Efficient Refrigeration Systems

Project Protocol

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

Technical Draft Protocol

*Stakeholder Team Draft 2*

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# 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.

## Introduction to the Technical Draft

1. 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]](#footnote-2) or the Québec Cap and Trade System.[[2]](#footnote-3)
2. 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:
		1. 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;
		2. 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:
		1. 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).
		2. 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:
		1. For projects to be registered with the Ontario Cap and Trade Program, the equivalent term is “Offset Initiative Operator.”[[3]](#footnote-4)
		2. For projects to be registered with the Québec Cap and Trade Program, the equivalent term is “Project Promoter.”

# 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 (NH3)** means a chemical compound composed of nitrogen and hydrogen. Can be used as a low-GWP refrigerant.

**Carbon dioxide (CO2)** means the greenhouse gas consisting of a single carbon atom and two oxygen atoms.

**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.

**CO2 equivalent (CO2e)** 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.

**Direct expansion refrigeration system** means a system where refrigeration happens directly in the coolers without separate fluid pumping equipment.

**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 CO2 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 (CO2), methane (CH4), nitrous oxide (N2O), sulfur hexafluoride (SF6), 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 CO2 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 (CH4)** 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.

**Project refrigeration system** means the specific combination of refrigeration equipment and refrigerant which is used to provide refrigeration services to the project facility.

**Refrigeration 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 (or Indirect 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.

# Advanced Refrigeration Systems GHG Reduction Project

## Project Definition

1. 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]](#footnote-5) The following four project scenarios are eligible:
	1. For projects at a facility in an eligible sector, as per (b), with an existing, high-GWP refrigeration system:
		1. Replacing the previous system (including all components utilizing fluorinated gas refrigerants) with a new system which operates using a low or zero-GWP refrigerant;
		2. Retrofitting the previous system (including all components utilizing fluorinated gas refrigerants) in order to operate using a low or zero-GWP refrigerant
	2. For projects at a new facility in an eligible sector:
		1. Installation of a new refrigeration system which operates using a low or zero-GWP refrigerant;
2. Eligible refrigeration system categories include (as defined in Section 2):
	1. Stand-alone commercial refrigeration
	2. Centralized commercial refrigeration
	3. Centralized industrial refrigeration (food processing)
	4. Centralized industrial refrigeration (other)
	5. Commercial or industrial chillers

## Project Start Date

1. The Project Start Date is the date on which the project refrigeration system begins providing refrigeration services to the project facility. Refrigeration systems may be operational prior to the Project Start Date but are not eligible if they were providing refrigeration services to the project facility prior to the Project Start Date.

# Eligibility

## General Requirements

1. 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.

## Eligibility Criteria

1. 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 summarized in Table 4.1.

Table 4.1 Excerpt of Schedule 1.1 of SOR/2017-216

| **Category** | **GWP Limit of Refrigerant** | **Date of Limit Application** |
| --- | --- | --- |
| 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 | 1400 | January 1, 2020 |
| 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 | 1500 | January 1, 2020 |
| 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 | 2200 | January 1, 2020 |
| Chiller: refrigeration or air-conditioning system that has a compressor, an evaporator and a secondary coolant, other than an absorption chiller | 750 | January 1, 2025 |

1. Table 4.2 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. Canada’s National Inventory Report, 1990-2015[[5]](#footnote-6)
	2. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change[[6]](#footnote-7)
	3. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change[[7]](#footnote-8)
	4. IPCC/TEAP Special Report: Safeguarding the Ozone Layer and the Global Climate System.[[8]](#footnote-9)
2. GWP values for blends are calculated as a mass-weighted average of the GWP values for the constituent chemicals.

Table 4.2 Potential Refrigerants for the Baseline and Project Scenarios

| **Refrigerant** | **Trade Name** | **100-Year Global Warming Potential (GWP)** |
| --- | --- | --- |
| NH3 (Ammonia) | R-717 | 09 |
| HFO-1234ze | R-1234ze | <18 |
| HFO-1234yf | R-1234yf | <18 |
| CO2 | R-744 | 16 |
| Propylene | R-1270 | 4.99 |
| Isobutane | R-600a | 3[[9]](#footnote-10) |
| Propane | R-290 | 6.39 |
| HFO-1233zd | R-1233zd | 59 |
| HFO-1336mzz | R-1336mzz | 28 |
| HFC-152a | R-152a | 1246 |
| HFC-32 | R-32 | 6756 |
| HFC-245fa | R-245fa | 10306 |
| HFC-134a | R-134a | 14306 |
| HFC-125 | R-125 | 35006 |
| HFC-143a | R-143a | 44706 |
| HFC-23 | R-23 | 148006 |
| Refrigerant Blends |  |  |
| R-1234yf (75.5%), R-32 (21.5%), R-744 (3%) | R-455A | 145 |
| 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-125 (27%), HFC-32 (27%), R-227ea (6%), R-1234ze (40%) | R-464A | 1321 |
| HFC-32 (20%), HFC-125 (20%), HFC-134a (53.8%), HFC-227ea (5%), R-600 (0.6%), R-601a (0.6%) | R-453A | 1765 |
| HFC-32 (23%), HFC-125 (25%), HFC-134a (52%) | R-407C | 1774 |
| HFC-32 (31%), HFC-125 (31%), HFC-134a (30%), R-227ea (5%), R-152a (3%) | R-442A | 1888 |
| HFC-32 (50%), HFC-125 (50%) | R-410A | 2088 |
| HFC-32 (20%), HFC-125 (40%), HFC-134a (40%) | R-407A | 2107 |
| HFC-32 (11%), HFC-125 (59%), HFO-1234yf (30%) | R-452A | 2140 |
| HFC-125 (44%), HFC-134a (4%), HFC-143a (52%) | R-404A | 3922 |
| HFC-125 (50%), HFC-143a (50%) | R-507A | 3985 |

1. 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.
		1. Absence of legal barrier: a project developer should prove that based on current regulations, a refrigeration system could have been replaced with a new system using the same technology.
		2. Absence of technical barrier: the project developer should prove that the system to be replaced was not at the end of its operational life.
2. 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 refrigerant system category, depending upon the project start date in relation to the ODSHAR deadlines, as specified in Table 4.3

**Two new options for Table 4.3:**

|  |
| --- |
| **NOTE TO REVIEWERS:** PLEASE REVIEW APPENDIX A FOR ADDITIONAL INFORMATION AND QUESTIONS RELATED TO TABLE 4.3  |

**Option 1 Separate baselines for direct expansion and secondary loop systems**

| **Category** | **ODSHAR deadline** | **Annual Emission Factor (kgCO2e/kW/yr)** |
| --- | --- | --- |
| **Pre-deadline** | **Post-deadline** |
| **Stand-alone units** |  |  |  |
| Medium temperature | 1/1/2020 | 66 | 32 |
| Low temperature | 1/1/2020 | 429 | 225 |
| **Centralized commercial** |  |  |  |
| *Direct expansion* |  |  |  |
| Medium temperature | 1/1/2020 | 801 | 616 |
| Low temperature | 1/1/2020 | 1574 | 1210 |
| *Indirect (secondary loop)* |  |  |  |
| Medium temperature | 1/1/2020 | 229 | 176 |
| Low temperature | 1/1/2020 | 343 | 264 |
| **Centralized industrial (food processing)** |  |  |  |
| *Direct expansion* |  |  |  |
| Medium temperature | 1/1/2020 | 1574 | 1210 |
| Low temperature | 1/1/2020 | 2518 | 1936 |
| *Indirect (secondary loop)* |  |  |  |
| Medium temperature | 1/1/2020 | 286 | 220 |
| Low temperature | 1/1/2020 | 429 | 330 |
| **Centralized industrial (other)**Medium temperatureLow temperature | 1/1/20201/1/2020 | 5681574 | 5061210 |
| **Chillers (commercial or industrial)** | 1/1/2025 | 73 | 23 |

**Option 2. Direct expansion baseline values for all centralized commercial and industrial systems**

| **Category** | **ODSHAR deadline** | **Annual Emission Factor (kgCO2e/kW/yr)** |
| --- | --- | --- |
| **Pre-deadline** | **Post-deadline** |
| **Stand alone** |  |  |  |
| Medium temperature | 1/1/2020 | 66 | 32 |
| Low temperature | 1/1/2020 | 429 | 225 |
| **Centralized commercial** |  |  |  |
| Medium temperature | 1/1/2020 | 801 | 616 |
| Low temperature | 1/1/2020 | 1574 | 1210 |
| **Centralized industrial (food processing)** |  |  |  |
| Medium temperature | 1/1/2020 | 1574 | 1210 |
| Low temperature | 1/1/2020 | 2518 | 1936 |
| **Centralized industrial (other)**Medium temperatureLow temperature | 1/1/20201/1/2020 | 6581574 | 5061210 |
| **Chillers (commercial or industrial)** | 1/1/2025 | 73 | 23 |

# GHG Assessment Boundary

1. The following GHG sources, sinks, and reservoirs (SSRs) have been considered in determining the GHG Assessment Boundary.
	1. Figure 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.

Figure 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 | CO2 | B,P | E | Excluded, as this emission source is assumed to be very small |
| CH4 | 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 | CO2 | B,P | E | Excluded, as this emission source is assumed to be very small |
| CH4 | B,P | E |
| N2O | B | E |
| 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 | Excluded, as project activity is unlikely to affect emissions relative to baseline activity |
| Low and zero-GWP refrigerants | P | E |
| 4 | Equipment Installation | Emissions of refrigerant during the installation of refrigeration systems | HFC and HCFCs | B | E | Excluded, as this emission source is assumed to be very small |
| Low and zero-GWP refrigerants | P | E |
| 5 | Equipment Operations | Fossil fuel emissions from the operation of the refrigeration or A/C equipment system | CO2 | B,P | E | Excluded, as project activity is unlikely to affect emissions relative to baseline activity |
| CH4 |
| N2O |
| Refrigerant leaks from the operation of the refrigeration system | HFC and HCFCs | B,P | I | Baseline and project emissions are expected to be significant. |
| CO2 leaks from operation of a new refrigeration system | CO2 | P | I |
| Leaks of non-GHG refrigerants from operation of a new refrigeration system | NH3, others | P | E | Project emissions are excluded for advanced refrigerants with no global warming potential. |
| 6 | Equipment Servicing | Fossil fuel emissions from servicing refrigeration or A/C equipment or system to replace leaked refrigerant | CO2 | B,P | E | Excluded, as this emission source is assumed to be very small |
| CH4 | B,P | E |
| N2O | B,P | E |
| Refrigerant emissions from servicing refrigeration or A/C equipment or system to replace leaked refrigerant | HFCs, HCFCs, HFOs, others | B,P | I | Baseline and project emissions are expected to be significant. |
| 7 | Equipment Disposal | Emissions from the disposal of the equipment at end-of-life including destruction of refrigerant | CO2 |  | E | Excluded for simplification. This emission source is not expected to increase in the project scenario. |
| CH4 |  | E |
| CFCs |  | E |
| HCFC |  | E |
| HFCs |  | E |

# Calculation of Emission Reductions

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

Equation 6.1. GHG Emission Reductions

$$ER=BE-PE$$

| *Where,* |  |  | Units |
| --- | --- | --- | --- |
| ER | = | GHG emission reductions attributable to the project during the project reporting period | tCO2e |
| BE | = | Emissions under the baseline scenario during the project reporting period, calculated using Equation 6.2 or Equation 6.3, as appropriate. | tCO2e |
| PE | = | Project emissions during the project reporting period, calculated using Equation 6.4. | tCO2e |

## Calculation of Baseline Scenario Emissions

1. 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

$$BE=\sum\_{i,j}^{}\left(Q\_{BR,i,j}×LR\_{j}\right)\left./1000×GWP\_{REF,k}\right]$$

| *Where,* |  |  | Units |
| --- | --- | --- | --- |
| BE | = | Baseline emissions during the project reporting period | tCO2e |
| QBR,i,j | = | Quantity of refrigerant *i* in equipment *j* used in baseline system (kgs at new facilities, see Table 7.1; 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 |
| LRj | = | Annual leak rate ( A default value of 0.1 shall be applied to all projects) | fraction |
| 1000 | = | Conversion from tonnes to kilograms | kg/t |
| GWPREF,k | = | Global warming potential of baseline refrigerant *k* (see Table 4.2) | tCO2e/t refrigerant |

1. For all other projects, the project developer shall use the default emission factor for the relevant market sector and project start date, from Table 4.3, applied to Equation 6.3:

Equation 6.3. Calculating Baseline Emissions with Default Values

$$BE=\sum\_{j}^{}\left[\left(CAP\_{PR,j}×BEF\_{j}\right)\right]\left./1000\right]$$

| *Where,* |  |  | Units |
| --- | --- | --- | --- |
| BE | = | Baseline emissions during the project reporting period | tCO2e |
| CAPPR,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 |
| BEFj | = | Baseline emission factor for system *j*, as found in Table 4.3. | kgCO2e/kW |
| 1000 | = | Conversion from tonnes to kilograms | kg/t |

## Calculation of Project Emissions

1. Project emissions are actual GHG emissions that occur within the GHG Assessment Boundary calculated in accordance with Equation 6.4.
2. The quantity of project refrigerant which has leaked out of the project refrigeration system during the reporting period is determined through one of the following options:
	1. For systems where the GWP value for the project refrigerant is less than 5% of the GWP value of the baseline refrigerant (either default or site-specific, according to Section 4.2), the value for LEAKk,i may be equal to 10% of the total quantity of refrigerant *k* in the project refrigeration system *j*;
	2. For projects which may not (or choose not to) use the default approach above, the value for LEAKk,i shall be the actual quantity of refrigerant *k* added to the project refrigeration system *j* during the reporting period, as determined through maintenance records.

Equation 6.4. Calculating Project Emissions

$$PE=\sum\_{j}^{}LEAK\_{k,j}÷1000×GWP\_{REF,k}$$

| *Where,* |  |  | Units |
| --- | --- | --- | --- |
| PE | = | Project emissions during the project reporting period | tCO2e |
| LEAKk,i | = | Quantity of alternative refrigerant *k* that leaked out of the project system *j* during the reporting period (not including the intial system charge) | kg |
| 1000 | = | Conversion from tonnes to kilograms | kg/t |
| GWPREF,k | = | Global warming potential of refrigerant *k* used in the project (Table 4.2) | tCO2e/t refrigerant |

### Leakage

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

# Data Management and Project Monitoring

## Data Collection

1. 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.
2. 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 1.1, 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.
3. The data management system for the project 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.
4. 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.
5. 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).[[10]](#footnote-11) 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.
6. 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.

## Monitoring Requirements

1. 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:
		1. Description of the system(s) and/or equipment used
		2. Refrigerant(s) used
		3. Initial charge size(s), in kg
		4. kW 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.
		1. Each project system must be checked for the level of refrigerant at least once during the reporting period by an appropriately-trained and certified refrigerant service provider, with the as-found and as-left pressures recorded, as well as the amount of any refrigerant added to the system, in kg.

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

1. All project refrigeration equipment must be operated and maintained according to the manufacturers’ specifications and recommendations.

## Monitoring Parameters

1. 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

| **Eq. #** | **Parameter** | **Description** | **Units** | **Calculated (c) Measured (m) Reference (r)****Operating Records (o)** | **Measurement Frequency** | **Comment** |
| --- | --- | --- | --- | --- | --- | --- |
| Equation 6.1 | ER | GHG emission reductions during the reporting period | tCO2e | c | Per reporting period |  |
| Equation 6.1, Equation 6.2, Equation 6.3 | BE | Baseline emissions during the reporting period | tCO2e | c | Per reporting period |  |
| Equation 6.1, Equation 6.4 | PE | Project emissions during the reporting period | tCO2e | c | Per reporting period |  |
| Equation 6.2 | QBR,i,i | Quantity of refrigerant *i* that would have been used in initial charge of system *j* in absence of project activity | kg | o | Once |  |
| Equation 6.2 | LRj | Average annual leak rate of historical system *j* | % per year | r | Once | Default value of 10% |
| Equation 6.2 | GWPREF,i | 100-year global warming potential of refrigerant *i* | tCO2e/t refrigerant | r | Once | GWP values are included in Table 4.1 and Table 4.2 |
| Equation 6.3 | CAPPR,j | Cooling capacity of the project refrigeration system | kW | o | Once |  |
| Equation 6.2 | BEFj | Baseline emission factor for system *j* | kgCO2e/kW | r | Once | Referenced from Table 4.3  |
| Equation 6.4 | LEAKk,j | Quantity of refrigerant *k* leaked from project system *j* during the reporting period | kg | M,r | Per reporting period | Determined according to Section 6.2(b) |

# Reversals

## Errors, Omissions, or Misstatements

1. 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 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 | tCO2e |
| N | = | Total number of project reports affected by the reversal |  |
| R | = | Specific project reports affected by the reversal |  |
| ERc,r | = | Corrected GHG emission reductions from the project during the specific reporting period, *r*, calculated in accordance with Subsection 8.1(a)(1) | tCO2e |
| ERi,r | = | Initially reported GHG emission reductions from the project during the reporting period, *r* | tCO2e |

# Reporting

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

## Project Report

### Eligibility Criteria Information

1. The location of the project facility
2. The nature of the project activity (i.e., new facility, new system at existing facility, or retrofit of existing system)
3. 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)
4. 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)

### Monitoring Information

1. 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.
2. Identification of the measurement frequency used for each monitoring parameter.

### Quantification Information

1. All calculations set out in Section 6 that were used.
2. Supporting documentation related to the calculations.

## Reversal Report

### General

1. Information about the circumstances and causes of the reversal including the number of reporting periods affected.
2. 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.
3. 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.
4. Supporting documentation for each of the items in paragraphs (a) through (c) above.

### Quantification Information

1. 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.
2. Supporting documentation related to the calculations.

# Record Keeping

1. 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:
		1. Project related refrigerant usage
		2. Identifying and logging the equipment/system to be installed
		3. 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.
2. Development of Default Baseline Emission Factors

|  |
| --- |
| **NOTE TO REVIEWERS:****The following three issues impact the calculated emission factors in Table 4.3.**1. **Baseline selection for projects installing indirect (secondary loop) centralized refrigeration systems:**

We are considering two types of baseline centralized systems in the protocol, direct expansion (DX) and secondary loop systems (indirect systems). Indirect systems require significantly lower charge sizes than DX systems because they use a secondary fluid that is cooled centrally and is circulated in a closed loop to display cabinets or cold stores. Indirect systems generate less GHG emissions than DX systems due to their lower charge sizes and thereby smaller leaks. Both types of refrigeration systems are currently employed in the industrial and commercial sectors. Available information indicates that the trend is for indirect systems to substitute DX systems. According to IPCC, DX systems constituted the largest category in use in supermarkets in 2005. While according to ARB, in 2009 70% of centralized systems in California were DX and 30% were indirect systems. This information is relevant to our refrigeration systems protocol because project developers installing new indirect systems (without historical refrigerant use data) could argue that DX would have been their baseline scenario. Projects using direct systems as their baseline scenario would result in much higher GHG emission reductions than projects using indirect systems as the baseline. This is not necessarily a negative outcome since indirect systems can be deemed as more desirable than DX systems to achieve overall GHG emission reduction outcomes.We have thought of two options that to determine the applicable baseline scenario to indirect systems which differ in their level of conservativeness. The first and most conservative option, is to assume that an indirect system project there would have been an indirect system in its baseline. With this option, we would assume that the only difference in the project scenario would be the type of refrigerant used and the charge of refrigerant used. The second option is to assume that all indirect systems would have had a DX system as its baseline. In this case, new indirect projects would generate significantly more GHG emission reductions than in the first option. This option rewards project developers for installing new indirect systems. We created two tables in Section 4.2 that reflect these two options and would appreciate your thoughts on which option you consider more appropriate for the protocol.1. **Market shares of baseline (BAU) refrigerants.**

The default tables rely on the BAU assumptions from the 2016 ODSHAR amendments. The Regulatory Impact Analysis Statement (RIAS) includes the refrigerants which are assumed to be BAU for commercial refrigeration in Canada. However, it does not indicate the expected market share of each of these refrigerants. Since they have very different GWP values, adjusting the market share can dramatically change the blended GWP used to create the default emission factor. The current emission factors in Table 4.3 reflect a simple average (i.e., equal weighting) of all BAU refrigerants (the resulting blended GWP is 2861 for stand-alone and centralized systems, 2428 for chillers). For reference, the ACR protocol uses R-407A (GWP 2107) for centralized systems and a blended GWP of 2676 for stand-alone systems. We have been working with ECCC to try and determine the market share assumptions used for the ODSHAR amendments RIAS, but have been unable to determine actual market shares. The only other source for market shares of Canadian refrigerants which we have identified is the NIR, but in that case the refrigerants are reported by individual chemical, rather than blend. The weighted-average GWP of refrigerants installed into commercial equipment in Canada over the last 5 years is 3157, which is far higher than the numbers discussed above, and thus not conservative.You can see more information regarding this question in the new Appendix A.1. **Baseline leak rate**

The current default leak rate (10% per year) is drawn from the assumed leak rate in the Canadian NIR. A stakeholder commented that the US EPA’s Green Chill program reports leak rages of 20-25% and that even for advanced technologies, leak rates have been measured in the range of 15%. As we know, actual leak rates could vary widely, but the goal is to choose a default leak rate which is reasonable, conservative, and appropriate for Canada. The TTT initially indicated that the assumption from the NIR was a good choice, but we wanted to raise this issue again to offer the opportunity for feedback. |

The default baseline emission factors represent the kilograms of CO2e that would have been released to the atmosphere every year per kW of Cooling capacity of a refrigeration system in a baseline scenario. The default baseline emission factors are specific to each category of refrigeration system (see section 3.1 (b)). The default baseline emission factors are applicable to projects without historical refrigerant use data.

**Approach for the derivation of default baseline emission factors**

The default baseline emission factors were derived using the following equation:

$$EF=\left(Charge ratio\right)×\left(Leak rate\right)×\left(Blended GWP\right)$$

*Where,*

|  |  |  |
| --- | --- | --- |
| EF | = | Annual emission factor per refrigerant system category (units as kgCO2e/kW/yr) |
| Charge ratio | = | kg of refrigerant per kW of cooling capacity (units as kg/kW) |
| Leak rate | = | percentage of refrigerant released to the atmosphere in a year (units as %) |
| Blended GWP | = | are a market-share weighted average of the GWP of refrigerants assumed to be used in the baseline scenario of refrigerant system categories in 2017 ODSHAR amendments (RIAS Table 3) (Units as CO2e). |

Blended GWP values for project start dates prior to ODSHAR deadlines were derived using the following equation:

$$Blended GWP=\sum\_{i}^{}\left[\left(Refrigerant market share\right)\_{i}×GWP\_{i}\right]$$

*Where,*

|  |  |  |
| --- | --- | --- |
| *i* | = | Indicator for each individual type of refrigerant used by that market sector. |
| Refrigerant market sharei | = | Portion of the Canadian refrigerant market controlled by the particular refrigerant for the refrigerant system category (units as %) |
| GWPi | = | 100-year GWP for refrigerant *i* (units in CO2e) |

It was assumed that all refrigerants shared an equal market share thereby resulting in a linear average of 100-year GWP.

 **Default Baseline Emission Factor calculations**

Table A.1. presents the calculation process for default baseline emission factors. Table A.2. presents the calculation process for Blended GWP values.

**Table A.1.** Calculation of default baseline emission factors

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** | **Charge Ratio (kg/kW)[[11]](#footnote-12)** | **Leak Rate[[12]](#footnote-13)** | **GWP** | **ODSHAR Deadline22** | **Annual Emission Factor (kgCO2e/kW/yr)** |
| **Pre-Deadline** | **Post-Deadline****[[13]](#footnote-14)** | **Pre-Deadline** | **Post-Deadline** |
| **Stand alone** |  |  |  |  |  |  |  |
| Medium temperature | 0.23 | 10% | 2861 | 1400 | 2020 | 66 | 32 |
| Low Temperature | 1.5 | 10% | 2861 | 1500 | 2020 | 429 | 225 |
| **Centralized commercial** |  |  |  |  |  |  |  |
| *Direct expansion* |  |  |  |  |  |  |  |
| Medium temperature | 2.8 | 10% | 2861 | 2200 | 2020 | 801 | 616 |
| Low Temperature | 5.5 | 10% | 2861 | 2200 | 2020 | 1574 | 1210 |
| *Indirect (secondary loop)* |  |  |  |  |  |  |  |
| Medium temperature | 0.8 | 10% | 2861 | 2200 | 2020 | 229 | 176 |
| Low Temperature | 1.2 | 10% | 2861 | 2200 | 2020 | 343 | 264 |
| **Centralized industrial (food processing)** |  |  |  |  |  |  |  |
| *Direct expansion* |  |  |  |  |  |  |  |
| Medium temperature | 5.5 | 10% | 2861 | 2200 | 2020 | 1574 | 1210 |
| Low Temperature | 8.8 | 10% | 2861 | 2200 | 2020 | 2518 | 1936 |
| *Indirect (secondary loop)* |  |  |  |  |  |  |  |
| Medium temperature | 1 | 10% | 2861 | 2200 | 2020 | 286 | 220 |
| Low Temperature | 1.5 | 10% | 2861 | 2200 | 2020 | 429 | 330 |
| **Centralized industrial (other)** |  |  |  |  |  |  |  |
| Medium temperature | 2.3 | 10% | 2861 | 2200 | 2020 | 658 | 506 |
| Low Temperature | 5.5 | 10% | 2861 | 2200 | 2020 | 1574 | 1210 |
| **Chillers (commercial or industrial)** | 0.3 | 10% | 2428 | 750 | 2025 | 73 | 23 |

**Table A.2.** Calculation process for blended GWP for projects with start dates before ODSHAR deadlines

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Refrigeration system category** | **BAU refrigerant[[14]](#footnote-15)** | **Market share** | **100-Year GWP[[15]](#footnote-16)** | **Blended GWP** |
| Stand-alone refrigeration | R-404A | 25% | 3922 | 2861 |
| R-507A | 25% | 3985 |
| R-407A | 25% | 2107 |
| HFC-134a | 25% | 1430 |
| Centralized refrigeration | R-404A | 25% | 3922 | 2861 |
| R-507A | 25% | 3985 |
| R-407A | 25% | 2107 |
| HFC-134a | 25% | 1430 |
| Chillers | R-404A | 20% | 3922 | 2428 |
| R-507A | 20% | 3985 |
| R-407C | 20% | 1774 |
| HFC-134a | 20% | 1430 |
| HFC-245fa | 20% | 1030 |

1. As created by the Climate Change Mitigation and Low-Carbon Economy Act, 2016, Ontario Regulation 144/16, *The Cap and Trade Program*. [↑](#footnote-ref-2)
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*. [↑](#footnote-ref-3)
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. [↑](#footnote-ref-4)
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>. [↑](#footnote-ref-5)
5. Table 1-1 IPCC Global Warming Potentials (page 34) in Environment and Climate Change Canada. 2015. National Inventory Report 1990-2015: Greenhouse gas sources and sinks in Canada. Part 1. Gatineau Qc. (Page 34) [↑](#footnote-ref-6)
6. Table 2.14 (Errata) in IPCC. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp. [↑](#footnote-ref-7)
7. Appendix 8.A: Lifetimes, Radiative Efficiencies and Metric Values (page 732) in IPCC. 2013. IPCC, 2013: Climate Change 2013: 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. [↑](#footnote-ref-8)
8. Table 2.6. Lifetimes, radiative efficiencies, and direct global warming potentials (GWPs) relative to carbon dioxide, for the ODs and their replacements (page 160) in IPCC/TEAP. 2005. Special Report: Safeguarding the Ozone Layer and the Global Climate System. Cambridge University Press, New York. [↑](#footnote-ref-9)
9. US EPA. n.d. Significant New Alternatives Policy (SNAP). Substitutes in Stand-alone Equipment. Website available at: <https://www.epa.gov/snap/substitutes-stand-alone-equipment#self> [↑](#footnote-ref-10)
10. Consolidated Canadian Federal Halocarbon Regulations, 2003, SOR/2003-289, (last amended on July 30, 2009). [↑](#footnote-ref-11)
11. ARB, 2009. Inventory of Direct and Indirect GHG Emissions from Stationary Air Conditioning and Refrigeration Sources, with Special Emphasis on Retail Food Refrigeration and Unitary Air Conditioning. Sacramento, CA. Center for Energy and Processes. [↑](#footnote-ref-12)
12. Canadian National Inventory Report to the UNFCCC (2017), Table B2(II)B-Hs2. [↑](#footnote-ref-13)
13. RIAS Table 2 in Canada Gazette, Part II. Vol.151, No. 21. Statutory Instruments 2017. SOR/2017-209 to 222 and SI/2017-56 to 61 AND 63 to 64. [↑](#footnote-ref-14)
14. RIAS Table 3 in Canada Gazette, Part II. Vol.151, No. 21. Statutory Instruments 2017. SOR/2017-209 to 222 and SI/2017-56 to 61 AND 63 to 64. [↑](#footnote-ref-15)
15. See table 4.2 [↑](#footnote-ref-16)