Efficient Refrigeration Systems Project Protocol

Use of low or no-GWP commercial and industrial refrigeration systems

Protocol Version

Effective Date : Stakeholder Team Draft 1

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1 Introduction

This protocol sets out the requirements that will enable a project developer to undertake an Efficient Refrigeration Systems (ERS) GHG reduction project for the purpose of registering and receiving offset credits in Ontario or Quebec's cap and trade program.

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

1.1 Introduction to the Technical Draft

a) This document represents a technical draft of the ERS project protocol, which will ultimately be redrafted into official, regulatory drafts by the Ministries. Project Developers may use this document to register GHG emission reductions with either the Ontario Cap and Trade Program[1] or the Québec Cap and Trade System.[2]

b) The following notes on terminology apply to the technical draft of the ERS protocol:

1) For the purposes of this protocol, the term "Regulation" is used to refer to the following:
    i) For projects to be registered with the Ontario Cap and Trade Program, the term "Regulation" shall refer to the Ontario Regulation concerning *The Cap and Trade Program*, made under the Climate Change Mitigation and Low-Carbon Economy Act;
    ii) For projects to be registered with the Québec Cap and Trade Program, the term "Regulation" shall refer to the Québec *Regulation respecting a cap-and-trade system for greenhouse gas emission allowances*, made under the Environment Quality Act.
2) For the purposes of this protocol, the term "Ministry" is used to refer to the following:
    i) For projects to be registered with the Ontario Cap and Trade Program, the term "Ministry" shall refer to the Ontario Ministry of Environment and Climate Change (MOECC).
    ii) For projects to be registered with the Québec Cap and Trade Program, the term "Ministry" shall refer to the Québec Ministry of Sustainable Development, Environment, and Fight Against Climate Change (MDDELCC).
3) For the purposes of this protocol, the term "project" is equivalent to the term "offset initiative" in the Ontario Regulation.
4) For the purposes of this protocol, the term "Project Developer" is used to refer to the following:
    i) For projects to be registered with the Ontario Cap and Trade Program, the equivalent term is "Offset Initiative Operator."[3]
    ii) For projects to be registered with the Québec Cap and Trade Program, the equivalent term is "Project Promoter."

[1] As created by the Climate Change Mitigation and Low-Carbon Economy Act, 2016, Ontario Regulation 144/16, *The Cap and Trade Program*.
[2] As created by the Environmental Quality Act, Chapter Q-2, r. 46.1, *Regulation respecting a cap-and-trade system for greenhouse gas emission allowances*.
[3] In certain circumstances, the Ontario Regulation may allow for an Offset Initiative Sponsor to fulfill duties that this protocol assigns to the Project Developer.

2 Definitions

Additionality means project activities that are above and beyond "business as usual" operation, exceed the baseline characterization, and are not mandated by regulation.

Aerosol Product means a product pressurized by a propellant that expels its contents from a canister through a nozzle. Propellants include compressed gases and liquefied gases. Liquefied gases include HFCs, including HFC-134a, which can be recovered and reclaimed for re-use as a refrigerant, at which point it is considered a reclaimed HFC refrigerant.

Ammonia (NH_3) means a chemical compound composed of nitrogen and hydrogen. Can be used as a low-GWP refrigerant.

Carbon dioxide (CO_2) means the greenhouse gas consisting of a single carbon atom and two oxygen atoms.

Cascade Refrigeration System means a system that employs dual cycles, and utilizes a heat exchanger and two types of refrigerants. This enables the system to achieve colder temperatures that may not be achievable through primary or secondary refrigerant systems.

Centralized refrigeration system means 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.

Certified reclaimed HFC refrigerant means used (recovered) HFC that has been reclaimed by an EPA-certified reclaimer to meet the AHRI 700-2015 Standard for Specifications for Fluorocarbon Refrigerants by an EPA certified reclaimer, and tested by an AHRI certified refrigerant testing laboratory to meet the AHRI Standard.

Chiller mean a refrigeration or air-conditioning system that has a compressor, an evaporator, and a secondary coolant, other than an absorption chiller.

Chlorofluorocarbon (CFC) means a class of compounds of carbon, hydrogen, chlorine, and fluorine that are commonly used as refrigerants.

Condensing unit means a refrigeration system with a cooling evaporator in the refrigerated space connected to a compressor and condenser unit that are located in a different location.

CO_2 equivalent (CO_2e) means 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.

Direct emissions means GHG emissions from sources that are owned or controlled by the reporting entity.

Effective Date means the date of adoption of this protocol by the MOECC or the MDDELCC.

Emission factor (EF) means 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 reduction means baseline GHG emissions minus project GHG emissions, measured in CO_2 equivalent.

Environment and Climate Change Canada means Governmental organization responsible for accurate and transparent monitoring, reporting, and verification of Canada's greenhouse gas emissions and removals.

Fossil fuel means a fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.

Greenhouse gas (GHG) means carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).

GHG reservoir means 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 means a physical unit or process that removes GHG from the atmosphere.

GHG source means a physical unit or process that releases GHG into the atmosphere.

Global Warming Potential (GWP) means 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 over a defined period of time (e.g., 100 years). GWPs for this protocol are defined by the Regulation.

Hydrocarbon (HC) means a class of compounds containing predominantly hydrogens and carbons (e.g. propane, isobutene, propylene). Certain HCs can be used as low-GWP refrigerants.

Hydrochlorofluorocarbon (HCFC) means a class of compounds of carbon, hydrogen, chlorine, and fluorine that are commonly used as refrigerants.

Hydrofluorocarbon (HFC) means a class of compounds that contain carbon, fluorine, and hydrogen that are commonly used as refrigerants, as well as solvents, aerosol propellants, and foam blowing agents.

Hydrofluoroolefins (HFO) means a class of compounds composed of hydrogen, fluorine, and carbon. This class of compounds can be used as low-GWP refrigerants. Some HFO refrigerants are comprised of a mix of HFOs, referred to as an HFO blend.

HFC Refrigerant means refrigerant comprised of either a mix of hydrofluorocarbons (HFCs) referred to as an “HFC blend”, or a single HFC.

Indirect emissions means 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.

Metric ton (t, tonne) means a common international measurement for mass, equivalent to about 2204.623 pounds or 1.1 short tons.

Methane (CH_4) means a GHG consisting of a single carbon atom and four hydrogen atoms. The GWP for methane is defined by the Regulation.

Ministry means Ontario Ministry of the Environment and Climate Change (MOECC) or Québec Ministry of Sustainable Development, Environment, and Fight Against Climate Change (MDDELC).

Project baseline means a "business as usual" GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured.

Project emissions means actual GHG emissions that occur within the GHG Assessment Boundary as a result of project activities. Project emissions are calculated at a minimum on an annual, ex post basis.

Project Developer means an entity that undertakes a GHG project, as identified in Section 2.1 of this protocol.

Refrigeration or air conditioning equipment means an appliance, or component parts of a system, that uses refrigerant to provide cooling under controlled conditions.

Reporting period means specific time period of project operation for which the Project Developer has calculated and reported emission reductions and is seeking verification and issuance of credits. The reporting period must be no longer than 12 months.

Secondary Loop Refrigeration System means an advanced refrigeration system where a heat transfer medium (e.g. glycol) is used in conjunction with a primary refrigerant.

Stand-alone refrigeration system means a self-contained refrigeration system with components that are integrated within its structure.

Verification means the process used to ensure that a given Project Developer's GHG emissions or emission reductions have met the minimum quality standard and complied with the respect to the province's (Ontario's or Québec's procedures and protocols for calculating and reporting GHG emissions and emission reductions).

Verification organization means an organization that is accredited under ISO 14065 by a member of the International Accreditation Forum in Canada or the United States according to an ISO 17011 program.

3 Advanced Refrigeration Systems GHG Reduction Project

3.1 Project Definition

a) The project shall avoid emissions of high-GWP refrigerants at commercial and industrial facilities in Canada through the use of low or zero-GWP refrigeration systems.[4] The following four project scenarios are eligible:

[4] For a general discussion of advanced refrigeration systems, see the United State EPA discussion here (accessed July 3, 2017): https://www.epa.gov/greenchill/advanced-refrigeration.

1) For projects at a facility in an eligible sector, as per (b), with an existing, high-GWP refrigeration system:
    i) Replacing the previous system (including all components utilizing fluorinated gas refrigerants) with a new system which operates using a low or zero-GWP refrigerant;
    ii) Replacing the previous system with an alternative source of refrigeration which does not rely on refrigerants;
2) For projects at a new facility in an eligible sector:
    i) Installation of a new refrigeration system which operates using a low or zero-GWP refrigerant;
    ii) Installation of or connection to an alternative source of refrigeration which does not rely on refrigerants.

b) Eligible market sectors include (as defined in Section 2):
1) Centralized commercial refrigeration
2) Stand-alone commercial refrigeration
3) Industrial process refrigeration

Commented [MD1]: I've put this option here, but will not yet address it in the remainder of the document. Expanding to include this means we'd need to expand the GHG assessment boundary and provide quantification methodology for the project emissions of other types of systems. Something to consider.

3.2 Project Start Date

a) The date on which the project refrigeration system begins providing refrigeration services to the project facility, following the completion of a start-up and/or testing period, which is not to exceed six (6) months.[5]

4 Eligibility

4.1 General Requirements

a) A legal requirement to use low- or no-GWP refrigerant must not be applicable to the project facility. Applicable legal requirements include legislative or regulatory provisions, permits or other types of authorization, orders made under an Act or regulation, or court decisions.

4.2 Eligibility Criteria

a) The Refrigeration project must install a system that uses a 100-year GWP lower than the limits set in the 2017 ODSHAR amendments, Schedule 1.1, as shown in Figure 4.1.

[5] The start-up period begins after the final day of installation and/or commissioning of the project system.

Products Containing or Designed to Contain an HFC Used as a Refrigerant

	Column 1	Column 2	Column 3	Column 4
Item	Product	Use	Date	Global Warming Potential (GWP) Limit of Refrigerant Used in Product
1	Stand-alone medium-temperature refrigeration system: self-contained refrigeration system with components that are integrated within its structure and that is designed to maintain an internal temperature ≥ 0°C	**(a)** Commercial or industrial	January 1, 2020	1 400
		(b) Residential	January 1, 2025	150
2	Stand-alone low-temperature refrigeration system: self-contained refrigeration system with components that are integrated within its structure and that is designed to maintain an internal temperature < 0°C but < -50°C	**(a)** Commercial or industrial	January 1, 2020	1 500
		(b) Residential	January 1, 2025	150
3	Centralized refrigeration system: 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, and that is designed to maintain an internal temperature at ≥ -50°C	Commercial or industrial	January 1, 2020	2 200
4	condensing unit: refrigeration system with at a cooling evaporator in the refrigerated space connected to a compressor and condenser unit that are located in a different location, and that is designed to maintain an internal temperature at ≥ -50°C	Commercial or industrial	January 1, 2020	2 200
5	chiller: refrigeration or air-conditioning system that has a compressor, an evaporator and a secondary coolant, other than an absorption chiller	Commercial or industrial	January 1, 2025	750
6	mobile refrigeration system: refrigeration system that is normally attached to or installed in, or operates in or with a means of transportation	Commercial or industrial	January 1, 2025	2 200

Figure 4.1 Schedule 1.1 of SOR/2017-216

b) Table 4.1 lists the 100-year GWP values for several alternative refrigerants. GWP values for refrigerants not listed in Table 4.1 shall be referenced from the following sources. If the first source on the list does not list a 100-year GWP value for the refrigerant in question, then the next source on the list shall be referenced, descending the list in order until a value is found.
   1) [Canadian Federal Government Reference]
   2) [Ontario & Quebec GHG reporting reference]
   3) The Fourth Assessment Report of the Intergovernmental Panel on Climate Change
c) GWP values for blends are calculated as a mass-weighted average of the GWP values for the constituent chemicals.

Table 4.1 Potential Advanced Refrigerants for the Project Scenario

Refrigerant	Trade Name	100-Year Global Warming Potential (GWP)
NH_3 (Ammonia)	R-717	0
HFO-1234ze	R-1234ze	6

Commented [MD2]: Please consider suggesting additional refrigerants to be added to this list.

Commented [MD3]: These numbers need citations

Refrigerant	Trade Name	100-Year Global Warming Potential (GWP)
HFO-1234yf	R-1234yf	<1
CO_2	R-744	1
Propylene	R-1270	1.8
Isobutane	R-600a	3
Propane	R-290	3.3
HFO-1233zd	R-1233zd	5
HFO-1336mzz	R-1336mzz	9
HFC-134a (42%), HFO-1234ze (58%)	R-450A	604
HFC-134a (44%), HFO-1234yf (56%)	R-513A	631
HFC-32 (26%), HFC-125 (26%), HFC-134a (21%), HFO-1234ze (7%), HFO-1234yf (20%)	R 448A	1387
HFC-32 (24.3%), HFC-125 (24.7%), HFC-134a (25.7%), HFO-1234yf (25.3%)	R-449A	1387
HFC-32 (20%), HFC-125 (40%), HFC-134a (40%)	R-407A	2107
HFC-32 (11%), HFC-125 (59%), HFO-1234yf (30%)	R-452A	2140

Commented [MD3]: These numbers need citations

d) Projects may not receive credit for installation of a low or no-GWP refrigeration system that was already operational prior to the project start date.

e) For projects at existing facilities (either new installations or retrofits for new refrigerants), the baseline is based on the refrigerant type and charge size of the system which is being replaced by the project system.

1) The baseline system shall be characterized using data from regulatory compliance reporting and other, verifiable, historical operating documentation.
2) For historical systems, the baseline GWP value shall be referenced from Table 4.2.
3) Projects using historical baselines must provide documentation to prove that there is no legal or technical barrier to continued use of the baseline system for the entire project lifetime.

Table 4.2 Global Warming Potential (GWP) for Baseline Refrigerants

Baseline Refrigerant	100-Year GWP[6]
HFC-23	14800
HFC-32	675
HFC-125	3500
HFC-134a	1430
HFC-143a	4470
HFC-152a	124
HFC-245fa	1030
R-404A	3922
R-407A	2107

Commented [MD4]: Question for TTT and ST: are we missing any relevant baseline refrigerants?

[6] GWP values are referenced from the IPCC Fourth Assessment Report. GWPs for blends are calculated as a weighted average of the constituent chemicals.

Baseline Refrigerant	100-Year GWP[6]
R-407C	1774
R-410A	2088
R-507A	3985

f) For new facilities, or facilities without sufficient data on historical refrigerant use, the baseline refrigerant which is being avoided is based on the current common practice refrigerant for the specific market sector, depending upon the project start date:

1) For commercial refrigeration projects with start dates prior to January 1, 2020, the baseline is based on the most recent 5 years of reported data for refrigerant use in new commercial installations in Canada from the Canadian National Inventory Report, Table B2(II)B.
2) For commercial refrigeration projects with start dates of January 1, 2020, or later, the assumed baseline is based on GWP-based limits set by the 2017 ODSHAR amendments, as detailed in Schedule 1.1 of SOR/2017-216.
3) For industrial refrigeration, regardless of project start date, the assumed baseline is the use of HFC-134a. Based on the most recent five years of industrial refrigeration installations reported in the Canadian National Inventory Report, HFC-134a comprised 93%, by mass. It also has a lower GWP than other refrigerant blends used in industrial refrigeration, and is thus the most conservative assumption.

NOTE:

The market sector categorizations and emission factor values in Tables 4.3 and 4.4 are preliminary. We are working on an alternate approach which would allow for both tables to use the same market sector categorization and thus reduce any potential confusion. Thus, for the purposes of this draft, please consider Tables 4.3 and 4.4 to reflect the general approach to setting the baseline, rather than representing the final emission factor.

Table 4.3 Default Baseline Assumptions for ERS Projects Prior to ODSHAR Deadlines

Market Sector	Refrigerant	Market Share	100-Year Global Warming Potential[7]	Charge Size (kg/kW)[8]	Annual Leak Rate[9]	Annual Emission Factor (kg CO_2e/kW/yr)
Commercial stand-alone refrigeration	HFC-32	2.6%	675	0.783	10%	**247**
	HFC-125	32.7%	3500			
	HFC-143a	35.2%	4470			
	HFC-134a	29.5%	1430			
Commercial centralized refrigeration	HFC-32	2.6%	675	0.340	10%	**107**
	HFC-125	32.7%	3500			
	HFC-143a	35.2%	4470			

[7] GWP values are referenced from the IPCC Fourth Assessment Report. GWPs for blends are calculated as a weighted average of the constituent chemicals.
[8] Converted from the values used in the ACR Use of Certified Reclaimed HFC and Advanced Refrigeration Systems Methodology v1.0, Table 7. The values of 1.16 and 2.67 kg/MBTU/hr for centralized and stand-alone commercial refrigeration (respectively) were converted based on 0.2931 kW per MBTU/hr.
[9] Annual leak rate assumptions are taken from the Canadian National Inventory Report, Table B2(II)B.

Market Sector	Refrigerant	Market Share	100-Year Global Warming Potential[7]	Charge Size (kg/kW)[8]	Annual Leak Rate[9]	Annual Emission Factor (kg CO_2e/kW/yr)
	HFC-134a	29.5%	1430			
Industrial refrigeration	HFC-134a[10]	100%	1430	0.340[11]	10%	**49**

Table 4.4 Default Baseline Assumptions for ERS Projects in Following ODSHAR Deadlines

Market Sector	100-Year Global Warming Potential[12]	Charge Size (kg/kW)[13]	Annual Leak Rate	Annual Emission Factor (kg CO_2e/kW/yr)	ODSHAR Deadline
Stand-alone refrigeration (>0° C)	1400	0.783	10%	**110**	January 1, 2020
Stand-alone refrigeration (<0° C)	1500	0.783	10%	**117**	January 1, 2020
Centralized refrigeration	2200	0.340	10%	**75**	January 1, 2020
Chillers	750	0.340	10%	**25**	January 1, 2025

5 GHG Assessment Boundary

a) The following GHG sources, sinks, and reservoirs (SSRs) have been considered in determining the GHG Assessment Boundary.
   1) Figure 5.5.1 illustrates all relevant GHG SSRs associated with ERS activities and delineates the GHG Assessment Boundary.
   2) Table 5.1 provides greater detail on each relevant GHG SSR associated with ERS activities and includes justification for their inclusion or exclusion from the GHG Assessment Boundary.

[10] Based on the most recent five years of industrial refrigeration installations reported in the Canadian National Inventory Report, HFC-134a comprised 93%, by mass. It also has a lower GWP than other refrigerant blends used in industrial refrigeration, and is thus the most conservative assumption.
[11] The charge size for industrial refrigeration is assumed to be the same as centralized commercial refrigeration.
[12] GWP values for commercial refrigeration are the regulatory limits set by Schedule 1.1 of the 2017 ODSHAR amendments (SOR/2017-216). The GWP used for industrial refrigeration is that of HFC-134a. Based on the most recent five years of industrial refrigeration installations reported in the Canadian National Inventory Report, HFC-134a comprised 93%, by mass. It also has a lower GWP than other refrigerant blends used in industrial refrigeration, and is thus the most conservative assumption.
[13] Converted from the values used in the ACR Use of Certified Reclaimed HFC and Advanced Refrigeration Systems Methodology v1.0, Table 7. The values of 1.16 and 2.67 kg/MBTU/hr for centralized and stand-alone commercial refrigeration (respectively) were converted based on 0.2931 kW per MBTU/hr.

Figure 5.5.1. GHG Assessment Boundary for Advanced Refrigeration Systems Projects

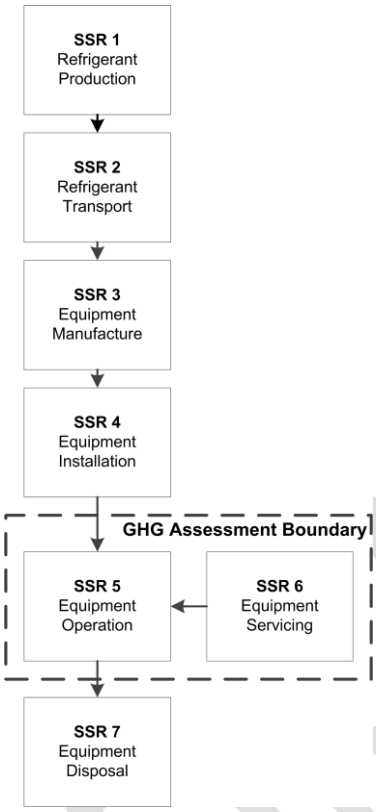

Table 5.1. Description of all Sources, Sinks, and Reservoirs

SSR	SSR Name	Source Description	GHG	Relevant to Baseline (B) or Project (P)	Included or Excluded	Justification/Explanation
1	Refrigerant Production	Fossil fuel emissions from the production of refrigerants	CO_2	B,P	E	
			CH_4	B,P	E	
		Refrigerant leaks during production	HFC and HCFCs	B	E	
			Low and zero-GWP refrigerants	P	E	
2	Refrigerant Transport	Fossil fuel emissions from the transport of refrigerants	CO_2	B,P	E	
			CH_4	B,P	E	
			N_2O	B	E	

SSR	SSR Name	Source Description	GHG	Relevant to Baseline (B) or Project (P)	Included or Excluded	Justification/Explanation
		Refrigerant leaks during transport	HFC and HCFCs	B	E	
			Low and zero-GWP refrigerants	P	E	
3	Equipment Manufacture	Emissions of refrigerant during the manufacture of refrigeration systems	HFC and HCFCs	B	E	
			Low and zero-GWP refrigerants	P	E	
4	Equipment Installation	Emissions of refrigerant during the installation of refrigeration systems	HFC and HCFCs	B	E	
			Low and zero-GWP refrigerants	P	E	
5	Equipment Operations	Fossil fuel emissions from the operation of the refrigeration or A/C equipment system	CO_2	B,P	E	
			CH_4			
			N_2O			
		Refrigerant leaks from the operation of the refrigeration system	HFC and HCFCs	B,P	I	
		CO2 leaks from operation of a new refrigeration system	CO_2	B,P	I	
		Leaks of non-GHG refrigerants from operation of a new refrigeration system	NH_3, Hydrocarbons	B,P	E	Excluded for simplification. This emission source is assumed to be very small.
6	Equipment Servicing	Fossil fuel emissions from servicing refrigeration or A/C equipment or system to replace leaked refrigerant	CO_2	B,P	E	
			CH_4	B,P	E	
			N_2O	B,P	E	

Commented [MD5]: Up for discussion in the context of projects where the project system is more energy intensive

SSR	SSR Name	Source Description	GHG	Relevant to Baseline (B) or Project (P)	Included or Excluded	Justification/Explanation
		Refrigerant emissions from servicing refrigeration or A/C equipment or system to replace leaked refrigerant	HFCs, HCFCs, HFOs, others	B,P	I	
7	Equipment Disposal	Emissions from the disposal of the equipment at end-of-life including destruction of refrigerant	CO_2		E	Excluded for simplification. This emission source is not expected to increase in the project scenario.
			CH_4		E	
			CFCs		E	
			HCFC		E	
			HFCs		E	

6 Calculation of Emission Reductions

a) Reductions of GHG emission from the project shall be calculated in accordance with Equation 6.1.

Equation 6.1. GHG Emission Reductions

$$\boldsymbol{ER = BE - PE}$$

Where,			Units
ER	=	GHG emission reductions attributable to the project during the project reporting period	tCO_2e
BE	=	Emissions under the baseline scenario during the project reporting period, calculated using Equation 6.2 or Equation 6.3, as appropriate.	tCO_2e
PE	=	Project emissions during the project reporting period, calculated using Equation 6.4.	tCO_2e

6.1 Calculation of Baseline Scenario Emissions

a) For projects at existing facilities where the project activity involves installation of a new refrigeration system or the retrofit of an existing system, baseline GHG emissions shall be calculated using Equation 6.2.

Equation 6.2. Calculating Baseline Emissions at Pre-Existing Facilities

$$BE = \sum_{i,j} \left[\left(Q_{BR,i,j} \times LR_j \right) / 1000 \times GWP_{REF,k} \right]$$

Where,			Units
BE	=	Baseline emissions during the project reporting period	tCO_2e
$Q_{BR,I,j}$	=	Quantity of refrigerant *i* in equipment *j* used in baseline system (kgs at new facilities, see Table 7; for projects located at existing facilities, use regulatory compliance reporting or verifiable historical operating records to establish the charge size of the replaced baseline system)	kg refrigerant
LR_j	=	Average annual leak rate (amount of refrigerant added divided by the total refrigerant charge) from historical system *j*, based on maintenance records for at least 5 years prior to the project start date. If historical records are not available, the default value of 0.1 shall be applied.	fraction
1000	=	Conversion from tonnes to kilograms	kg/t
$GWP_{REF,k}$	=	Global warming potential of baseline refrigerant *k* (see Table 4.2)	tCO_2e/t refrigerant

b) For all other projects, the project developer shall use the default emission factor for the relevant market sector and project start date, from either Table 4.3 or Table 4.4, as appropriate, applied to Equation 6.3:

Equation 6.3. Calculating Baseline Emissions with Default Values

$$BE = \sum_{j} \left[\left(CAP_{PR,j} \times BEF_j \right) \right] / 1000]$$

Where,			Units
BE	=	Baseline emissions during the project reporting period	tCO_2e
$CAP_{PR,j}$	=	Cooling capacity of the project refrigeration system *j*, expressed in total kW. For systems rated in MBTU/hr, a conversion of 0.2931 kW per MBTU/hr shall be applied.	kW
BEF_j	=	Baseline emission factor for system *j*, as found in Table 4.3 or Table 4.4, as appropriate.	$kgCO_2e$/kW
1000	=	Conversion from tonnes to kilograms	kg/t

6.2 Calculation of Project Emissions

a) Project emissions are actual GHG emissions that occur within the GHG Assessment Boundary calculated in accordance with Equation 6.4.

Equation 6.4. Calculating Project Emissions

$$PE = \sum_{j} LEAK_{k,j} \div \mathbf{1000} \times \boldsymbol{GWP_{REF,k}}$$

Where,			Units
PE	=	Project emissions during the project reporting period	tCO_2e
$LEAK_{k,i}$	=	Quantity of alternative refrigerant *k* added to the project system *j* during the reporting period (not including the intiail system charge)	kg
1000	=	Conversion from tonnes to kilograms	kg/t
$GWP_{REF,k}$	=	Global warming potential of refrigerant *k* used in the project (Table 4.1)	tCO_2e/t refrigerant

6.2.1 Leakage

a) ERS projects are not expected to result in either activity-shifting or market-shifting leakage. Thus, quantification of project leakage is not required.

7 Data Management and Project Monitoring

7.1 Data Collection

a) A data management system shall be implemented to collect, manage, and store information related to the project in a way that ensures the integrity, exhaustiveness, accuracy, and validity of the information.
b) The data management system for the project shall include procedures to:
   1) Monitor the performance of the project and the operation of all project-related equipment, in accordance with Sections **Error! Reference source not found.**, 7.2, 7.3, and 7.4.
   2) Manage information, including data in respect of the baseline scenario and the project;
   3) Provide the accredited verification body access to the project site, operational staff, and where necessary, the third-party refrigeration maintenance service provider, and any other information or persons that the accredited verification body may require to verify the project.
   4) Assess whether the project meets the eligibility criteria set out in the Regulation and this protocol;
   5) Identify and record any violations of legal requirements that apply to the project and that may have an impact on the amount of GHG reductions, avoidances, or removals; and
   6) Assess and record a description of the impact of each violation identified under 5.
c) The data management system for the initiative shall include records required by the Regulation and this protocol, including the following information:
   1) Methods used to collect and record the data required for all the relevant parameters in Table 7.1;
   2) The frequency of data acquisition;
   3) A record keeping plan;
   4) Refrigeration system maintenance records for all project equipment;
   5) Description of the refrigerant tracking system, if applicable;
   6) The role and qualifications of the personnel responsible for each monitoring activity, as well as the quality assurance and quality control measures taken to ensure that data acquisition is carried out consistently and with precision;
   7) Identification of the refrigerant service provider and description of their qualifications; and

8) Procedures which will be followed to ascertain and demonstrate that he project is not in violation of any applicable regulations.

d) The Project Developer is responsible for collecting the information required for project monitoring. The Project Developer must show that the data collected are actual and that rigorous supervision and record-keeping procedures are applied at the project site.

e) For all projects, the installation, servicing, testing, and charging of the project refrigeration system (excluding systems for which these requirements do not apply) must be carried out in conformance with the requirements of the Federal Halocarbon Regulations of 2003 (FHR, as amended in 2009).[14] For projects which involve the decommissioning and/or removal of a pre-existing refrigeration system, such activities shall be carried out in conformance with the applicable sections of the FHR.

f) The Project Developer must institute a transparent, verifiable methodology for the validation of all project data to ensure that any erroneous or unusual data are identified, subject to verifier review and approval. Any data that are determined to be invalid shall be replaced using the Missing Data procedures in **Error! Reference source not found.**.

Commented [MD6]: May not be necessary for this protocol

7.2 Monitoring Requirements

a) Project Developers are responsible for monitoring the performance of the project and ensuring that the operation of all project-related equipment is consistent with the manufacturer's recommendations. GHG emission reductions from advanced refrigeration system projects must be monitored through the following:

1. Identifying and logging the equipment/systems to be installed, including:
   i) Description of the system(s) and/or equipment used
   ii) Refrigerant(s) used
   iii) Initial charge size(s)
   iv) MBTU/hr cooling capacity of the project system(s)
2. Recordkeeping of project-related refrigerant usage, including records of any servicing and recharge of the project system.

7.3 Instrument Quality Assurance and Quality Control (QA/QC)

a) All project refrigeration equipment must be operated and maintained according to the manufacturers' specifications and recommendations.

7.4 Monitoring Parameters

a) Table 7.1 sets out the monitoring parameters required to be used in the calculation of baseline scenario and project scenario emissions.

Table 7.1. Efficient Refrigeration Systems Project Monitoring Parameters

Commented [MD7]: This table is not complete.

Need to add the equation references and comments

Eq. #	Parameter	Description	Units	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Measurement Frequency	Comment
	ER	GHG emission reductions during the reporting period	tCO_2e	c	Per reporting period	
	BE	Baseline emissions during the reporting period	tCO_2e	c	Per reporting period	

[14] Consolidated Canadian Federal Halocarbon Regulations, 2003, SOR/2003-289, (last amended on July 30, 2009).

Eq. #	Parameter	Description	Units	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Measurement Frequency	Comment
	PE	Project emissions during the reporting period	tCO_2e	c	Per reporting period	
	$Q_{BR,k,i}$	Quantity of refrigerant *k* that would have been used in initial charge of system *j* in absence of project activity	kg	o	Per reporting period	
	LRi	Average annual leak rate of historical system *j*	% per year	o	Determined once and recorded annually	
	$GWP_{REF,k}$	100-year global warming potential of refrigerant *k*	tCO_2e/t refrigerant	r	Once	GWP values are included in Table 4.1 and Table 4.2
	$CAP_{PR,j}$	Cooling capacity of the project refrigeration system	kW	o	Once	
	BEF_j	Baseline emission factor for system *j*	$kgCO_2e$/kW	r	Once	Referenced from Table 4.3 or Table 4.4, as appropriate
	$LEAK_{k,j}$	Quantity of refrigerant *k* added to project system *j* during the reporting period	kg	m	Per reporting period	

8 Reversals

8.1 Errors, Omissions, or Misstatements

a) In the event that an error, omission, or misstatement is discovered after offset credits have been created and issued for a reporting period, the Project Developer shall determine the total amount of the reversal by:
   1. Using the this protocol to re-calculate the corrected value of the GHG emission reductions from the project during the reporting period for each project report affected by the reversal.
   2. Calculating the total reversal of GHG emission reductions from the initiative using

$$RE = \sum_{r=1}^{n} ER_{c,r} - ER_{i,r}$$

Where,			Units
RE	=	GHG emission reductions reversed	tCO_2e
N	=	Total number of project reports affected by the reversal	
R	=	Specific project reports affected by the reversal	
$ER_{c,r}$	=	Corrected GHG emission reductions from the project during the specific reporting period, *r*, calculated in accordance with Subsection 8.1(a)(1)	tCO_2e
$ER_{i,r}$	=	Initially reported GHG emission reductions from the project during the reporting period, *r*	tCO_2e

9 Reporting

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

9.1 Project Report

9.1.1 Eligibility Criteria Information

a) The location of the project facility
b) The nature of the project activity (i.e., new facility, new system at existing facility, or retrofit of existing system)
c) The baseline scenario
   1. Refrigerant used in the baseline scenario and the appropriate GWP
   2. Charge size (kg) of the baseline refrigeration system
   3. Source of these data (default values or site-generated data, and relevant documentation)
d) The project scenario
   1. Refrigerant used in the project scenario and the appropriate GWP
   2. Charge size (kg) of the project refrigeration system
   3. Source of these data (relevant documentation)

9.1.2 Monitoring Information

a) Identification of refrigeration maintenance and monitoring procedures
   1. The frequency and method of monitoring for leaks, and identification of any instances where leaks were detected, including actions taken in response.
   2. The frequency of system maintenance and/or recharge by qualified service technicians
   3. The quantity of refrigerant added to the project system during the reporting period, in kg.
b) Identification of the measurement frequency used for each monitoring parameter.

9.1.3 Quantification Information

a) All calculations set out in Section 6 that were used.
b) Supporting documentation related to the calculations.

9.2 Reversal Report

9.2.1 General

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

9.2.2 Quantification Information

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

10 Record Keeping

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

1. The information and data required under the monitoring plan, including all GHG calculations and their related data inputs;
2. Information on equipment operation including initial HFC charge;
3. The maintenance records for servicing of refrigeration or A/C equipment or systems;
4. Operating records showing:
    i) Project related refrigerant usage
    ii) Identifying and logging the equipment/system to be installed
    iii) Historical refrigerant usage (existing facilities only)
5. All documentation related to permits related to the refrigeration or A/C equipment or system (e.g., permits, air quality, water quality, land use, system construction, etc.), as well as documentation related to any regulatory compliance inquiries, warnings, or violations.