are used without adjustment to calculate emission reductions. The mass of eligible halocarbons shall then be determined using these weights and the results of the laboratory analyses discussed further below.

[49] The Reserve strongly encourages calibration verifications occur prior to the destruction event to minimize risk to the project developer. However, due to the fact that this protocol requires more frequent calibration verification (within 3 months of destruction) than the Mexican regulation requires (annual), additional flexibility is provided.
[50] SCFI, Norma Oficial Mexicana NOM-010-SCFI-1994, http://www.consumidor.gob.mx/wordpress/wp-content/uploads/2012/03/Modificacion-NOM-010-SCFI-1994.pdf.
[51] SCFI, Norma Oficial Mexicana NOM-010-SCFI-1994, http://www.consumidor.gob.mx/wordpress/wp-content/uploads/2012/03/Modificacion-NOM-010-SCFI-1994.pdf.
[52] Full and empty weights must be taken within 48 hours (or two calendar days) of destruction.

6.4.2 Halocarbon Composition and Concentration Analysis

Composition and concentration of halocarbons and contaminants shall be established for each individual container by taking a sample from each container of halocarbon and having it analyzed for composition and concentration following the Air-Conditioning, Heating and Refrigeration Institute (AHRI) 700-2017 standard or its successor *or* at an AHRI-certified laboratory using the AHRI 700-2017 standard or its successor.

At the time of protocol drafting, laboratories in Mexico were capable of following the AHRI standard, but no laboratories were certified because the certification service was not available in the country. To allow for halocarbon composition and concentration analyses to be performed in Mexican laboratories, this protocol will allow the tests to be performed without an AHRI certification up to one year after certification is available in Mexico. One year after the certification becomes available, all tests must be undertaken in a certified laboratory. The Reserve will announce through a newsletter or policy memo when the certification is considered to be fully available in Mexico and the deadline to become certified. During the period when certification is not available, project developers must demonstrate to the verifier´s reasonable assurance that the AHRI standard was followed to perform the laboratory halocarbon composition and concentration analyses. At a minimum, the project developer must provide:

1. An attestation from the lab declaring that the AHRI 700:2017 standard was followed for the analysis of project refrigerants and,
2. The laboratory process documents that demonstrate adherence to the AHRI standard.

The laboratory must not be affiliated with the project developer or the project beyond performing composition analysis services. Affiliated for the purposes of this protocol means that the project developer and laboratory have not had prior significant paid contractual engagements other than for testing as required under this protocol.

Project developers may also export halocarbon samples to U.S. AHRI-certified laboratories. If the laboratory is located in the U.S., the transport and delivery of project samples must comply with Mexican and U.S. import/export laws, particularly Article 26, subarticle IV of the Mexican LGPGIR[53] (where SEMARNAT-07-029 authorizes export),[54] Title VI of the United States Clean Air Act,[55] and any additional regulations or requirements promulgated by SEMARNAT, Mexican Customs, U.S. EPA and/or U.S. Customs. Both Mexico and the U.S. allow for *de minimis* quantities of halocarbons to be exported/imported under an exemption for laboratory and analytical uses, which should help to streamline the import/export process for small samples of halocarbons exported/imported to a laboratory for composition analyses.

The following requirements must be met for each sample:

1. The sample must be taken while halocarbon is in the possession of the company that will destroy the halocarbon (i.e., the destruction facility).

[53] SEMARNAT, Ley General para la Prevención y Gestión Integral de los Residuos, http://www.diputados.gob.mx/LeyesBiblio/ref/lgpgir/LGPGIR_orig_08oct03.pdf.
[54] SEMARNAT, Tramites y Servicios. Residuos peligrosos: Importacion/Exportacion, http://tramites.semarnat.gob.mx/index.php/residuos-peligrosos/importacion-exportacion.
[55] U.S. 40 CFR 82 (b) specifically allows for the exemption of halocarbon samples to be imported for the laboratory and analytical use exemption.

2. Samples must be taken by a properly trained technician[56] unaffiliated with the project developer,[57]
3. Samples must be taken utilizing procedures contained in the SEMARNAT's UPO's Good Practices Handbook.[58]
4. Samples must be taken with a clean, fully evacuated sample bottle with a minimum capacity of 0.45kg (or 1lb).[59]
5. The technician must ensure that the sample is representative of the contents of the container. All valves between the interior of the container and the sample port must be opened for a minimum of 15 minutes before the sample is taken
6. Each sample must be taken in liquid state
7. A minimum sample size of 0.45kg (or 1lb)[60] must be drawn for each sample. Each sample must be individually labeled and tracked according to the container from which it was taken, and the following information recorded:
    a) Time and date of sample
    b) Name of project developer
    c) Name of technician taking sample
    d) Employer of technician taking sample
    e) Volume of container from which sample was extracted
    f) Ambient air temperature at time of sampling[61]
    g) Chain of custody from point of sampling to laboratory for each sample must be documented by paper bills of lading or electronic, third-party tracking that includes proof of delivery (e.g., FedEx, UPS)

All project samples shall be analyzed using AHRI 700-2017 or its successor to confirm the mass percentage and identity of each component of the sample. The analysis shall provide:

1. Identification of the refrigerant
2. Purity (%) of the halocarbon mixture by weight using gas chromatography
3. Moisture level in parts per million: the moisture content of each sample must be less than 75 percent of the saturation point for the halocarbon taking into account the temperature recorded at the time the sample was taken. For containers that hold mixed halocarbon, the sample's saturation point shall be assumed to be that of the halocarbon species in the mixture with the lowest saturation point that is at least 10 percent of the mixture by mass
4. Analysis of high boiling residue, which must be less than 10 percent by mass

[56] While not required, completion of the SEMARNAT course "Services Refrigeration and Air Conditioning Good Practices" and subsequent listing on SISSAO is one option that should help demonstrate a technician has been properly trained.
[57] For instances where the project developer is the destruction facility itself, an outside technician must be employed for sample taking.
[58] SEMARNAT, Buenas Practicas en Refrigeración y Aire Acondicionado, http://app1.semarnat.gob.mx:8080/sissao/archivos/ManualBuenasPracticas2.pdf.
[59] The requirement that samples be taken into a fully evacuated sample bottle with a minimum capacity of 0.45 kg (or 1 lb) is retained from the U.S. and Article 5 ODS Protocols, as well as U.S. Department of Transportation requirements, for consistency. Article 109 of the Mexican LGPPGR as well as NOM-002-SCT-2011 govern halocarbon samples but do not include a similar requirement.
[60] As noted in Footnote 59, the minimum 0.45 kg (or 1 lb) sample size requirement is retained from the U.S. and Article 5 ODS Protocols for consistency.
[61] Projects that destroy halocarbon prior to the adoption date of this protocol may use proxy data from weather recording stations in the area.

5. Analysis of other halocarbons in the case of mixtures of halocarbon and their percentage by mass

If any of the requirements above are not met, no GHG reductions may be verified for the halocarbons from that container. If a sample is tested and does not meet one of the requirements as defined above, the project developer may elect to have the material re-sampled and re-analyzed. While there is no limit to the number of samples that may be taken, the analysis results of all samples must be disclosed to the verification body, and the most conservative composition analysis from these samples shall be used for the quantification. If a project developer elects to have the material dried prior to resampling, the previous samples (prior to drying) may be disregarded.

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 is below 0°C. Project developers may sample for moisture content and perform any necessary de-watering prior to the required sampling and laboratory analysis.

If the container holds non-mixed halocarbons (defined as greater than 90 percent composition of a single halocarbon species), no further information or sampling is required to determine the mass and composition of the halocarbon.

If the container holds mixed halocarbon, which is defined as less than 90 percent composition of a single halocarbon species, the project developer must meet additional requirements as provided in Section 6.4.2.1.1.

6.4.2.1.1 Analysis of Mixed Halocarbons

Mixed halocarbons are defined as less than 90% composition of one species, blends are also considered mixed halocarbons and their composition should be analyzed following the procedures outlined in this section. If a container holds mixed halocarbons, its contents must be processed and measured for composition and concentration according to the requirements of this section (in addition to the requirements of Section 6.4.2). The sampling required under this section may be conducted at the final destruction facility or prior to delivery to the destruction facility. However, the circulation and sampling activities must be conducted by a third-party organization (i.e., not the project developer), and by individuals who have been properly trained for the functions they perform.[62] Circulation and sampling may be conducted at the project developer's facility, but all activities must be directed by a properly trained and contracted third-party. The project's Monitoring and Operations Plan must specify the procedures by which mixed halocarbons are analyzed. If the mixing and sampling are conducted at the destruction facility, then the most conservative result of the two samples shall be used to satisfy the requirements of Section 6.4.2. If the mixing and sampling do not occur at the destruction facility, then the most conservative composition analysis from the mixing facility samples shall be used for the quantification of emission reductions.

The composition and concentration of halocarbon on a mass basis of each container shall be determined using the results of the analysis of this section. The results of the composition

[62] While not required, completion of the SEMARNAT course "Services Refrigeration and Air Conditioning Good Practices" and subsequent listing on SISSAO is one option that should help demonstrate a technician has been properly trained.

analysis in Section 6.4.2 shall be used by verifiers to confirm that the destroyed halocarbon was in fact the same halocarbon that is sampled under these requirements.

The halocarbon mixture must be circulated in a container that meets all of the following criteria:

1. The container has no solid interior obstructions[63]
2. The container was fully evacuated prior to filling
3. The container must have mixing ports to circulate liquid and gas phase halocarbons
4. The liquid port intake shall be at the bottom of the container, and the vapor port intake shall be at the top of the container. For horizontally-oriented mixing containers, the intakes shall be located in the middle third of the container
5. The container and associated equipment can circulate the mixture via a closed loop system from the liquid port to the vapor port

If the original mixed halocarbon container does not meet these requirements, the mixed halocarbon 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 halocarbon into and out of the temporary container, halocarbon shall be recovered to the vacuum levels recommended in the SEMARNAT's UPO's Good Practices Handbook[64]

Once the mixed halocarbon is in a container or temporary storage unit that meets the criteria above, circulation of mixed halocarbon 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. Circulation must occur at a rate of at least 114 L/minute. Alternatively, circulation may occur at a rate that is less than 114 L/minute, as long as criterion #2 is achieved within the first six hours of mixing
4. Start and end times shall be recorded

Within 30 minutes of the completion of circulation, a minimum of two samples shall be taken from the bottom liquid port according to the procedures in Section 6.4.2. Both samples shall be analyzed at an appropriate laboratory per the requirements of Section 6.4.2. The mass composition and concentration of the mixed halocarbon shall be equal to the lesser of the two GWP-weighted concentrations.

If a temporary holding tank is used, after drawing the sample, the holding tank shall be emptied back into the original container for transport to the destruction location.

[63] Mesh baffles or other interior structures that do not impede the flow of halocarbons are acceptable.
[64] SEMARNAT, Buenas Prácticas en Refrigeración y Aire Acondicionado, http://app1.semarnat.gob.mx:8080/sissao/archivos/ManualBuenasPracticas2.pdf.

6.4.3 Requirements for the Import/Export of Halocarbon Samples

Project developers must maintain sufficient documentation to provide a full record of the export/import process for verification purposes. According to Mexican law,[65] the record must include the following:

- Name, legal address, corporate registration number (RFC), telephone, fax, and email of the applicant
- Name of hazardous waste, hazardous characteristics, and chemical composition
- Quantity of hazardous waste in kilograms or its equivalent in another unit of measure and the technical justification for importing or exporting such amount
- Description of the sample's purpose
- Name and location of the organization undertaking hazardous waste sampling

According to the U.S. Customs and Border Protection (CBP),[66] the following documentation must be filed within 15 calendar days of the date the shipment arrives at a U.S. port of entry:

- Entry Manifest (CBP Form 7533) or Application and Special Permit for Immediate Delivery (CBP Form 3461) or other form of merchandise release required by the port director
- Evidence of right to make entry
- Commercial invoice or a *pro forma* invoice when the commercial invoice cannot be produced
- Packing lists, if appropriate
- Other documents necessary to determine merchandise admissibility

While the import of halocarbons for use or destruction is tightly regulated by the EPA and requires significant paperwork, the import of *de minimis* samples of halocarbons for laboratory analysis is allowable under the laboratory and analytical use exemption under Section 604 of the Clean Air Act and requires less paperwork and fewer explicit permissions. However, the Reserve encourages project developers to include documentation with the imported sample that refers to this laboratory and analytical use exemption. Further, the voluntarily submission of paperwork to U.S. and Mexican Customs *in advance* of import/export and/or working with an experienced customs broker, may help to expedite this process, especially where it is possible to secure pre-import/export clearance.

The Reserve recommends that the following documentation be included in the record for verification, as well as made available to customs officials to assist with the import/export process:

- Commercial invoice showing transfer of ownership of the halocarbon from the owner in the source country to the project developer
- Shipping manifests or bills of lading (where appropriate) showing Mexico as the country of export
- U.S. Customs import declaration showing the product being imported into the U.S

[65] SEMARNAT, Guía Para la Importación y Exportación de Residuos en México, http://tramites.semarnat.gob.mx/Doctos/DGGIMAR/Guia/07-029AF/guia_Import_Export_RP.pdf.
[66] U.S. Customs and Border Protection, Importing into the United States: A Guide for Commercial Importers, http://www.cbp.gov/sites/default/files/documents/Importing%20into%20the%20U.S.pdf.

- Copy of Class 1 halocarbon import report showing that a small amount of the product has been imported for use under the laboratory and analytical use exemption
- For imports of used halocarbon, copy of EPA non-objection notice that corresponds to the import of used halocarbon (this non-objection notice is not required for imports of virgin Class 1 substance for destruction)
- Source of halocarbon: stockpile or end-of-life
- Serial or ID numbers of containers used for storage and transport
- Mode of transport, distance travelled prior to arriving at a U.S. port of entry, and net weight of halocarbon and containers transported

6.5 Destruction Facility Requirements

Under this protocol, destruction of halocarbons must occur at a facility in Mexico that is permitted under Mexico's General Law for the Prevention and Management of Wastes (Ley General para la Prevención y Gestión Integral de los Residuos – LGPGIR) to destroy hazardous waste, including halocarbons, and that meets all of the guidelines provided in Appendix C and in the TEAP Report of the Task Force on Destruction Technologies.[67]

At the time of halocarbon destruction, the destruction facility must have a valid permit to destroy hazardous waste, which explicitly allows for the destruction of halocarbons, under Mexico's LGPGIR. More specifically, the facility must have a permit under either NOM-098-SEMARNAT-2002[68] or NOM-040-SEMARNAT-2002[69] that explicitly allows for CFC, HCFC-22 and HFC destruction.[70] The facility must also have any other air or water permits required by local, state, or federal law to destroy halocarbons. This list of permits is non exhaustive, the Project Developer must demonstrate to the verifier satisfaction that all permits required to implement the project have been met.

Facilities must document compliance with all monitoring and operational requirements associated with the destruction of halocarbon materials, as dictated by these permits and the LGPGIR, including emission limits, calibration schedules, and personnel training. Any upsets or exceedances of emission limits with corrective actions taken must be noted in a daily log and managed in keeping with the facility's Plan for Risk Prevention (Programa de Prevención de Riesgo). Facilities must document operation consistent with the TEAP requirements, including maintaining a destruction and removal efficiency (DRE) of at least 99.99 percent, as defined in this section and Appendix C.

[67] UNEP TEAP, Report of the Task Force on Destruction Technologies, http://www.uneptie.org/ozonaction/topics/disposal.htm.

[68] This regulation sets forth the requirements for environmental protection on waste incineration activities, including for hazardous waste. While a facility may be permitted under NOM-098-SEMARNAT-2002 to destroy a variety of hazardous wastes, if the facility intends to destroy CFCs, the facility needs to seek a permit which explicitly allows this. http://www.profepa.gob.mx/innovaportal/file/1309/1/nom-098-semarnat-2002.pdf.

[69] This regulation sets forth requirements for environmental protection at cement manufacturing facilities. Under this regulation, hazardous waste and other halocarbons may potentially be destroyed in cement kilns and used as alternative fuels for cement manufacturing activities. If a facility wants to use CFCs as an alternative fuel, however, the facility needs to seek a permit which explicitly allows this. http://www.profepa.gob.mx/innovaportal/file/1236/1/nom-040-semarnat-2002.pdf.

[70] At present, these two NOMs are the only relevant permissions that might allow for the destruction of halocarbons under the LGPGIR. However, if additional regulations are promulgated, which explicitly allow for halocarbon destruction under a new permission type, they will be considered and a clarification to the protocol issued to allow for immediate inclusion of such eligible destruction facilities.

In addition to the facility's permit to destroy hazardous waste and halocarbons, destruction facilities must provide third-party certified results indicating that the facility meets all performance criteria set forth in Appendix C. This third-party certification shall be performed by an independent laboratory certified by EMA. Following the facility's initial performance testing, project developers must demonstrate with third-party certified results that the facility has conducted comprehensive performance testing every three years to validate compliance with the TEAP DRE and emissions limits as reproduced in Appendix C. No halocarbon destruction credits shall be issued for destruction that occurs at a facility that has failed to undergo comprehensive performance testing according to the required schedule, or has failed to meet the requirements of such performance testing.

Operating parameters of the destruction unit while destroying halocarbon material shall be monitored and recorded as described in the TEAP Code of Good Housekeeping[71] approved by the Montreal Protocol, as well as compliant with the facility permit. This data shall be used in the verification process to demonstrate that during the destruction process, the destruction unit was operating similarly to the period in which the DRE was calculated. The DRE is determined by using the comprehensive performance test (CPT)[72] as a proxy for DRE. This protocol requires facilities to maintain a DRE of 99.99 percent or better.[73]

To monitor that the destruction facility operates in accordance with applicable regulations and within the parameters recorded during DRE testing, the following parameters must be tracked continuously during the entire halocarbon destruction process:

- The halocarbon feed rate
- The amount and type of consumables used in the process (not required if default project emission factor for transportation and destruction is used)
- The amount of electricity and amount and type of fuel consumed by the destruction unit (not required if default project emission factor for transportation and destruction is used)
- Operating temperature and pressure of the destruction unit during halocarbon destruction
- Effluent discharges measured in terms of water and pH levels
- Continuous emissions monitoring system (CEMS) data on the emissions of carbon monoxide during halocarbon destruction

The project developer must maintain records of all these parameters for review during the verification process.

Destruction facilities shall provide a valid Certificate of Destruction for all halocarbon destroyed. The Certificate of Destruction shall include:

- Project developer (project account holder)
- Destruction facility
- Generator name
- Certificate of Destruction ID number
- Serial, tracking, or ID number of all containers for which halocarbon destruction occurred

[71] TEAP. (2006). Code of Good Housekeeping. *Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer - 7th Edition*.
[72] CPT must have been conducted with a less combustible chemical than the halocarbon in question.
[73] NOM-098-SEMARNAT-2002 requires that the DRE be 99.9999% or better.

- Weight of material destroyed from each container (including eligible and ineligible material)
- Type of material destroyed from each container (including all materials listed on laboratory analysis of halocarbon composition from sampling at the destruction facility)
- Start destruction date
- End destruction date

6.6 Monitoring Parameters

Prescribed monitoring parameters necessary to calculate baseline and project emissions are provided in Table 6.2 below. In addition to the parameters below that are used in the calculations provided in Section 5, project developers are responsible for maintaining all records required under Sections 6 through 7.

Table 6.2. Project Quantitative Monitoring Parameters

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Comment
Equation 5.1	ER_t	Total quantity of emission reductions during the reporting period	tCO_2e	For each reporting period	C	
Equation 5.1, Equation 5.3	BE_t	Total quantity of baseline emissions during the reporting period	tCO_2e	For each reporting period	C	
Equation 5.1, Equation 5.4	PE_t	Total quantity of project emissions during the reporting period	tCO_2e	For each reporting period	C	
Equation 5.2	$ER_{stock,i}$	Average annual emission rate of refrigerant halocarbon *i*	%	For each reporting period	C	
Equation 5.2	Q_{end}	Total quantity of halocarbon refrigerant *i* in government stockpile at time of destruction	kg halocarbon	For each reporting period	M	
Equation 5.2	Q_{start}	Total quantity of halocarbon refrigerant *i* in stockpile at time of seizure or at time of collecting the stockpile prior to sealing the container	kg halocarbon	For each reporting period	M	

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Comment
Equation 5.3, Equation 5.5, Equation E.3, Equation E.4	$Q_{refr,i}$	Total quantity of eligible refrigerant halocarbon *i* destroyed	kg halocarbon	For each reporting period	M	
Equation 5.3	$ER_{refr,i}$	10-year cumulative emission rate of refrigerant halocarbon *i*	%	N/A	R	See Table 5.1
Equation 5.3, Equation E.3	$GWP_{refr,i}$	Global warming potential of refrigerant halocarbon *i*	kg CO_2e/ kg halocarbon	N/A	R	See Table 5.2
Equation 5.3	VR	Vapor risk deduction factor	% (0-1)	For each reporting period	R	Default value of 5% unless project specific value is determined, See Table 5.5
Equation 5.4, Equation 5.5	Sub_{refr}	Total emissions from substitute refrigerant	kg CO_2e	For each reporting period	C	
Equation 5.4, Equation 5.6	Tr	Total emissions from transportation of halocarbon	kg CO_2e	For each reporting period	C	Calculated using default factor provided in Equation 5.6
Equation 5.4, Equation 5.6	Dest	Total emissions from the destruction process associated with destruction of halocarbon	kg CO_2e	For each reporting period	C	Calculated using default factor provided in Equation 5.6
Equation 5.5	Leak	Leak rate of substitute refrigerant	% (0-1)	For each reporting period	R	
Equation 5.6	Q_i	Total quantity of refrigerant *i* sent for destruction, including eligible and ineligible material	kg halocarbon	For each reporting period	M	
Equation 5.7	$Fill_{liquid}$	Liquid fill level in project container	% (0-1)	For each reporting period	C	
Equation 5.7	$M_{destroyed}$	Total mass of material destroyed in the project container	kg	For each reporting period	M	

Eq. #	Parameter	Description	Data Unit	Measurement Frequency	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Comment
Equation 5.7	$V_{container}$	Volumetric capacity of project container	L	For each reporting period	O	
Equation 5.7	ρ_{vapor}	Density of the vapor phase material in the project container	kg/L	For each reporting period	C	
Equation 5.7	ρ_{liquid}	Density of the liquid phase material in the project container	kg/L	For each reporting period	C	

Table 6.3. Qualitative Monitoring Parameters for Halocarbon Projects

Description	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comments
Legal requirement test	O	Each reporting period	Must be monitored and confirmed for each reporting period
Regulatory compliance	O	Each reporting period	Must be monitored and confirmed for each reporting period
Mass of halocarbons (or halocarbon mixture) in each container	M	Each reporting period	Must be determined for each container destroyed
Concentration of halocarbon (or halocarbon mixture) in each container	C	Each reporting period	Must be determined for each container destroyed

7 Reporting Parameters

This section provides requirements and guidance on reporting rules and procedures. A priority of the Reserve is to facilitate consistent and transparent information disclosure by project developers. Project developers must submit verified emission reduction reports to the Reserve at the conclusion of every project reporting period.

7.1 Project Documentation

Project developers must provide the following documentation to the Reserve in order to register a halocarbon destruction project.

- Project Submittal form
- Certificate(s) of Destruction (not public)
- Laboratory analysis of halocarbon composition from sampling at destruction facility (not public)
- Signed AHRI 700:2017 laboratory attestation
- Laboratory analysis of halocarbon composition from sampling at mixing facility, if applicable (not public)
- Project diagram from Monitoring and Operations Plan (see Appendix F) (not public)
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form
- Verification Report
- Verification Statement

Project developers must provide the following documentation each reporting period in order for the Reserve to issue CRTs for quantified GHG reductions.

- Verification Report
- Verification Statement
- Certificate(s) of Destruction (not public)
- Laboratory analysis of halocarbon composition from sampling at destruction facility (not public)
- Laboratory analysis of halocarbon composition from sampling at mixing facility, if applicable (not public)
- Signed AHRI 700:2017 laboratory attestation
- Project diagram from Monitoring and Operations Plan (see Appendix F) (not public)
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form

Unless otherwise specified, the above project documentation will be available to the public via the Reserve's online registry. Further disclosure and other documentation may be made available by the project developer on a voluntary basis. Project submittal forms can be found at https://www.climateactionreserve.org/how/program/documents/.

7.2 Record Keeping

For purposes of independent verification and historical documentation, project developers are required to keep all information outlined in this protocol for a period of 10 years after verification.

System information the project developer should retain includes:

- All data inputs for the calculation of the project emission reductions, including all required sampled data
- 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 project start date
- Executed Attestation of Title forms, Attestation of Regulatory Compliance forms, and Attestation of Voluntary Implementation forms
- Destruction facility monitoring information (CEMS data, DRE documentation, scale readings, calibration procedures, and permits)
- Verification records and results
- Chain of custody and point of origin documentation
- Halocarbon composition and quantity lab reports
- Signed AHRI 700:2017 laboratory attestations

7.3 Reporting Period and Verification Cycle

Halocarbon destruction projects may be no greater than 12 months in duration, measured from the project start date to completion of halocarbon destruction. As stated in Section 5, project developers may choose a shorter time horizon for their project (e.g., three months or six months), but no project may run longer than 12 months. At the project developer's discretion, a project may have one or more destruction events as described in Section 5.

8 Verification Guidance

This section provides verification bodies with guidance on verifying GHG emission reductions from halocarbon destruction projects developed to the standards of this protocol. This verification guidance supplements the Reserve's Verification Program Manual and describes verification activities specifically related to halocarbon destruction projects.

Verification bodies trained to verify Mexico halocarbon destruction projects must be familiar with the following Climate Action Reserve documents:

- Reserve Offset Program Manual
- Verification Program Manual
- Mexico Halocarbon Protocol Version 1.0 (this document)

The Reserve Offset Program Manual, Verification Program Manual, and protocols are designed to be compatible with each other and are available on the Reserve's website at http://www.climateactionreserve.org.

ISO-accredited verification bodies trained by the Reserve for this project type are eligible to verify halocarbon destruction project reports. Verification bodies approved under other Reserve or California Air Resources Board industrial gas protocols are also permitted to verify Mexico halocarbon destruction projects. Information about verification body accreditation and Reserve project verification training can be found on the Reserve website at http://www.climateactionreserve.org/how/verification/.

8.1 Standard of Verification

The Reserve's standard of verification for halocarbon destruction projects is the Mexico Halocarbon Protocol (this document), the Reserve Offset Program Manual, and the Verification Program Manual. To verify a halocarbon destruction project developer's project report, verification bodies apply the guidance in the Verification Program Manual and this section of the protocol to the standards described in Sections 2 through 7 of this protocol. Sections 2 through 7 provide eligibility rules, methods to calculate emission reductions, performance monitoring instructions and requirements, and procedures for reporting project information to the Reserve.

8.2 Monitoring and Operations Plan

The Monitoring and Operations Plan serves as the basis for verification bodies to confirm that the monitoring and reporting requirements in Section 6 and Section 7 have been met, and that consistent, rigorous monitoring and record keeping has been conducted. Verification bodies shall confirm that the Monitoring and Operations Plan covers all aspects of monitoring and reporting contained in this protocol and specifies how data for all relevant parameters in Table 6.2 are collected and recorded.

8.3 Verifying Project Eligibility

Verification bodies must affirm a halocarbon destruction project's eligibility according to the rules described in this protocol. The table below outlines the eligibility criteria for a halocarbon destruction project. This table does not present all criteria for determining eligibility comprehensively; verification bodies must also look to Section 3 and the verification items list in Table 8.2.

Table 8.1. Summary of Eligibility Criteria for a Mexico Halocarbon Destruction Project

Eligibility Rule	Eligibility Criteria	Frequency of Rule Application
Start Date	For 12 months following the Effective Date (June 16, 2021) of this protocol, a pre-existing project with a start date on or after June 16, 2019 may be submitted for listing; after this 12-month period, projects must be submitted for listing within 6 months of the project start date. Privately held virgin CFC refrigerant projects are only eligible under this protocol if they are destroyed within 12 months of the Effective Date.	Once per project
Location of Destruction	Mexico	Once per project
Point of Origin of Halocarbon	Mexico	Each verification
Project Definition	▪ Project developer and GHG ownership is the same for all halocarbon destroyed ▪ A single destruction facility has been used for all halocarbon destruction ▪ All project activities span no more than 12 months from the project start date ▪ Eligible halocarbons include CFC-11, CFC-12, CFC-113, CFC-114, HCFC-22, HFC-32, HFC-125, HFC-134a and HFC-143a ▪ Refrigerants meet the refrigerant sources established in Section 2.4 for each halocarbon group ▪ Stockpiles of HCFC-22, HFC-32, HFC-125, HFC-134a and HFC-143a are only eligible until 12 months after the Effective Date (June 16, 2021) ▪ Refrigeration equipment at end-of-life is disposed of, destroyed or sent to a landfill ▪ Evidence is provided for equipment retrofit ▪ Substitute retrofit refrigerant is demonstrated ▪ Baseline refrigerant for retrofit projects could have continued to be used for 10 years ▪ Refrigerant from servicing cylinder may not have a higher volume than 1 kg per cylinder	Each verification
Performance Standard	Project destroys halocarbons that meet project definitions	Each verification
Legal Requirement Test	Signed Attestation of Voluntary Implementation form and monitoring procedures for ascertaining and demonstrating that the project passes the legal requirement test	Each verification
Regulatory Compliance	Signed Attestation of Regulatory Compliance form and disclosure of all non-compliance events to verification body; project must be in material compliance with all applicable laws	Each verification
Exclusions	▪ Halocarbon sourced from any country other than Mexico ▪ Halocarbon destroyed outside of Mexico ▪ Halocarbon produced for or used in any application other than refrigeration	Each verification

8.4 Core Verification Activities

The Mexico Halocarbon Protocol provides explicit requirements and guidance for quantifying the GHG reductions associated with the destruction of halocarbons sourced from Mexico at destruction facilities in Mexico. The Verification Program Manual describes the core verification activities that shall be performed by verification bodies for all project verifications. They are summarized below in the context of a halocarbon destruction project, but verification bodies must also follow the general guidance in the Verification Program Manual.

Verification is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review. The three core verification activities are:

1. Identifying emission sources, sinks, and reservoirs (SSRs)
2. Reviewing GHG management systems and estimation methodologies
3. Verifying emission reduction estimates

Identifying emission sources, sinks, and reservoirs
The verification body reviews for completeness the sources, sinks, and reservoirs identified for a project, including but not limited to, the halocarbon baseline emissions, substitute emissions, emissions from transportation, and emissions from the destruction of halocarbons.

Reviewing operations, GHG management systems and estimation methodologies
The verification body reviews and assesses the appropriateness of the operations, methodologies, and management systems that the halocarbon project operator employs to perform project activities, to gather data on halocarbons recovered, aggregated, and destroyed and to calculate baseline and project emissions.

Verifying emission reduction estimates
The verification body further investigates areas that have the greatest potential for material misstatements and then confirms whether or not material misstatements have occurred. This involves site visits to the project facility (or facilities if the project includes multiple facilities) to ensure the halocarbon management, sampling and destruction systems on the ground correspond to and are consistent with data provided to the verification body. In addition, the verification body recalculates a representative sample of the performance or emissions data for comparison with data reported by the project developer in order to double-check the calculations of GHG emission reductions.

8.5 Verification Site Visits

Project verifiers shall conduct site visits for each project to assess operations, management systems, QA/QC procedures, personnel training, and conformance with the requirements of this protocol. Site visit scope definition shall be risk based. Destruction facilities must be visited *at least* once per project developer and verification body in a calendar year basis but the verification body may visit any destruction facility with a higher frequency if necessary.

The verification body may choose to visit the following facilities, in addition to the destruction facility, for any project in any reporting period if risk is perceived to be high:

- Point of origin

- Project developer's office[74]
- Mixing and sampling facility
- Refrigerant recovery facilities
- Refrigerant analysis laboratories

8.6 Halocarbon Verification Items

The following tables provide lists of items that a verification body needs to address while verifying a halocarbon destruction project. The tables include references to the section in the protocol where requirements are further specified. The table also identifies items for which a verification body is expected to apply professional judgment during the verification process. Verification bodies are expected to use their professional judgment to confirm that protocol requirements have been met in instances where the protocol does not provide (sufficiently) prescriptive guidance. For more information on the Reserve's verification process and professional judgment, please see the Verification Program Manual.

Note: These tables shall not be viewed as a comprehensive list or plan for verification activities, but rather guidance on areas specific to halocarbon destruction projects that must be addressed during verification.

8.6.1 Project Eligibility and CRT Issuance

Table 8.2 lists the criteria for reasonable assurance with respect to eligibility and CRT issuance for halocarbon destruction projects. These requirements determine if a project is eligible to register with the Reserve and/or have CRTs issued for the reporting period. If any requirement is not met, either the project may be determined ineligible or the GHG reductions from the reporting period (or subset of the reporting period) may be ineligible for issuance of CRTs, as specified in Sections 2, 3, and 6.

[74] Where project-related documents and data were produced, managed, and retained.

Table 8.2. Eligibility Verification Items

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
2.2	Verify that the project meets the definition of a Mexico halocarbon destruction project	No
2.2	Verify that the project activities involve a single project developer and a single qualifying destruction facility	No
2.2	Verify that the destroyed halocarbon is sourced from Mexico	Yes
2.2	Verify that the halocarbon was not used as nor produced for use as solvents, medical aerosols, or other non-refrigeration applications	Yes
2.2	Verify that project activities span no more than 12 months	No
2.3	Verify that stockpiles of used HCFC-22 and HFC were recovered no later than one year after the date of adoption of the protocol	No
2.3	Verify the refrigerant subsector of recovered HCFC-22 and HFC from EOL equipment or retrofitted equipment	No
2.3	Verify that equipment at EOL was disposed of or destroyed	No
2.3	Verify that a zero or low GWP refrigerant was used to substitute the refrigerant recovered from a retrofitted system (See footnote 24 for a list of zero or low GWP refrigerants)	No
2.3	Verify that the volume of recovered refrigerant from servicing cylinders was not higher than 1 kg per cylinder	No
2.3	Verify that the baseline refrigerant in retrofit projects could have been used for 10 years after project commencement.	Yes
2.5	Verify ownership of the reductions by reviewing Attestation of Title and chain of custody documentation	No
2.5	Verify that credits for destroyed halocarbons have not been claimed on the Reserve or any other registry, using Attestation of Title and the Reserve Software	No
3.2	Verify accuracy of project start date based on operational records	No
3.2	Verify that the project has documented and implemented a Monitoring and Operations Plan	No
3.4.1	Confirm execution of the Attestation of Voluntary Implementation form to demonstrate eligibility under the legal requirement test	No
3.4.1, 6	Verify that the project Monitoring and Operations Plan contains procedures for ascertaining and demonstrating that the project passes the legal requirement test at all times	Yes
3.4.2	Verify that the project meets the performance standard test	No
3.5	Verify that the project activities comply with applicable laws by reviewing any instances of non-compliance provided by the project developer and performing a risk-based assessment to confirm the statements made by the project developer in the Attestation of Regulatory Compliance form	Yes
5	Verify that monitoring meets the requirements of the protocol. If it does not, verify that a variance has been approved for monitoring variations	No
6	Verify the Monitoring and Operations Plan includes a project diagram and that the project diagram is complete, accurate, and up-to-date	No
Appendix C	Verify that the destruction facility meets the requirements of this protocol; verify that the facility is permitted under NOM-098-SEMARNAT-2002 or NOM-040-SEMARNAT-2002 to destroy hazardous waste including halocarbons and that the facility has been third-party certified as meeting the requirements of the TEAP *Report on the Task Force on HCFC Issues* in Appendix C and has successfully completed the comprehensive performance testing within the three years prior to the end date of destruction activities	No

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
	If any variances were granted, verify that variance requirements were met and properly applied	No

8.6.2 Conformance with Operational Requirements and Halocarbon Eligibility

Table 8.3 lists the verification items to determine the project's conformance with the operational and monitoring requirements of this protocol, and the eligibility of discreet halocarbon sources. A subset of destroyed halocarbons may be deemed ineligible if it was obtained in a manner inconsistent with this protocol, or if documentation is insufficient. If any items in Table 8.3 cannot be verified, no CRTs may be issued for that quantity of halocarbons.

Table 8.3. Operational Requirement and Halocarbon Eligibility Verification Items

Protocol Section	Operational Requirement and Halocarbon Eligibility Items	Apply Professional Judgment?
5	Verify that the destruction facility monitored the parameters identified in Section 6	No
6.1	For all halocarbons, verify that information has been correctly entered in Reserve Software and that the Certificate of Destruction entry is unique to this project	No
6.2	For all halocarbons, verify that the point of origin is correctly identified and documented	Yes
6.2, 6.4	For all halocarbons, verify that the point of origin documentation agrees with the data reported at the destruction facility (weight and composition) with no significant discrepancies	Yes
6.3	For all halocarbons, verify that the halocarbon can be tracked through retained chain of custody documentation from the Certificate of Destruction back to the point of origin	Yes
6.4.1	Verify that the scales used for measuring mass of halocarbon destroyed are properly maintained and tested for calibration quarterly	No
6.4.1	Verify that the weight of full and empty halocarbon containers was measured no more than 48 hours prior to destruction commencing and no more than 48 hours following completion, respectively	No
6.4.2	Verify that all halocarbon samples were taken by a properly trained third-party technician while in the possession of the destruction company	No
6.4.2	Verify the chain of custody by which a halocarbon sample was transferred from the destruction facility to the lab	No
6.4.2	Verify that all halocarbon was analyzed for composition and concentration at a lab following the AHRI 700-2017 standard, or its successor by reviewing, at a minimum, a declaration of the lab and the lab halocarbon analysis processes	No
6.4.2	Verify that the lab is AHRI certified if the deadline to certify labs published by the Reserve has passed	No
6.4.2	Verify that the calculation of halocarbon composition and mass concentration correctly accounted for moisture, mixing, and high boiling residue	No
6.4.2.1.1	For mixed refrigerants, verify that credits are only claimed for refrigerants eligible under this protocol	No

Protocol Section	Operational Requirement and Halocarbon Eligibility Items	Apply Professional Judgment?
6.4.2.1.1	For mixed refrigerants, verify that proper re-circulation occurred	No
6.4.2.1.1	For mixed refrigerants, verify that recirculation and sampling were performed by properly trained technicians	Yes
6.4.2.1.1.	Verify that blends followed mixing procedures	No
6.5	Verify that the Certificate of Destruction contains all required information	No
2.2	Verify that the facility has a valid NOM-098-SEMARNAT-2002 or NOM-040-SEMARNAT-2002 permit which expressly permits destruction of hazardous waste including halocarbons.	No
Appendix C	Verify that the facility has been third-party certified as meeting the requirements of the TEAP *Report on the Task Force on HCFC Issues* and of this protocol	No
Appendix C	Verify that the destruction facility where the halocarbon was destroyed has a documented destruction and removal efficiency greater than 99.99 percent, and that CPT was conducted with a material less combustible than the halocarbon destroyed	No
Appendix C	Verify that the destruction facility operated within the parameters under which it was tested to achieve a 99.99 percent or greater destruction and removal efficiency	No

8.6.3 Quantification of GHG Emission Reductions

Table 8.4 lists the items that verification bodies shall include in their risk assessment and recalculation of the project's GHG emission reductions. These quantification items inform any determination as to whether there are material and/or immaterial misstatements in the project's GHG emission reduction calculations. If there are material misstatements, the calculations must be revised before CRTs are issued.

Table 8.4. Quantification Verification Items

Protocol Section	Quantification Item	Apply Professional Judgment?
2.2	Verify that all destroyed halocarbons for which CRTs are claimed appear on a valid Certificate of Destruction	No
4	Verify that SSRs included in the GHG Assessment Boundary correspond to those required by the protocol and those represented in the project documentation	No
5.1	Verify that the project was correctly characterized as end-of-life, retrofitted system, stockpile, or servicing cylinder	Yes
5.1	Verify that the appropriate baseline scenario was applied for each quantity of halocarbon destroyed	No
5.2.1	Verify that the substitute emissions have been properly characterized, calculated, and aggregated correctly	No
5	Verify that any project-specific data used in lieu of a protocol default value was approved by the Reserve	No
5.2.2	Verify that project emissions from destruction and transportation were correctly quantified and that the project developer applied the default factor appropriately	No
5.3	Verify that the correct Vapor Composition Risk Deduction was applied	No

8.6.4 Risk Assessment

Verification bodies will review the following items in Table 8.5 to guide and prioritize their assessment of data used in determining eligibility and quantifying GHG emission reductions.

Table 8.5. Risk Assessment Verification Items

Protocol Section	Item that Informs Risk Assessment	Apply Professional Judgment?
6	Verify that the project Monitoring and Operations Plan is sufficiently rigorous to support the requirements of the protocol and proper operation of the project	Yes
6	Verify that appropriate monitoring equipment is in place at destruction facility to meet the requirements of the protocol	Yes
6	Verify that the individual or team responsible for managing and reporting project activities are qualified to perform these functions	Yes
6	Verify that appropriate training was provided to personnel assigned to operations, record-keeping, sample-taking, and other project activities	Yes
6	Verify that all contractors are qualified for managing and reporting greenhouse gas emissions if relied upon by the project developer. Verify that there is internal oversight to assure the quality of the contractor's work	Yes
7	Verify that all required records have been retained by the project developer	No

8.6.5 Completing Verification

The Verification Program Manual provides detailed information and instructions for verification bodies to finalize the verification process. It describes completing a Verification Report, preparing a Verification Statement, submitting the necessary documents to the Reserve, and notifying the Reserve of the project's verified status.

9 Glossary of Terms

Accredited verifier	An individual approved by the Climate Action Reserve to provide verification services for project developers.
Additionality	Project activities that are above and beyond "business as usual" operation, exceed the baseline characterization, and are not mandated by regulation.
Anthropogenic emissions	GHG emissions resultant from human activity that are considered to be an unnatural component of the Carbon Cycle (i.e., fossil fuel destruction, de-forestation, etc.).
Biogenic CO_2 emissions	CO_2 emissions resulting from the destruction and/or aerobic decomposition of organic matter. Biogenic emissions are considered to be a natural part of the Carbon Cycle, as opposed to anthropogenic emissions.
Carbon dioxide (CO_2)	The most common of the six primary greenhouse gases, consisting of a single carbon atom and two oxygen atoms.
Centralized refrigeration system	A refrigeration system with a cooling evaporator in the refrigerated space connected to a compressor rack located in a machinery room and to a condenser located outdoors.
Certificate of Destruction	An official document provided by the destruction facility certifying the date, quantity, and type of halocarbon destroyed.
Chiller	A refrigeration or air-conditioning system that has a compressor, an evaporator, and a secondary coolant, other than an absorption chiller.
Chlorofluorocarbon	
CO_2 equivalent (CO_2e)	The quantity of a given GHG multiplied by its total global warming potential. This is the standard unit for comparing the degree of warming which can be caused by different GHGs.
Commencement of destruction process	When the halocarbon waste-stream is hooked up to the destruction chamber.
Commercial refrigeration equipment	The refrigeration appliances used in the retail food, cold storage warehouse, or any other sector that require 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	An air- and water-tight unit for storing and/or transporting halocarbon material without leakage or escape of halocarbon.
Destruction	Destruction of ozone depleting substances by qualified destruction, transformation, or conversion plants achieving greater than 99.99 percent destruction and removal efficiency. Destruction may be performed using any technology, including transformation, that results in the complete breakdown of the halocarbon into either a waste or usable by-product.
Destruction facility	A facility that destroys, transforms, or converts ozone depleting substances using a technology that meets the standards defined by the UN Environment Programme Technology and Economic Assessment Panel Task Force on Destruction Technologies.
Direct emissions	GHG emissions from sources that are owned or controlled by the reporting entity.
Effective Date	The date of adoption of this protocol by the Reserve board, expected

	June 16, 2021.
Emission factor (EF)	A unique value for determining an amount of a GHG emitted for a given quantity of activity data (e.g., metric tons of carbon dioxide emitted per barrel of fossil fuel burned).
Emission rate	The annual rate at which halocarbons are lost to the atmosphere, including emissions from leaks during operation and servicing events.
Fossil fuel	A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.
Generator	The facility from which the halocarbon 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 reservoir	A physical unit or component of the biosphere, geosphere, or hydrosphere with the capability to store or accumulate a GHG that has been removed from the atmosphere by a GHG sink or a GHG captured from a GHG source.
GHG sink	A physical unit or process that removes GHG from the atmosphere.
GHG source	A physical unit or process that releases GHG into the atmosphere.
Global Warming Potential (GWP)	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of CO_2.
Greenhouse gas (GHG)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).
Halocarbon	Chemical compounds containing carbon atoms, and one or more atoms of chlorine, fluorine, bromine or iodine.
Hydrochlorofluorocarbon	An inert compound consisting of carbon, hydrogen, hydrocarbons, chlorine, and fluorine.
Hydrofluorocarbon	An organic compound composed of hydrogen, fluorine, and carbon.
Hydrofluoroolefin	Unsaturated organic compounds containing hydrogen, fluorine, and carbon.
Indirect emissions	Reductions in GHG emissions that occur at a location other than where the reduction activity is implemented, and/or at sources not owned or controlled by project participants.
Methane (CH_4)	A potent GHG with a GWP of 21, consisting of a single carbon atom and four hydrogen atoms.
Metric ton (t, tonne)	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons.
MMBtu	One million British thermal units.
Mixed halocarbons	Halocarbons with less than 90 percent composition of a single halocarbon species.
Mobile combustion	Emissions from the transportation of employees, materials, products, and waste resulting from the combustion of fuels in company owned or controlled mobile combustion sources (e.g., cars, trucks, tractors, dozers, etc.).
Ozone depleting substances (ODS)	Ozone depleting substances are 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 (CH_3Br), carbon tetrachloride (CCl_4), methyl chloroform (CH_3CCl_3),

	hydrobromofluorocarbons (HBFC) and bromochloromethane (CHBrCl).
Project baseline	A “business as usual” GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured.
Project developer	An entity that undertakes a GHG project, as identified in Section 2.5 of this protocol.
Refrigeration equipment	An appliance, or component parts of a system, that uses refrigerant to provide cooling under controlled conditions.
Recharge	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	Reprocessing and upgrading of a recovered halocarbon through mechanisms such as filtering, drying, distillation and chemical treatment in order to restore the halocarbon to a specified standard of performance. Chemical analysis is required to determine that appropriate product specifications are met. It often involves processing offsite at a central facility.
Recovery	The removal of halocarbons 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	Reuse of a recovered halocarbon following a basic cleaning process such as filtering and drying. For refrigerants, recycling normally involves recharge back into equipment and it often occurs onsite.
Stand-alone refrigeration system	A self-contained refrigeration system with components that are integrated within its structure.
Startup, shutdown, and malfunction plan (SSMP)	A management plan 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	Halocarbon 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 emissions	A term used in this protocol to describe the greenhouse gases emitted from the use of substitute chemicals used to replace the halocarbon destroyed by a project.
Substitute refrigerant	Those refrigerants that will be used to fulfill the function that would have been filled by the destroyed halocarbon refrigerants. These refrigerants may be drop-in replacements used in equipment that previously used the type of halocarbon destroyed, or may be used in new equipment that fulfills the same market function.
Transportation system	A term used to encompass the entirety of the system that moves the halocarbons from their origin to the destruction facility.
Verification	The process used to ensure that a given participant’s GHG emissions or emission reductions have met the minimum quality standard and complied with the Reserve’s procedures and protocols for calculating and reporting GHG emissions and emission reductions.
Verification body	A Reserve-approved firm that is able to render a verification opinion and provide verification services for operators subject to reporting under this protocol.

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Appendix A Summary of Legal Requirement Test Development

In Mexico, management activities for halocarbons are dictated by both the Montreal Protocol and domestic law. This appendix provides background information on the Montreal Protocol and demonstrates that this framework does not require the destruction of halocarbons. This appendix also provides background on the Mexican National CFC Phase-Out Plan and supporting Mexican regulations. The information presented confirms that there are no domestic rules requiring destruction of halocarbons in Mexico, and as such, destruction of halocarbons from Mexico meets the legal requirement test under this protocol.

A.1 Montreal Protocol

The original Montreal Protocol, signed in 1987, was the first step in international efforts to protect stratospheric ozone. Since that time, the Montreal Protocol has been repeatedly strengthened by both controlling additional ODS as well as by moving up the date by which previously controlled substances must be phased out. The Montreal Protocol controls only production and consumption (defined as production plus imports minus exports), but not emissions of ODS. There is no mandatory requirement to destroy ODS in the Montreal Protocol. Therefore, for analyses prepared under the Montreal Protocol, it is assumed that all ODS produced will eventually be released to the atmosphere, even though some developed countries have voluntary and/or mandatory requirements to destroy ODS.

Under the original Montreal Protocol agreement (1987), non-Article 5 countries were required to begin phasing out CFC in 1993 and achieve a 50 percent reduction relative to 1986 consumption levels by 1998. Under this agreement, CFC were the only ODS addressed. The London Amendment (1990) changed the ODS emission schedule by requiring the complete phase-out of CFC, halons, and carbon tetrachloride by 2000 in developed countries, and by 2010 in developing countries. Methyl chloroform was also added to the list of controlled ODS, with phase-out in developed countries targeted in 2005, and in 2015 for developing countries.

The Copenhagen Amendment (1992) significantly accelerated the phase-out of ODS and incorporated a HCFC phase-out for developed countries, beginning in 2004. Under this agreement, CFC, halons, carbon tetrachloride, methyl chloroform, and HBFC were targeted for complete phase-out in 1996 in developed countries. In addition, methyl bromide consumption was capped at 1991 levels.

The Montreal Amendment (1997) included the phase-out of HCFC in developing countries, as well as the phase-out of methyl bromide in developed and developing countries in 2005 and 2015, respectively.

The Beijing Amendment (1999) included tightened controls on the production and trade of HCFC. Bromochloromethane was also added to the list of controlled substances with phase-out targeted for 2002.

At the 19th Meeting of the Parties in Montreal in September 2007, the Parties agreed to an adjustment that more aggressively phases out HCFC in both developed and developing countries. Developed countries must reduce HCFC production and consumption by 75 percent by 2010, 99.5 percent by 2020, and 100 percent by 2030. The 0.5 percent during the period 2020-2030 is restricted to the servicing of existing refrigeration and air-conditioning equipment and is subject to review in 2015. Developing countries must freeze production and consumption of HCFC in 2013 and then reduce it by 10 percent in 2015, 35 percent by 2020, 67.5 percent by 2025, 97.5 percent by 2030 and 100 percent by 2040. The 2.5 percent during the period 2030-2039 is the average over that time frame (e.g., it can be five percent for five years and zero percent for the other five years), and is restricted to the servicing of existing refrigeration and air-conditioning equipment, subject to review in 2015.

The result of Montreal Protocol with its amendments and adjustments is that as of January 1, 2010, CFC, halons, methyl chloroform, carbon tetrachloride, methyl bromide, and bromochloromethane will be phased out of production in both developed and developing countries. Therefore, any ongoing uses of these substances must be supplied from already existing stocks that were never used, or from recycled or reclaimed material. However, it should be noted that there are allowances for some ongoing limited production of these substances for certain essential uses and critical uses approved by the Montreal Protocol Parties (e.g., as process agents and for quarantine and pre-shipment uses). Also, production and use of these substances as feedstock is not considered production since they are consumed in the feedstock process. Therefore, this protocol is limited to halocarbons used in refrigerant applications in Mexico.

A.2 Mexico

Mexico first signed the Montreal Protocol in 1987 and was the first Article 5 country to ratify the protocol in 1988.[75,76] Soon after, SEMARNAT established the Unit for National Ozone Protection (UPO) to help implement and comply with the Montreal Protocol, and SEMARNAT submitted a National CFC Phase-Out Plan to the Multilateral Fund for Implementation of the Montreal Protocol in 1989. By ratifying the Montreal Protocol, Mexico agreed to stop all domestic production and imports of CFC ODS, with the exception of certain critical use exemptions, by January 1, 2010. However, Mexico went further in its National CFC Phase-Out Plan, phasing out all production of CFCs by September 2005. It did this by establishing agreements directly with the three domestic CFC producers to phase-out CFC production and shift manufacturing to HCFC-22 by that date. The import of refrigeration equipment and appliances containing CFCs was allowed until January 1, 2010. [77,78,79]

[75] UNEP, Ozone Secretariat. Montreal Protocol on Substances that Deplete the Ozone Layer. "Status of Treaties." Retrieved 9 February 2015 from http://montreal-protocol.org/en/treaties.php.
[76] GIZ GmbH, Programme Proklima, Consumption and emission inventory of fluorinated greenhouse gases (CFC, HCFC and HFC) in Mexico: Final Report, www.giz.de/proklima.
[77] UNEP, Ozone Secretariat, Multilateral Fund for the Implementation of the Montreal Protocol, National Phase-out Plans and Projects (as of November 2014).
[78] GIZ GmbH, Programme Proklima, Consumption and emission inventory of fluorinated greenhouse gases (CFC, HCFC and HFC) in Mexico: Final Report, www.giz.de/proklima.
[79] "National CFC Phase-Out Plan," Included in UNEP/OzL.Pro/ExCom/42/39: "Project Proposals: Mexico," March 2004, Presented at the 42nd Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, Retrieved from http://www.multilateralfund.org/sites/42/Document%20Library2/1/4239.pdf.

Through the Kigali Amendment to the Montreal Protocol, all countries have committed to legally binding targets that require gradual reductions in HFC consumption and production. For Mexico, the agreement specifies that a licensing system for the import and export of HFCs should enter into force no later than January 1, 2021. Under this agreement, Mexico will have to freeze its consumption in 2024, taking as a baseline the average of HFC consumption in the period from 2020 to 2022. The goals that Mexico must meet to phase-down 80% of the baseline before 2045, by year are:

- 2020-2022: Average of consumption to set the baseline
- 2024: Consumption freeze
- By 2029: 10% consumption below baseline
- By 2035: 35% consumption below baseline
- By 2040: 50% consumption below baseline
- By 2045: 80% consumption below baseline

Also relevant to the management and handling of halocarbons in Mexico is the General Law for Waste Prevention and Integrated Waste Management (Ley General para la Prevención y Gestión Integral de los Residuos – LGPGIR). LGPGIR aims to ensure the right of all people to a healthy environment and promote sustainable development by regulating the generation, recovery and integrated management of hazardous waste, municipal solid waste and special waste management. The law creates strict liability against owners and possessors (including operators) of a contaminated site.

In particular, the LGPGIR establishes a number of regulations as to how and by whom halocarbon is managed. The law establishes that producers, importers, exporters, traders, consumers, and waste management utilities must implement a waste management disposal plan for “special management wastes,” such as refrigerators and air conditioning units. However, despite requiring a waste management disposal plan, there has been no enforcement of this requirement; the waste management plans that have been developed have not been reviewed or approved by SEMARNAT. Further, these waste management plans do not require destruction of the halocarbon waste as a means of management.[80]

The LGPGIR states that generators of hazardous waste, which includes recycling centers that reclaim halocarbons from appliances, must register with SEMARNAT as a hazardous waste generator through the administrative procedure SEMARNAT-07-017-Registration. Generators and owners of hazardous waste may also hire the services of a waste management company with an authorization issued by SEMARNAT, shifting the responsibility of various components of waste operations to the service companies. Generators of hazardous waste must ensure that service companies have SEMARNAT authorizations; otherwise, they will be responsible for any damages. In addition to authorizations to generate hazardous wastes under SEMARNAT-07-017-Registration, companies that manage hazardous waste may need to seek other authorizations depending on the handling processes used. Table A.1 shows authorizations that are required for hazardous waste management. While Table A.1 is thorough, it is not necessarily an exhaustive list as all applicable authorizations required for hazardous waste management. It is the responsibility of the project developer and verification body to identify and apply all of the applicable authorizations.

[80] SEMARNAT, Norma Oficial Mexicana NOM-161-SEMARNAT-2011, http://www.profepa.gob.mx/innovaportal/file/6633/1/nom-161-semarnat-2011.pdf.

Table A.1. Authorizations for Hazardous Waste Management

Service	Authorizations
Collection and storage	SEMARNAT-07-033-A. Authorization for handling hazardous waste - Collection centers
Reuse	SEMARNAT-07-033-B. Authorization for handling hazardous waste – Reuse[81]
Recycling or co-processing	SEMARNAT-07-033-C. Authorization for handling hazardous waste - Recycling or co-processing[61]
Treatment	SEMARNAT-07-033-D. Authorization for handling hazardous waste – Treatment[61]
Disposal	SEMARNAT-07-033-F. Authorization for handling hazardous waste – Incineration[61]
	SEMARNAT-07-033-H. Authorization for handling hazardous waste – Disposal[61]
Transport*	SEMARNAT-07-033-I. Authorization for handling hazardous waste – Transport[61]
	NOM-002-SCT-2011. Permission for road freight transport must be issued by the Secretariat of Communications and Transportation (SCT)[82]
Import and export	SEMARNAT-07-029. Authorization for the transboundary movement of hazardous wastes and other wastes under international treaties.[83]
	Accreditation of importation quota allocated by the SEMARNAT[84]

A.3 Conclusion

Though there are a number of regulations governing the proper management of halocarbons, neither Mexican domestic law nor the Montreal Protocol requires the destruction of extant stocks of halocarbons.[85] Rather, virgin stockpiles may be sold for use, and installed banks may be recovered, recycled, reclaimed, and reused indefinitely. Because neither the Montreal Protocol nor Mexican law forbids the use of existing or recycled controlled substances beyond the phase-out dates, even properly managed halocarbon banks will eventually be released to the atmosphere during equipment servicing, use, and end-of-life.

The Reserve's review of domestic and international law demonstrates that there are no regulations requiring destruction of halocarbons in Mexico at this time. Therefore, destruction of halocarbons from Mexico meets the legal requirement test.

[81] SEMARNAT, Tramites y Requisitos. Residuos peligrosos: Autorizaciones, http://tramites.semarnat.gob.mx/index.php/residuos-peligrosos/autorizaciones/.
[82] SCT, Norma Oficial Mexicana NOM-002-SCT/2011, http://www.sct.gob.mx/fileadmin/DireccionesGrales/DGAF/Normatividad/Materiales_y_residuos_peligrosos/NOM-002-SCT-2011.pdf.
[83] SEMARNAT, Tramites y Servicios. Residuos peligrosos: Importacion/Exportacion, http://tramites.semarnat.gob.mx/index.php/residuos-peligrosos/importacion-exportacion.
[84] SEMARNAT, Reglamento en Materia de Registros, Autorizaciones de Importación y Exportación y Certificados de Exportación de Plaguicidas, Nutrientes Vegetales y Sustancias y Materiales Tóxicos o Peligrosos, http://www.diputados.gob.mx/LeyesBiblio/regla/n109.pdf.
[85] Mexican Official Standard 52, Published Oct 2003, SEMARNAT. Retrieved from http://www.diputados.gob.mx/LeyesBiblio/ref/lgpgir/LGPGIR_orig_08oct03.pdf.

Appendix B Summary of Performance Standard Development

The Reserve assesses the additionality of projects through application of a performance standard test and a legal requirement test. The purpose of a performance standard is to establish a standard of performance applicable to all halocarbons projects that is significantly better than average halocarbon management practice, which, if met or exceeded by a project developer, satisfies one of the criteria of "additionality."[86]

Appendix A described the regulatory framework surrounding the end-of-life treatment of halocarbons and established that there is no legal requirement in Mexico to destroy halocarbons. However, the Reserve looks not only at what the regulatory requirements are, but also at the prevailing practice. Therefore, with the project defined as the destruction of halocarbons, the Reserve sought to establish whether domestic destruction of halocarbons sourced in Mexico is standard practice or whether it exceeds standard practice.

B.1 2010 Performance Standard Analysis

In 2009, the Reserve assessed common practice for all of the 146 countries operating as parties under Article 5 of the Montreal Protocol, including Mexico, as part of the development of the Reserve Article 5 Ozone Depleting Substances Protocol. Specifically, the Reserve assessed common practice for all halocarbons, but particularly the CFC phased out of production in Mexico and these Article 5 countries by the Montreal Protocol and domestic law. Based on data collected by the United Nations Environment Programme (UNEP), the Reserve determined that destruction of CFC is not standard practice in any Article 5 country. The Article 5 ODS Protocol, from which this protocol is adapted, is applicable to refrigerant sourced from Article 5 countries, which is then destroyed at facilities in the U.S., and has resulted in the destruction of 445 metric tons of ODS from three Article 5 countries, 300 metric tons of which were from Mexico, and the issuance of approximately 4 million CRTs.

After reviewing the analysis performed for Article 5 countries in 2009, as well as performing additional analysis on destruction of ODS sourced from Mexico since that date, the Reserve re-confirmed that destruction of CFC is not standard practice in Mexico. Further, based on an analysis of destruction facilities in Mexico, the Reserve determined that domestic destruction of halocarbons sourced in Mexico exceeds standard practice in Mexico.

B.2 Methodology Assessing the Destruction of ODS Sourced from Mexico

In 2009, the Reserve assessed common practice for all Article 5 countries by evaluating primary data from records maintained by the UNEP Ozone Secretariat,[87] as well as data from a 2009 UNEP report detailing ODS destruction from Article 5 countries between 1990 and 2008. This dataset indicated that, during this timeframe, only seven countries reported destruction of ODS.

[86] See the Reserve Offset Program Manual for further discussion of the Reserve's general approach to determining additionality.
[87] UNEP, Ozone Secretariat. Data Access Center. Retrieved on September 22, 2009 from http://ozone.unep.org/Data_Reporting/Data_Access/.

Mexico was one of those countries, with a reported 0.7 tonnes of ODS destroyed from 1990 to 2008.[88]

For these same countries, the Reserve also queried the Ozone Secretariat's Data Access Center to obtain data on the reported in-country consumption of ODS over the same period to determine the commonality of ODS destruction. Because the data reported to UNEP did not differentiate ODS by type, and the Reserve prefers to use publicly available data whenever possible, the Reserve conducted two analyses to arrive at a lower and upper bound of the relative quantity of ODS being destroyed. The lower bound is defined under the assumption that the ODS destroyed included all classes of ODS for which consumption occurred, including all Annexes and all Groups. The upper bound is defined under the assumption that only Annex A, Group I CFC were destroyed. As shown in Table B.2, the Reserve did receive confirmation that very little of the destroyed ODS was CFC. Nonetheless, the results of this sensitivity analysis are provided in Table B.1 below.

Table B.1. Destruction of ODS in Mexico (1990 to 2008)

Country	Destruction 1990-2008 (t)	Consumption of All ODS 1990-2008 (t)	Consumption Annex A, Class I 1990-2008 (t)	Lower Bound (destruction/ all ODS cons.)	Upper Bound (destruction/ CFC cons.)
Mexico	0.7	139,590	82,860	0.00%	0.00%

The analysis above indicates that since 1990, even using conservative assumptions, destruction of ODS has not been common practice in Mexico.

The Reserve further assessed the destruction and consumption that took place in these countries more recently (2005 to 2008) to determine if there have been shifts in ODS treatment in these countries. Table B.2 below indicates that destruction of ODS remained uncommon in Mexico from 2005 to 2008.

Table B.2. Destruction of ODS in Mexico (2005 to 2008)

Country	Destruction 2005-2008 (t)	Consumption of All Halocarbons 2005-2008 (t)	Consumption Annex A, Class I 2005-2008 (t)	Lower Bound (destruction/ all Halocarbons cons.)	Upper Bound (destruction/ CFC cons.)
Mexico	0.7	14,964	3,760	0.00%	0.02%

As many UNEP Reports are quadrennial, there have not been any comprehensive reports on global ODS destruction published since 2010. That said, a number of reports[89,90,91,92] refer to the

[88] UNEP, Addendum to Information provided by Parties in accordance with Article 7 of the Montreal Protocol on Substances that Deplete the Ozone Layer, http://ozone.unep.org/Meeting_Documents/mop/21mop/MOP-21-5-Add-1E.pdf.
[89] Synthesis Report to the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, UNEP, June 2011.
[90] "Study on Disposal of ODS Collected from Refrigerators and Air Conditioners under the Mexican Efficient Lighting and Appliances Program." Submitted by World Bank to the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol. March 2012.
[91] UNEP TEAP, 2010 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, http://ozone.unep.org/Assessment_Panels/TEAP/Reports/RTOC/RTOC-Assessment-report-2010.pdf.
[92] UNEP TEAP, 2014 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, http://ozone.unep.org/Assessment_Panels/TEAP/Reports/RTOC/RTOC-Assessment-Report-2014.pdf.

fact the halocarbon destruction continues to be rare, in large part due to the lack of incentives for destruction, both in Article 5 and non-Article 5 countries. In a number of these reports, carbon markets and protocols including those developed by the Reserve are identified as a potential resource to help incentivize destruction. In particular, the 2012 *Study on Disposal of ODS Collected from Refrigerators and Air Conditioners under the Mexican Efficient Lighting and Appliances Program*, developed by SEMARNAT and the World Bank, explicitly recommend that the Reserve Article 5 ODS Protocol be used to finance voluntary ODS destruction.

The Reserve Article 5 ODS Protocol is applicable to refrigerants sourced from Article 5 countries and destroyed at facilities in the U.S. First adopted in 2010, this protocol has resulted in projects from India, Nepal, and Mexico, which destroyed approximately 445 metric tons of halocarbons.[93] Of those five projects, two originated from Mexico, destroying approximately 288 metric tons of virgin stockpiled CFC-12 and another 12.6 metric tons of mixed CFC-12.[94] Even with the addition of the carbon incentive, halocarbon destruction from Mexico and other Article 5 countries has not increased significantly.

B.3 Methodology Assessing the Halocarbon Destruction at Mexican Facilities

The fact that CFC refrigerants will be destroyed at destruction facilities in Mexico further supports the additionality of halocarbon destruction projects implemented under this protocol. Though there have been a few pilot projects for halocarbon destruction led by the Ozone Protection Unit (UPO) of SEMARNAT, at the time of protocol adoption, there is only one destruction facility, Quimobásicos, S.A. de C.V.,that is expressly authorized to destroy halocarbons and is doing so using a TEAP screened-in technology, an argon arc plasma technology.

The Quimobásicos facility maintains two processing lines dedicated to the manufacture of HCFC-22 refrigerants and foams (HCFC-22) used for industrial, commercial, domestic and refrigeration and air conditioning appliances. To date, the facility has never destroyed any CFCs, but has destroyed HFC-23, an unwanted by-product in the manufacture of HCFC-22.[95]

In October 2008, a pilot test for ODS destruction was conducted at the Ecoltec facility located at Tecoman, Colima, which uses a cement kiln technology. This pilot was coordinated by UPO - SEMARNAT and Ecoltec technicians. The test destroyed a total of 794 kg of halocarbons, using a mix of R-12 (34.2%) and HCFC-22 (65.8%) in order to verify if permissible limits for air emissions could be met according to Mexican regulations.[96] This has been the only CFC destruction event to-date that has taken place in Mexico. Although the pilot test was successful, Ecoltec ultimately did not complete the process for SEMARNAT to authorize ongoing destruction of halocarbons.

[93] Project data from CAR 596, 597, 691, 826, 955.
[94] Data based on Verification Reports for both CAR 691 and CAR 826. https://thereserve2.apx.com/mymodule/mypage.asp.
[95] Cydsa. (2011). Quimobásicos. Monterrey. Retrieved from: http://www.cydsa.com/quimo.html.
[96] "Study on Disposal of ODS Collected from Refrigerators and Air Conditioners under the Mexican Efficient Lighting and Appliances Program." Submitted by World Bank to the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol. March 2012.

As the Ecoltec pilot test was the only instance of CFC destruction in Mexico to date, the Reserve concludes that it is not common practice to destroy CFCs at destruction facilities in Mexico.

B.4 2020 Update to the Performance Standard Analysis

In 2018, UNEP published an updated report that contained information on national halocarbon destruction. Mexico reported destruction of halocarbons in 2007, 2014, 2015 and 2016; there was no destruction in all other intervening years. As the destruction data are reported for all halocarbons irrespective of the specific gas, the Reserve estimated a conservative upper bound value for destruction for HCFC-22 and HFCs assuming that all destruction had been only for one type of gas.

No data were found on the amount of halocarbons at EOL that would be available for destruction every year. To estimate the value, the Reserve assumed that the average useful life of refrigeration equipment is 10 years. Under that assumption, the equipment from 2004 would be at the end of its useful life by 2014 and the halocarbon it contained could be available for destruction.

The results indicate that no more than 1.26% of HCFC-22 or HFC would have been destroyed annually under this assumption. The analysis demonstrates that destruction continues to be highly unusual and therefore additional in Mexico. In fact, Mexico continues to report destruction as isolated events that happen dependent on multilateral funding. See Table B.3 for the calculation of the upper bound destruction estimate of HCFC-22 and HFC in Mexico.

Table B.3. Halocarbon Destruction Relative to HCFC-22 and HFC at EOL in Mexico

Category	2014	2015	2016
Tonnes of destroyed halocarbons[97]	3.03	62.85	39.07
EOL HCFC-22 (Tonnes consumed in year -10)[98]	4,848[99]	6,498	8,990
EOL HFC[100] (Tonnes consumed in year -10)	NA	4,977	5,821
Estimated Relative Destruction[101]	**2014**	**2015**	**2016**
HCFC-22	0.05%	0.97%	0.43%
HFC	NA	1.26%	0.67%

[97] UNEP, 2018. Information provided by parties in accordance with Articles 7 and 9 of the Montreal Protocol on Substances that Deplete the Ozone Layer. Report of the Secretariat. Available at: https://ozone.unep.org/treaties/montreal-protocol/meetings/tenth-meeting-parties/decisions/decision-x2-data-and

[98] UNEP, 2011. Comments and recommendation of the Fund Secretariat on Mexico's HCFC phase-out management plan (stage I, first tranche). UNEP/OzL.Pro/ExCom/64/39

[99] The halocarbons at EOL in 2014 (HCFC-22 consumption in 2004) was estimated by assuming the consumption in 2004 was 90% of the consumption in 2005.

[100] Online Presentation by Ester Monroy on ODS Alternatives Surveys Results: Gaps, Challenges and Best Practices. Available at: https://www.unido.org/sites/default/files/2017-06/13June_ODSAlternatives_GeneralAnalysis_0.pdf. The presentation only provided the consumption for 2015. The 2016 HFC EOL value (consumption in 2006) was estimated backtracking consumption from 2015 by 14.5%.

[101] (UNEP, 2018. Information provided by parties in accordance with Articles 7 and 9 of the Montreal Protocol on Substances that Deplete the Ozone Layer. Report of the Secretariat. Available at: https://ozone.unep.org/treaties/montreal-protocol/meetings/tenth-meeting-parties/decisions/decision-x2-data-and),

B.5 Conclusion

Based on the analysis described above, the Reserve concludes that destruction of halocarbons continues to exceed standard practice in Mexico. Further, as the only halocarbons destroyed in Mexico to date were destroyed as part of a government supervised pilot project, the Reserve concludes that destruction of halocarbons at facilities in Mexico also exceeds common practice. Therefore, all phased-out halocarbons sourced in Mexico and destroyed at destruction facilities in Mexico meet the performance standard.

Appendix C Rules Governing Halocarbon Destruction

This protocol requires that all halocarbons be destroyed at a destruction facility that is compliant with both the international standards specified in the TEAP *Report of the Task Force on Destruction Technologies*[102] and Code of Good Housekeeping, as well as the requirements of Mexican law. This appendix provides a brief summary of the rules dictated by Mexican law for destruction of halocarbons and the TEAP criteria that must be met for a destruction facility to qualify under this protocol.

C.1 Mexican Regulation Governing Halocarbon Destruction

As noted in Sections 2.2 and 6.5, in order to be a qualifying destruction facility under this protocol a facility must be permitted by SEMARNAT under Mexico's General Law for the Prevention and Management of Wastes (Ley General para la Prevención y Gestión Integral de los Residuos – LGPGIR) to destroy hazardous waste, including halocarbons. More specifically, at the time of halocarbon destruction, a destruction facility must have a valid permit under either NOM-098-SEMARNAT-2002 or NOM-040-SEMARNAT-2002, which explicitly allows for CFC destruction.

At present, NOM-098-SEMARNAT-2002 and NOM-040-SEMARNAT-2002 are the only relevant permits that may allow for the destruction of halocarbons under the LGPGIR. However, there is no regulation in Mexico governing specifically how halocarbons must be destroyed. NOM-098-SEMARNAT-2002 is the regulation that sets forth the requirements for environmental protection from hazardous waste incineration activities, but a facility must also specifically seek to include permission to destroy CFCs in that permit.[103] NOM-040-SEMARNAT-2002 sets forth requirements for environmental protection at cement manufacturing facilities. Under this regulation, hazardous waste and other halocarbons may potentially be destroyed in cement kilns and used as alternative fuels for cement manufacturing activities. Again, a facility seeking to destroy CFCs in a cement kiln must have a permit explicitly allowing it to do so.[104]

However, additional technologies are recognized on the TEAP Screened-in Technology list. If additional regulations are promulgated in Mexico that explicitly allow for CFC destruction at facilities utilizing technologies on this list, they will be considered and a clarification to the protocol issued to allow for immediate inclusion of such eligible destruction facilities.

Technologies approved by the Montreal Protocol include:

1. Liquid injection incineration
2. Reactor cracking
3. Gaseous/fume oxidation
4. Rotary kiln incineration
5. Cement kiln
6. Radio frequency plasma
7. Municipal waste incinerators (only for the destruction of foams)
8. Argon arc plasma

[102]UNEP TEAP, Report of the Task Force on Destruction Technologies.
[103] SEMARNAT, Norma Oficial Mexicana NOM-098-SEMARNAT-2002, http://www.profepa.gob.mx/innovaportal/file/1309/1/nom-098-semarnat-2002.pdf.
[104] SEMARNAT, Norma Oficial Mexicana NOM-040-SEMARNAT-2002, http://www.profepa.gob.mx/innovaportal/file/1236/1/nom-040-semarnat-2002.pdf.

As noted in Section 2.1.1 of the excerpt from TEAP *Report of the Task Force on Destruction Technologies* below, TEAP considers concentrated sources, such as CFC refrigerants, to be "completely destroyed" at a destruction and removal efficiency (DRE) limit of 99.99 percent, and as such, this protocol requires DRE of 99.99 percent for any destruction facility operating under this protocol. However, NOM-098-SEMARNAT-2002 requires a DRE of 99.9999 percent,[105] so regardless of TEAP and this protocol's minimum requirements, the destruction facility must also be in compliance with its permitted DRE at all times.

C.2 TEAP Guidelines Governing Halocarbon Destruction

As noted above, in addition to compliance with Mexican laws, this protocol requires that all halocarbons be destroyed at a destruction facility that is compliant with the international standards specified in the TEAP *Report of the Task Force on Destruction Technologies*[106] and Code of Good Housekeeping. By inclusion below, the recommendations of the excerpted section of the TEAP report shall be binding on all Mexican destruction facilities. Destruction facilities must provide third-party certified results indicating that the facility meets all performance criteria set forth in the excerpt below. This third-party certification shall be performed by an independent laboratory certified by EMA. Following the initial performance testing, project developers 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 as reproduced below. No halocarbon destruction credits shall be issued for destruction that occurs at a facility that has failed to undergo comprehensive performance testing according to the required schedule, or has failed to meet the requirements of such performance testing.

Excerpt from the TEAP *Report of the Task Force on Destruction Technologies*, Chapter 2: Technology Screening Process

(Reproduced in full from TEAP *Report of the Task Force on Destruction Technologies*. References in the following section pertain to the *Report* document, not this protocol.)

2.1 Criteria for Technology Screening

The following screening criteria were developed by the UNEP TFDT. Technologies for use by the signatories to the Montreal Protocol to dispose of surplus inventories of halocarbons were assessed on the basis of:

1. Destruction and Removal Efficiency (DRE)
2. Emissions of dioxins/furans
3. Emissions of other pollutants (acid gases, particulate matter, and carbon monoxide)
4. Technical capability

The first three refer to technical performance criteria selected as measures of potential impacts of the technology on human health and the environment. The technical capability criterion indicates the extent to which the technology has been demonstrated to be able to dispose of halocarbons (or a comparable recalcitrant halogenated organic substance such as PCB) effectively and on a commercial scale.

[105] Available at: http://www.profepa.gob.mx/innovaportal/file/1309/1/nom-098-semarnat-2002.pdf.
[106] UNEP TEAP, Report of the Task Force on Destruction Technologies.

For convenience, the technical performance criteria are summarized in Table 2-1. These represent the minimum destruction and removal efficiencies and maximum emission of pollutants to the atmosphere permitted by technologies that qualify for consideration by the TFDT for recommendation to the Parties of the Montreal Protocol for approval as halocarbon destruction technologies. The technologies must also satisfy the criteria for technical capability as defined in section 2.1.4.

Table 2-1: Summary of Technical Performance Qualifications[107]

Performance Qualification	Units	Diluted Sources	Concentrated Sources
DRE	%	95	99.99
PCDDs/PCDFs	ng-ITEQ/Nm^3	0.5	0.2
HCl/Cl_2	mg/Nm^3	100	100
HF	mg/Nm^3	5	5
HBr/Br_2	mg/Nm^3	5	5
Particulates (TSP)	mg/Nm^3	50	50
CO	mg/Nm^3	100	100

2.1.1 Destruction and Removal Efficiency

Destruction Efficiency (DE) [108] is a measure of how completely a particular technology destroys a contaminant of interest – in this case the transformation of halocarbon material into non-halocarbon by-products. There are two commonly used but different ways of measuring the extent of destruction – DE and Destruction and Removal Efficiency (DRE) .[109] For a more detailed explanation of how DRE is calculated, see section 4.2.1. The terms are sometimes interchanged or used inappropriately. DE is a more comprehensive measure of destruction than DRE, because DE considers the amount of the chemical of interest that escapes destruction by being removed from the process in the stack gases and in all other residue streams. Most references citing performance of halocarbon destruction processes only provide data for stack emissions and thus, generally, data is only available for DRE and not DE.

Because of the relatively volatile nature of halocarbons and because, with the exception of foams, they are generally introduced as relatively clean fluids, one would not expect a very significant difference between DRE and DE.

For these reasons this update of halocarbon destruction technologies uses DRE as the measure of destruction efficiency.

For the purposes of screening destruction technologies, the minimum acceptable DRE is:

- 95 percent for foams; and,

[107] All concentrations of pollutants in stack gases and stack gas flow rates are expressed on the basis of dry gas at normal conditions of 0ºC and 101.3 kPa, and with the stack gas corrected to 11% O_2.
[108] Destruction Efficiency (DE) is determined by subtracting from the mass of a chemical fed into a destruction system during a specific period of time the mass of that chemical that is released in stack gases, fly ash, scrubber water, bottom ash, and any other system residues and expressing that difference as a percentage of the mass of the chemical fed into the system.
[109] Destruction and Removal Efficiency (DRE) has traditionally been determined by subtracting from the mass of a chemical fed into a destruction system during a specific period of time the mass of that chemical alone that is released in stack gases, and expressing that difference as a percentage of the mass of that chemical fed into the system.

- 99.99 percent for concentrated sources.

It should be noted that measurements of the products of destruction of CFC, HCFC and halons in a plasma destruction process have indicated that interconversion of halocarbons can occur during the process. For example, under some conditions, the DRE of CFC-12 (CCl_2F_2) was measured as 99.9998 percent, but this was accompanied by a conversion of 25 percent of the input CFC-12 to CFC-13 ($CClF_3$), which has the same ozone-depleting potential. The interconversion is less severe when hydrogen is present in the process, but can nonetheless be significant.[110] For this reason, it is important to take into account all types of halocarbons in the stack gas in defining the DRE.

For the reasons described in the previous paragraph, the Task Force recommends that future calculations of DRE use the approach described below.[111]

DRE of a halocarbon should be determined by subtracting from the number of moles of the halocarbon fed into a destruction system during a specific period of time, the total number of moles of all types of halocarbons that are released in stack gases, and expressing that difference as a percentage of the number of moles of the halocarbon fed into the system.

In mathematical terms, $\boldsymbol{DRE = \frac{N_i^{in} - \sum_i N_i^{out}}{N_i^{in}}}$

Where N_i^{in} is the number of moles of the halocarbon fed into the destruction system, and N_i^{out} is the number of moles of the *i*th type of halocarbon that is released in the stack gases.

2.1.2 Emissions of Dioxins and Furans

Any high temperature process used to destroy halocarbons has associated with it the potential formation (as by-products) of polychlorinated dibenzo-paradioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). These substances are among the products of incomplete combustion (or PICs) of greatest concern for potential adverse effects on public health and the environment. The internationally recognized measure of the toxicity of these compounds is the toxic equivalency factor (ITEQ),[112] which is a weighted measure of the toxicity for all the members of the families of these toxic compounds that are determined to be present.

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110 Deam et al., 1995, and Murphy et al., 2002.

111 Since different ODS have different ozone depletion potentials (ODP), consideration should be given to taking into account the ODP of each type of ODS present in the stack gas in calculating the DRE. An appropriate definition that takes into account the differences in ODP is: *DRE of an ODS is determined by subtracting from the number of moles of the ODS fed into a destruction system during a specific period of time, the total number of moles of all types of ODS that are released in stack gases, weighted by their ODP relative to that of the feed ODS, and expressing that difference as a percentage of the number of moles of the ODS fed into the system.*

112 There are 75 chlorinated dibenzo-p-dioxins and 135 chlorinated dibenzofurans that share a similar chemical structure but that have a wide range in degree of chlorination and a corresponding wide range in toxicity. Of these, one specific dioxin [2,3,7,8-Tetrachlorodibenzo-p-dioxin, or (TCDD)] is the most toxic and best characterized of this family of compounds. Since PCDDs and PCDFs are generally released to the environment as mixtures of these compounds, the scientific community has developed a system of toxic equivalency factors (TEFs) which relate the biological potency of compounds in the dioxin/furan family to the reference TCDD compound. The concentration of each specific compound is multiplied by its corresponding TEF value, and the resulting potency-weighted concentration values are summed to form an expression of the mixture's overall toxic equivalence (TEQ). The result of this exercise is a standardized expression of toxicity of a given mixture in terms of an equivalent amount of TCDD (the reference compound). The internationally accepted protocol for determining TEQ – i.e., ITEQ – was established by NATO in 1988. [North Atlantic Treaty Organization, Committee on the Challenge of Modern Society. (1988). Scientific Basis for the Development of International Toxicity Equivalency Factor (I-TEF), Method of Risk Assessment for Risk Assessment of Complex Mixtures of Dioxins and Related Compounds. *Report No. 176*, Washington, D.C.]

The task force members note that the World Health Organization has developed a new system for calculating TEQs, however, most of the existing data on emissions is expressed in the former ITEQ system established in 1988.

For purposes of screening destruction technologies, the maximum concentration of dioxins and furans in the stack gas from destruction technologies is:

- 0.5 ng-ITEQ/Nm^3 for foams; and,
- 0.2 ng-ITEQ/Nm^3 for concentrated sources.

These criteria were determined to represent a reasonable compromise between more stringent standards already in place in some industrialized countries [for example, the Canada-Wide Standard of 0.08 ng/m^3 (ITEQ)], and the situation in developing countries where standards may be less stringent or non-existent. Although a previous standard of 1.0 ng/m^3 (ITEQ) had been suggested in the UNEP 1992 report, advances in technology in recent years, and the level of concern for emissions of these highly toxic substances justified a significantly more stringent level.

2.1.3 Emissions of Acid Gases, Particulate Matter and Carbon Monoxide

Acid gases are generally formed when halocarbons are destroyed, and these must be removed from the stack gases before the gases are released to the atmosphere. The following criteria for acid gases have been set for purposes of screening destruction technologies:

- a maximum concentration in stack gases of 100 mg/Nm^3 HCl/Cl_2;
- a maximum concentration in stack gases of 5 mg/Nm^3 HF; and,
- a maximum concentration in stack gases of 5 mg/Nm^3 HBr/Br_2.

Particulate matter is generally emitted in the stack gases of incinerators for a variety of reasons and can also be emitted in the stack gases of facilities using non-incineration technologies. For the purposes of screening technologies, the criterion for particulate matter is established as:

- a maximum concentration of total suspended particulate (TSP) of 50 mg/Nm^3.

Carbon monoxide (CO) is generally released from incinerators resulting from incomplete combustion and may be released from some halocarbon destruction facilities because it is one form by which the carbon content of the halocarbon can exit the process. Carbon monoxide is a good measure of how well the destruction process is being controlled. For the purposes of screening technologies, the following criterion has been established:

- a maximum CO concentration in the stack gas of 100 mg/Nm^3.

These maximum concentrations apply to both foams and concentrated sources. They were set to be achievable by a variety of available technologies while ensuring adequate protection of human health and the environment.

2.1.4 Technical Capability

As well as meeting the above performance requirements it is necessary that the destruction technologies have been demonstrated to be technically capable at an appropriate scale of operation. In practical terms, this means that the technology should be demonstrated to achieve the required DRE while satisfying the emissions criteria established above. Demonstration of destruction of halocarbons is preferred but not necessarily required. Destruction of halogenated compounds that are refractory, i.e., resistant to destruction, is acceptable. For example, demonstrated destruction of polychlorinated biphenyls (PCBs) was often accepted as an adequate surrogate for demonstrated halocarbon destruction.

For this evaluation, a halocarbon destruction technology is considered technically capable if it meets the following minimum criteria:

- It has been demonstrated to have destroyed halocarbons to the technical performance standards, on at least a pilot scale or demonstration scale (designated in Table 2-2 as "Yes").
- It has been demonstrated to have destroyed a refractory chlorinated organic compound other than a halocarbon, to the technical performance standards, on at least a pilot scale or demonstration scale (designated in Table 2-2 as "P," which indicates that the technology is considered to have a high potential for application with halocarbons, but has not actually been demonstrated with halocarbons).
- The processing capacity of an acceptable pilot plant or demonstration plant must be no less than 1.0 kg/hr of the substance to be destroyed, whether halocarbons or a suitable surrogate.

These criteria of technical capability will minimize the risk associated with technical performance and ensure that destruction of halocarbons will be performed in a predictable manner consistent with protecting the environment.

Appendix D Mexican Regulations Relevant to Halocarbon Management

As noted in Section 3.4.1 and Appendix A, the Reserve performed extensive analysis on the regulatory framework in Mexico to confirm that there are no legal requirements to destroy halocarbons in Mexico, and to better understand the regulations that destruction facilities and project developers need to comply with over the course of a project. While this protocol includes references to relevant regulations throughout, this appendix is included to summarize those regulations as a tool to streamline verification and project development and implementation activities.

In Mexico, halocarbon banks are classified as hazardous, and several procedures must be followed by generators, importers, exporters and handling, transportation and disposal service providers. Transboundary movements of hazardous waste follow international policies, including Basel Convention requirements.[113] See the table below for a list of the applicable regulations to halocarbons at EOL in Mexico, adapted from UNIDO, 2017. While the table below is thorough, it should not be considered comprehensive for any particular project or facility. As discussed in Section 3.5, projects must be in compliance with all applicable laws at all times during the reporting period.

Table D.1. Applicable Regulations to Halocarbons at EOL in Mexico

Applicable Legislation	Description
Waste Management	
LGPGIR	General law that regulates solid waste management activities, including that of hazardous waste (generation, handling transportation and disposal).
NOM-052-SEMARNAT-2005	Classification and identification of hazardous waste (standard). It classifies halocarbons at EOL as hazardous waste.
NOM-002-SCT-2011	Transportation of hazardous materials and waste
NOM-003-SCT-2008	Packaging and labeling of hazardous materials and waste.
NOM-161-SEMARNAT-2011	Classification of special management waste and waste management plans, including refrigerators and air conditioners discarded by large generators.
Disposal and Destruction	
NOM-098-SEMARNAT-2002	Environmental criteria for waste incineration facilities
NOM-040-SEMARNAT-2002	Environmental criteria for cement manufacturing facilities, including co-processing
Import and Export	
Basel convention	Trans-boundary movements of hazardous waste (international treaty)
LGPGIR and its rules of procedure	Specifies obligations and procedures for hazardous waste import and export into and from Mexico

[113] UNIDO, 2017. Demonstration Project for Disposal of Unwanted ODS in Mexico.

Appendix E Default Emission Factors for Calculating Halocarbon Transportation and Destruction Emissions

E.1 Summary

The GHG Assessment Boundary for halocarbon destruction projects in this protocol includes emissions in both the baseline and project scenario. These emission sources include the following:

Baseline	Project
▪ Emissions of halocarbons from refrigerant applications	▪ Emissions of substitute refrigerant applications ▪ CO_2 emissions from fossil fuel and electricity used in destruction facility ▪ CO_2 emissions from fossil fuel used in transport to destruction facility ▪ Halocarbon emissions from incomplete destruction of halocarbons ▪ CO_2 emissions from halocarbon oxidation during destruction

All of these emission sources must be accounted for to ensure complete, accurate, and conservative calculations of project emission reductions. However, some of these emission sources are of a significantly greater magnitude than others, and some of the smaller sources are costly to track and verify, and difficult to assess.

In order to reduce the burden on project developers and verifiers, the Reserve calculated a standard deduction that shall be applied to all projects in Equation 5.6 to account for the following project scenario emissions:

- CO_2 emissions from fossil fuel and electricity used by the destruction facility
- CO_2 emissions from fossil fuel used for transporting the halocarbons to the destruction facility
- Halocarbon emissions from incomplete destruction of halocarbons
- CO_2 emissions from halocarbons oxidation during destruction

The aggregate of these emission sources amounts to less than 0.5 percent of total emission reductions under even the most conservative assumptions. As a result, a conservative emission factor can be applied. This appendix provides background on the development of these default emission factors.

E.2 Methodology and Analysis

In the Reserve U.S. and Article 5 ODS Protocols, the project developer is given the option of applying the standard deduction or calculating project specific emissions from the transportation and destruction of ODS. However, since the protocols were adopted in 2010, very few projects have opted to use the project-specific equations. In an effort to further streamline project development, project reporting and documentation requirements, and verification activities, the

Reserve determined that no project-specific equations would be included, and as such, the standard deduction must be used.

The standard deduction is based on a model that conservatively calculates project emissions for transportation and destruction of halocarbons, from the four project sources mentioned above.

E.2.1 Quantification Methodology for the Standard Deduction

The quantification methodology applied in this model is outlined below. Notably, these equations are the same as Equations 5.7 through 5.12 in the A5 ODS Protocol and Equations 5.9 through 5.14 in the U.S. ODS Protocol.

Associated with the operation of destruction facilities are emissions of CO_2 from the fuel and electricity used to power the destruction, emissions of un-combusted halocarbons, and emissions of CO_2 from the oxidation of halocarbons. Equation E.1 through Equation E.6 outline how emissions from halocarbon destruction were estimated, along with assumptions from Table E.1 below.

Equation E.1. Project Emissions from the Destruction of Halocarbons

$$\boldsymbol{Dest = FF_{dest} + EL_{dest} + Halo_{emissions} + Halo_{CO_2}}$$

Where,

			Units
Dest	=	Total emissions from the destruction of halocarbons	lb CO_2e
FF_{dest}	=	Total emissions from fossil fuel used in the destruction facility (Equation E.2)	lb CO_2
EL_{dest}	=	Total indirect emissions from grid electricity used at the destruction facility (Equation E.3)	lb CO_2
$Halo_{emissions}$	=	Total emissions of un-destroyed halocarbons (Equation E.4)	lb CO_2e
$Halo_{CO2}$	=	Total emissions of CO_2 from halocarbon oxidation (Equation E.5)	lb CO_2

Equation E.2. Fossil Fuel Emissions from the Destruction of Halocarbons

$$\boldsymbol{FF_{dest} = \frac{\sum_k (FF_{PR,k} \times EF_{FF,k})}{0.454}}$$

Where,

			Units
FF_{dest}	=	Total carbon dioxide emissions from the destruction of fossil fuel used to destroy halocarbons	lb CO_2
$FF_{PR,k}$	=	Total fossil fuel *k* used to destroy halocarbons	volume fossil fuel
$EF_{FF,k}$	=	Fuel specific emission factor	kg CO_2/ volume fossil fuel
0.454	=	Conversion from kg to lb of CO_2	kg CO_2/ lb CO_2

Equation E.3. Electricity Emissions from the Destruction of Halocarbons

$$EL_{dest} = EL_{PR} \times EF_{EL}$$

Where, Units

EL_{dest}	=	Total carbon dioxide emissions from the consumption of electricity from the grid used to destroy halocarbons	lb CO_2
EL_{PR}	=	Total electricity consumed to destroy halocarbons	MWh
EF_{EL}	=	Carbon emission factor for electricity used	lb CO_2/ MWh

Equation E.4. Calculating Project Emissions from Halocarbon Not Destroyed

$$Halo_{emissions} = \sum_i Q_{refr,i} \times 0.0001 \times GWP_i$$

Where, Units

$Halo_{emissions}$	=	Total emissions of un-destroyed halocarbons	lb CO_2e
$Q_{refr,i}$	=	Total quantity of refrigerant halocarbon *i* sent for destruction	lb Halocarbon
0.0001	=	Maximum allowable portion of halocarbon fed to destruction that is not destroyed (0.01%)	
GWP_i	=	Global warming potential of halocarbon *i* (see Table 5.2)	lb CO_2e/ lb Halocarbon

Equation E.5. Calculating Project Emissions of CO_2 from the Oxidation of Halocarbons

$$Halo_{CO_2} = \sum_i Q_{refr,i} \times 0.9999 \times CR_i \times \frac{44}{12}$$

Where, Units

$Halo_{CO2}$	=	Total emissions of CO_2 from halocarbon oxidation	lb CO_2
$Q_{refr,i}$	=	Total quantity of refrigerant halocarbon *i* sent for destruction	lb Halocarbon
0.9999	=	Minimum destruction efficiency of destruction facility (99.99%)	
CR_i	=	Carbon ratio of halocarbon *i* CFC-11: 12/137 CFC-12: 12/121 CFC-113: 24/187 CFC-114: 24/171	MW C/ MW Halocarbon
44/12	=	Ratio of molecular weight of CO_2 to C	MW CO_2/ MW C

As part of any halocarbon destruction project, halocarbon must be transported from the within Mexico to the destruction facility. Halocarbon samples must also be sent from the destruction facility to an AHRI accredited laboratory (likely in the U.S.). Emissions from both of these activities are accounted for in the standard deduction, using Equation E.6 and the assumptions in Table E.1 below.

Equation E.6. Calculating Project Emissions from the Transportation of Halocarbons[114]

$$Tr = \sum_{i}(PMT_i \times EF_{PMT})$$

Where,

			Units
Tr	=	Total emissions from transportation of halocarbons	lb CO_2e
PMT_i	=	Pound-miles traveled[115] for halocarbon *i* destroyed (to be calculated including the eligible halocarbon, any accompanying material, and containers from point of aggregation to destruction)	pound-miles
EF_{PMT}	=	CO_2 emissions per pound-mile traveled On-road truck transport = 0.000297 Rail transport = 0.0000252 Waterborne craft = 0.000048 Aircraft = 0.0015279	lb CO_2/ pound-mile

E.2.2 Assumptions

In many cases, the equations used for estimating emissions required additional input and emission factors. Where calculations required such inputs (e.g., electricity grid emission factors), the most conservative factors available were used. Fossil fuel emissions from the destruction process were calculated based on confidential industry records made available to the Reserve that describe the energy requirements associated with halocarbon destruction projects. The assumptions used in this analysis are as follows:

Table E.1. Assumptions Used for Project Emissions from Transportation and Destruction of Halocarbons

Parameter	Assumption
$Halo_i$ =	1 tonne halocarbon
$FF_{PR,k}$ =	0.0009 MMBtu natural gas/lb halocarbon destroyed
$EF_{FF,k}$ =	54.01 kg CO_2/MMBtu[116]
EL_{PR} =	0.0018 MWh/lb halocarbon destroyed
EF_{EL} =	0.5165 tCO_{2e}/MWh[117]
PMTi =	2,000 miles by truck, 3,000 miles by ocean freighter
EF_{PMT} =	0.297 $kgCO_2$/PMT[118]
CR^i =	Actual per halocarbon

Under these assumptions, and use of Equation E.1 through Equation E.6 above, the calculations provided the following results for the different project categories.

[114]Derived from: U.S. EPA, Climate Leaders. (2008). Greenhouse Gas Inventory Protocol Core Module Guidance: Optional emissions from business travel, commuting, and product transport.

[115] A pound-mile is defined as the product of the distance travelled in miles and the mass transported in pounds. Therefore, 500 lbs transported four miles is equal to 2,000 pound-miles.

[116] U.S. EPA, Climate Leaders. (2007). Stationary Combustion Guidance. Note that the highest emission factor using natural gas was selected to be conservative.

[117] Programa GEI Mexico, Electric Emission Factor 2013, Retrieved 13 February 2015. http://www.geimexico.org/factor.html. Note that because the emission factors for 2011 and 2012 were adjusted in accordance with the updates to the National Energy Balance, and the unadjusted 2013 is lower, the emission factor for 2012 was selected to be conservative.

[118] U.S. EPA, Climate Leaders. (2008). Optional emissions from business travel, commuting, and product transport. Note that the highest emitting mode of transportation was selected to be conservative.

Table E.2. Project Emissions (Excluding Substitutes)
All quantities in tCO_2/t halocarbon destroyed.

	Fossil Fuel Emissions from Destruction	Electricity Emissions from Destruction	Emissions from halocarbon Not Destroyed	Emissions from CO_2	Emissions from Transport of halocarbons	Total
CFC-11 refrigerant	0.11	2.05	0.47	0.32	0.59	3.54
CFC-12 refrigerant	0.11	2.05	1.07	0.36	0.59	4.18
CFC-114 refrigerant	0.11	2.05	1.00	0.47	0.59	4.22

Because the halocarbons covered in this protocol have such high GWPs (750 to 10,900), even emissions of five to six tonnes CO_2e per tonne halocarbon destroyed are relatively small. These emissions amount to less than 0.15 percent baseline emissions.

E.3 Conclusion

To account for the emission sources above, project developers must apply a 7.5 tonne CO_2e/tonne halocarbon emission factor for all Mexico halocarbon projects. This default emission factor represents a very conservative estimate of these emission sources derived using worst-case emission factors and empirical data.

Appendix F Halocarbon Project Diagram Sample

Generalized Halocarbon Project System Diagram