METHODOLOGY FOR THE QUANTIFICATION, MONITORING, REPORTING AND VERIFICATION OF GREENHOUSE GAS EMISSIONS REDUCTIONS AND REMOVALS FROM

ADVANCED REFRIGERATION SYSTEMS

VERSION 3.0

September 2024

ACR
AT WINROCK INTERNATIONAL

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ABOUT ACR[SM]

ACR is a leading global carbon crediting program operating in regulated and voluntary carbon markets. Founded in 1996 as the first private voluntary greenhouse gas (GHG) registry in the world, ACR creates confidence in the integrity of carbon markets to catalyze transformational climate results. ACR ensures carbon credit quality through the development of environmentally rigorous, science-based standards and methodologies as well as oversight of GHG project verification, registration, and credit issuance and retirement reporting through its transparent registry system. ACR is governed by Environmental Resources Trust LLC, a wholly owned nonprofit subsidiary of Winrock International.

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Acronyms

Btu	British thermal units
CFC	Chlorofluorocarbon
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EOL	End-of-life
ERR	Emissions reduction and removal
ERT	Emission Reduction Ton
GHG	Greenhouse gas
GWP	Global warming potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin
HP	Horsepower
hr.	Hour
kg	Kilogram
kW	Kilowatt
lb.	Pound
MT	Metric ton
N_2O	Nitrous oxide

ODSHAR	Ozone-Depleting Substances and Halocarbon Alternatives Regulation
QA/QC	Quality assurance/quality control
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales
SNAP	Significant New Alternative Policy
SSR	Sources, sinks, and reservoirs (of GHGs)
UNEP	United Nations Environment Programme
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
VVB	Validation and Verification Body

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1 Methodology Description

This science-based Methodology provides the quantification and accounting framework for the creation of carbon credits from the reductions in greenhouse gas (GHG) emissions resulting from transitioning commercial refrigeration equipment to advanced refrigeration systems in eligible applications. It includes procedures for determining eligibility, assessing additionality, and quantifying, monitoring, reporting, and verifying GHG emissions reductions and removals (ERRs).

Modern society is dependent on refrigeration to process, store, and transport food and other goods. Until the mid-1990s, chlorofluorocarbons (CFCs) were in widespread use as refrigerants. CFCs destroy the Earth's protective ozone layer and are also powerful GHGs with global warming potentials (GWPs) thousands times that of carbon dioxide (CO_2). Under the Montreal Protocol nearly all CFC production in developed countries was phased out in 1996[1] and in developing countries in 2010 (United Nations Environment Programme [UNEP], 2012). As a result of this phase-out, many applications transitioned to using hydrochlorofluorocarbon (HCFC) refrigerants, which also contribute to ozone depletion and climate change (GWPs up to almost 2000), although to a lesser extent than CFCs. The Montreal Protocol reduced consumption of new HCFCs by 99.5% by 2020 in developed countries and by 67.5% by 2022 in developing countries on an accelerated phase-down path. The most commonly used refrigerants today are hydrofluorocarbons (HFCs) (UNEP, 2023). While HFCs are safe for the ozone layer, they are powerful GHGs when released to the atmosphere, with GWPs up to the thousands. Under the Kigali Amendment to the Montreal Protocol (UNEP, 2016), the phase down of HFC consumption is also underway, with developed countries reducing HFC consumption by 40% by 2024 and developing countries leveling off consumption by 2024 and reducing consumption 10% by 2029. Across the various refrigeration applications, there are many approaches that can be used to reduce GHG emissions from both new and installed equipment.

Advanced refrigeration systems projects encompass the replacement of CFC, HCFC, and/or HFC refrigerants and associated equipment with specific low-GWP refrigerants in the following applications: Large Commercial Refrigeration, Remote Condensing Units, and Stand-Alone Commercial Refrigeration. Low-GWP refrigerants include, but are not limited to, hydrocarbons, ammonia, CO_2, and hydrofluoroolefins (HFOs). In some advanced commercial refrigeration systems, these alternatives completely replace the use of HFC refrigerants, while in other advanced systems these alternatives are used in combination with HFCs. Businesses with existing Large Commercial Refrigeration equipment installed that currently use higher-GWP refrigerants can also retrofit the

[1] After 1996, the Montreal Protocol authorized limited production of CFCs for "essential uses" such as propellants in medical devices (e.g., metered dose inhalers) and for laboratory and analytical uses. Production for essential medical uses ended in the U.S. on January 1, 2012. The exemption for de minimis CFC production for essential laboratory and analytical uses remains in effect.

existing equipment to use lower-GWP refrigerants that are acceptable under the United States Environmental Protection Agency's (U.S. EPA's) Significant New Alternatives Policy (SNAP) program.

The potential GHG benefits from advanced refrigeration systems are significant, estimated to be over 10 million metric tons carbon dioxide equivalent (CO_2e) per year from large retail food stores in the U.S. alone.[2] The generation of carbon credits offsets the costs of the installation of new equipment and replacement or retrofitting of existing equipment that allows the use of low-GWP refrigerants. The carbon credits help to incentivize the use of refrigerants with much lower GWPs than ozone-destroying, high-GWP CFC and HCFC refrigerants and high-GWP HFC refrigerants.

To establish additionality, the Project Proponent must demonstrate that the project is surplus to existing law, regulation, or other regulatory framework that mandates the project activity and that the project meets or exceeds the benchmark performance standard set in this Methodology.

The baseline scenario represents the business-as-usual scenario of continuing to use higher-GWP refrigerants in existing and new refrigeration applications in Large Commercial Refrigeration, Remote Condensing Unit, and Stand-Alone Commercial Refrigeration applications.

Emission Reduction Tons (ERTs) are issued for the Total GHG Emissions Reductions and Removals, as quantified in this Methodology, equal to the baseline scenario less emissions from project implementation. There is no activity-shifting leakage or market leakage associated with this project type. Uncertainty is addressed throughout the Methodology in line with the principle of conservativeness, so no uncertainty deduction is applied.

[2] Per U.S. EPA (U.S. EPA, 2023a), there are 45,500 large retail food establishments in the U.S. that are charged with 3,000-4,000 pounds of refrigerant and can leak in excess of 20 percent of their charge each year. Assuming 50% of these stores switch to advanced refrigeration systems using low-GWP (<15) refrigerant resulting in a GWP differential of around 1,800 between baseline (default baseline GWP = 1688 to 1912) and project refrigerants (GWP<15).

2 Eligibility Conditions

In addition to satisfying the latest ACR program requirements, project activities must satisfy all of the following eligibility conditions:

I. Project activity includes one or more of the following activities:[3]
   A. The installation of an advanced refrigeration system as a new and/or additional commercial refrigeration system at an existing facility;
   B. The installation of an advanced refrigeration system in new commercial construction;
   C. The complete replacement of existing commercial refrigeration system (including all components) with an advanced refrigeration system at an existing facility;
   D. The retrofit of an existing Large Commercial Refrigeration system at an existing facility to use low-GWP refrigerant(s). A retrofit or a retrofit project is a project that includes the conversion of an existing refrigeration system to achieve system compatibility and that may include changes in lubricants, gaskets, filters, driers, valves, o-rings, or equipment components for that purpose;
   E. The manufacture and sale of new Stand-Alone Commercial Refrigeration equipment for commercial use that is charged and sealed at the manufacturing facility with low-GWP refrigerant(s).

II. Deployment of refrigeration product or system that uses a low-GWP refrigerant in the following applications with low adoption rates of low-GWP refrigerants: Large Commercial Refrigeration, Remote Condensing Units or Stand-Alone Commercial Refrigeration. These eligible refrigerant applications and their descriptions are provided below in Table 1.

[3] Advanced refrigeration systems that utilize low-GWP refrigerants encompass a wide variety of designs, including use of one refrigerant throughout the entire system, or secondary loop systems where the compressor uses a relatively small charge of HFC or a primary low-GWP refrigerant and the piping throughout the store is filled with a heat exchange fluid such as glycol. In this Methodology, use of HFC as a primary refrigerant in a secondary loop system is only allowed for use cold storage warehouse projects through 2025 and for large retail food projects through for 2026. Starting in 2026 for cold storage warehouse projects and in 2027 for retail food refrigeration projects, a low-GWP refrigerant must be used as the primary refrigerant.

Table 1: Eligible Advanced Refrigeration System Applications and Descriptions of Applications

APPLICATION	APPLICATION DESCRIPTIONS
Large Commercial Refrigeration	For the purposes of eligibility under this Methodology, Large Commercial Refrigeration is equipment used to store and/or display chilled and frozen goods for commercial sale such as in food retailers, supermarkets, convenience stores, cold storage warehouses, bakeries, and restaurants. For the purposes of this Methodology, this includes commercial refrigeration units with an initial charge of 50 pounds (lbs.)/ 22.7 kilograms (kg) or more of refrigerant. This application includes the sub-applications of retail food refrigeration and cold storage warehouses.
Remote Condensing Units	For the purposes of eligibility under this Methodology, Remote Condensing Units are composed of compressors, condensers, and receivers assembled into a single unit. The condenser (and often other parts of the system) is located outside the space or area cooled by the evaporator, typically ejecting heat to the outdoor ambient environment. Remote Condensing Units are commonly installed in convenience stores, specialty shops (e.g., bakeries, butcher shops), supermarkets, restaurants, and other locations where food is served or sold. Only Remote Condensing Units at retail food refrigeration facilities are eligible for crediting under this Methodology. They typically have refrigerating capacities from 1 kilowatt (kW) to 20 kW (0.3 to 5.7 ton of refrigeration).
Stand-Alone Commercial Refrigeration (Canada and Mexico)	For the purposes of eligibility under this Methodology, Stand-Alone Commercial Refrigeration includes refrigerators, freezers, reach-in coolers (either open or with doors), and refrigerated food processing and dispensing equipment where all refrigeration components are integrated, and, for the smallest types, the refrigeration circuit is entirely brazed or welded. These systems are fully charged with refrigerant at the factory and typically require only an electricity supply to begin operation. It includes the sub-applications of refrigerated food processing and dispensing and small retail food. Crediting for this broader category of Stand-Alone Commercial Refrigeration is only allowed in Canada and Mexico.
Stand-Alone Commercial Refrigeration – Refrigerated	For the purposes of eligibility under this Methodology, Stand-Alone Commercial Refrigeration – refrigerated food processing and dispensing equipment dispenses and often processes a variety of food and beverage products. All refrigeration components are integrated in this equipment, and

APPLICATION	APPLICATION DESCRIPTIONS
Food Processing and Dispensing (U.S.)	for the smallest equipment types, the refrigeration circuit is entirely brazed or welded. These systems are fully charged with refrigerant at the factory and typically require only an electricity supply to begin operation. This sub-application of the Stand-Alone Commercial Refrigeration application includes, but is not limited to, equipment that process and/or dispense chilled and frozen beverages (carbonated and uncarbonated, alcoholic and nonalcoholic), frozen custard, gelato, ice cream, Italian ice, sorbet, frozen yogurt, milkshakes, “slushies,” smoothies, and whipped cream. This is the only sub-application of Stand-Alone Commercial Refrigeration for which crediting is allowed for projects in the United States.

III. Any refrigerant used in the advanced refrigeration system must be a low-GWP refrigerant, as defined in this Methodology, be an acceptable substitute according to the U.S. EPA SNAP program for use in the commercial refrigeration applications and end-use(s), and be used in accordance with SNAP use conditions (U.S. EPA, 2024c). Refrigerants may not have an ozone-depletion potential greater than zero. Some of the SNAP-acceptable low-GWP refrigerants allowed for new and replacement advanced refrigeration systems that are increasingly being used are presented in Table 2.

Table 2: Select Low-GWP SNAP-Acceptable Refrigerants that are Methodology-Approved Alternatives to High-GWP Refrigerants for New and Replacement Advanced Refrigeration Systems

LOW-GWP SNAP-ACCEPTABLE REFRIGERANT	GWP
R-290 (propane)	3
R-600a (isobutane)	3
R-744 (CO_2)	1
R-717 (ammonia)	0
HFO-1234yf	1
HFO-1234ze(E)	1

IV. The project is located in the United States, Canada, or Mexico.

V. For a project activity in which an existing refrigeration system is decommissioned or retrofitted, the refrigerant in the original refrigeration system must be recovered and managed in accordance with applicable rules and regulations.[4] For refrigeration systems decommissioned or retrofitted in the U.S., this includes U.S. EPA regulations (40 CFR Part 82, Subpart F) under Section 608 of the Clean Air Act (Clean Air Act, 2024) and any relevant state rules and regulations. For systems decommissioned or retrofitted in Canada, the Ozone-Depleting Substances and Halocarbon Alternatives Regulation (ODSHAR, 2016) and any relevant provincial rules and regulations. For refrigeration systems decommissioned or retrofitted in Mexico, this includes the General Law for Waste Prevention and Integrated Waste Management (Ley General para la Prevención y Gestión Integral de los Residuos) (General Law, 2003) and any relevant state rules and regulations.

VI. Assess compatibility of the project activities with transition to net zero and demonstrate compatibility in the GHG Project Plan with reference to the net zero objectives of the host country.

[4] Additional credits can be generated for destroying recovered refrigerants by using ACR's Destruction of Ozone Depleting Substances and High-GWP Foam Methodology. See https://acrcarbon.org/methodology/destruction-of-ozone-depleting-substances-and-high-gwp-foam/.

3 Additionality Assessment

The climate benefits of GHG Projects developed under this Methodology are additional to what would have occurred under a business-as-usual scenario, current laws and regulations, current industry practices, and without carbon market incentives. To qualify as additional, every GHG Project must pass a regulatory surplus test and exceed the performance standard set forth below.

3.1 Regulatory Surplus Test

To pass the regulatory surplus test, Project Proponents must establish regulatory additionality, demonstrating that there is no existing law, regulation, statute, legal ruling, or other regulatory framework that directly mandates the project activity or effectively requires the GHG emissions reductions associated with advanced refrigeration systems. If a statutory, regulatory, or similar (e.g., legal ruling, permit condition) requirement comes into force during the Crediting Period and such requirement effectively mandates the project activity, the GHG Project will no longer be eligible for crediting from the date the statute, regulation, or similar requirement takes effect.

U.S. EPA finalized SNAP rules 20 and 21 in 2015 to restrict use of unacceptable refrigerants in various refrigeration sectors (Protection of Stratospheric Ozone, 2015; Protection of Stratospheric Ozone, 2016; U.S. EPA, 2024b). However, these rules were declared invalid by the Court of Appeals for the D.C. Circuit (Mexichem Fluor Inc. v. EPA, 2017). Since 2019, 12 states have introduced SNAP-like legislation that prohibit the use of specific refrigerants in specific end-uses.[5] For advanced refrigeration units sold in these states, baseline emissions calculations take into account these prohibitions (see Tables 7 and 8).

On October 5, 2023, U.S. EPA finalized a rule to restrict use of certain HFCs under subsection (i) of the American Innovation and Manufacturing (AIM) Act of 2020 (U.S. EPA, 2023b). This rule sets compliance dates for the manufacture, import, sale, distribution, and installation of refrigeration products and systems using restricted HFC refrigerants. Tables 9 and 10 document these compliance dates and baseline GWPs for the refrigeration categories eligible under this Methodology. The GWP limits set by this rule will serve as default baseline GWP for new refrigeration products and systems starting on the GWP limit compliance dates. Existing refrigeration systems are not affected by this rule and can

[5] An act to add Section 39734, 2018; An Act to Limit, 2021; An Act concerning, 2020; Colorado Greenhouse Gas, 2023; Hydrofluorocarbon Greenhouse Gas Emissions, 2019; Hydrofluorocarbon Standards, 2020; Prohibitions on Use, 2020; An act relating, 2019; Prohibition of Hydrofluorocarbons, 2022; Prohibitions on Use, 2020; Prohibitions on Use, 2021; Regulations for Control, 2021.

continue to use higher-GWP refrigerants. Manufacture and import of higher-GWP refrigerants and other spare parts to service existing refrigeration system are not restricted by this rule.

In Canada, ODSHAR (2016) sets GWP limits for different refrigeration categories and is reflected in Tables 7, 8, and 11 of this Methodology. In Mexico, consumption phasedown of HFC refrigerants, per the Kigali Amendment, starts in 2029 (UNEP, 2016). According to the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) Roadmap to Implement the Kigali Amendment in Mexico (SEMARNAT, 2019), Mexico's HFC phasedown plan is expected to be finalized and implemented over the 2024-2028 period.

3.2 Performance Standard

This Methodology utilizes a practice-based performance standard to demonstrate that a GHG project carrying out the eligible project activities are implementing technologies that exceed the industry standard for the relevant sectors and applications (see Table 1) in the applicable geographic areas. Market adoption rates for low-GWP refrigerants and associated technologies are discussed below.

U.S. market adoption rates for low-GWP refrigerants and associated technologies eligible under this Methodology are sourced from the U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990-2022) (U.S. EPA Inventory) (U.S. EPA, 2024a). This data shows no market penetration for SNAP-acceptable, low-GWP refrigerants in condensing units (equivalent to Remote Condensing Units application) and retail food refrigeration (a sub-application of the Large Commercial Refrigeration application) and around 7% market penetration for ammonia as a refrigerant in cold storage warehouses (a sub-application of the Large Commercial Refrigeration application). In the Stand-Alone Commercial Refrigeration application, there is no market penetration for low-GWP (<15 GWP) refrigerants in refrigerated food processing and dispensing equipment, but there is market penetration of ~30% for the low-GWP refrigerant propane in the small retail food sub-application (which includes refrigerators, freezers, reach-in coolers) in the U.S. (U.S. EPA, 2024a).

The latest national GHG inventories for Canada (ECCC, 2024) and Mexico (Gobierno de Mexico, 2022) do not show any use of low-GWP refrigerants in Stand-Alone Commercial Refrigeration equipment. Canada allows use of Stand-Alone Commercial Refrigeration equipment with refrigerants having GWP of up to 1,400 in medium-temperature (≥32 ° F) applications and up to 1,500 in low-temperature (-58 °F<T<32 °F) applications (ODSHAR, 2016). Market adoption rates in Canada and Mexico were also evaluated using data from ATMOsphere's *Natural Refrigerants: State of the Industry* report. The 2022 and 2023 editions of this report show persistently low adoption rates of low-GWP refrigerants in North America. As of December 2023, 1,080 food retail stores in Canada have installed transcritical CO_2-based refrigeration systems (i.e., the most commonly used low-GWP commercial refrigeration system in supermarkets and grocery stores) (ATMOsphere, 2023). This represents just a 6% penetration level among the 18,078 supermarkets, groceries and convenience stores in Canada (ATMOsphere, 2023).

The same ATMOsphere report states that there is at least one store in Mexico that has installed a transcritical CO_2 system and a number of ammonia/CO_2 systems installed in cold storage warehouses (ATMOsphere, 2023). Assuming that "a number" of systems plus one store translates to less than 100 such installations, evaluated conservatively against Mexico's 3,333 supermarket chain stores[6] (U.S. Department of Agriculture, 2023), the penetration level is less than 0.1%.

The low (0.1%–7%) penetration levels for the U.S., Canada, and Mexico demonstrate that the use of low-GWP refrigerants for commercial refrigeration purposes is not common practice in these countries. Adoption rates are expected to remain low in the near future as a result of market entry barriers, including the high upfront costs and a technician shortage for these systems (North American Sustainable Refrigeration Council, 2023).

As a result of the analysis and findings of low market adoption rates for low-GWP refrigerants and associated technologies within the eligible sectors and segments, any advanced refrigeration system project that meets the eligibility and other requirements of the Methodology exceeds common practice.

[6] This conservatively excludes other non-supermarket food retailers.

4 Project Boundaries

4.1 Physical Boundary

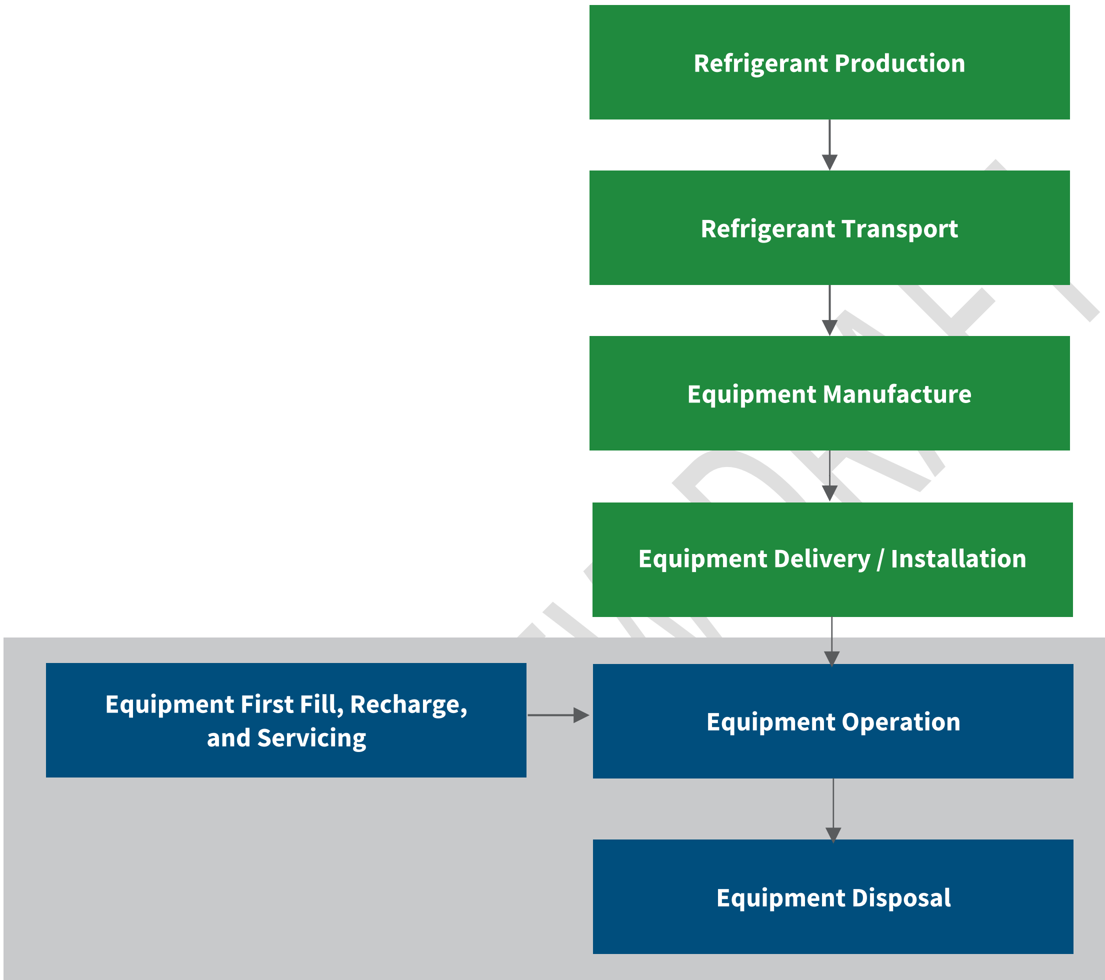
The physical boundary demarcates the GHG emissions sources, sinks, and reservoirs (SSRs) included in the baseline and with-project scenario emissions calculations. The project boundary is intentionally drawn broadly to avoid unaccounted emissions associated with refrigeration system or equipment initial charging (first-fill), operation, servicing, recharge, and disposal.

To ensure the emissions reduction calculation approach reflects the relevant change in emissions due to the GHG Project, the physical boundary shall incorporate all GHG sources affected by the project in the baseline and with-project scenarios. It includes the physical location where the advanced refrigerant system is installed or manufactured, as well as the locations involved in disposal of the older technology, including management of any recovered refrigerant in the older system that is replaced or retrofitted. The physical boundary for advanced refrigeration systems is depicted in the dark blue boxes in Figure 1.

For each registered GHG Project, a Project Proponent may only include project activities that result in GHG emissions reductions being generated within the geographic boundary of one country.[7] For projects that include Stand-Alone Commercial Refrigeration equipment (as defined in Table 1), which are fully charged with refrigerants and sealed at the manufacturing facility, and for which the manufacturer is the Project Proponent, the location of the project shall be the manufacturing facility.

[7] This ensures accurate representation of the host countries associated with projects and credits for the purpose of facilitating use under the Paris Agreement.

Figure 1: Project Boundary Diagram for Advanced Refrigeration Systems



4.2 Temporal Boundary

4.2.1 START DATE

For projects that involve filling equipment after manufacture, the project Start Date is the date that the advanced refrigeration system(s) first became fully operational. For projects that manufacture and seal equipment at the manufacturing facility, the project Start Date shall be the date on which equipment is first sold by the manufacturer.

4.2.2 CREDITING PERIOD

The Crediting Period for all project activities shall be ten years. The Crediting Period begins on the project Start Date. This time period aligns with the shortest equipment lifetime for eligible equipment per the U.S. EPA Inventory (U.S. EPA, 2024a). Carbon credits for GHG emissions reductions over the 10-year Crediting Period will be issued following ACR's acceptance of the verification of the Reporting Period.

4.2.3 REPORTING PERIOD

A project shall have one Reporting Period that shall not exceed 12 months in length. For projects that involve filling equipment after manufacture, the Reporting Period shall cover all equipment included in the project becoming fully operational. For projects that manufacture and seal equipment at the manufacturing facility, the Reporting Period shall cover all equipment in the project being sold. The Reporting Period begins on the project Start Date.

4.3 GHG Assessment Boundary

The GHG sources relevant to this Methodology are listed in Table 3 below. Sources must be consistently included or excluded in both the baseline and with-project scenarios.

Table 3: GHG Sources

GAS	SOURCE	INCLUDED (I) / EXCLUDED (E)	JUSTIFICATION / EXPLANATION OF CHOICE
CO_2, CH_4, & N_2O	Refrigerant Production	E	No change in the quantity of emissions as a result of the project
	Refrigerant Transport	E	No change in the quantity of emissions as a result of the project
	Equipment Manufacture	E	No change in the quantity of emissions as a result of the project
	Equipment Delivery / Installation	E	No change in the quantity of emissions as a result of the project

GAS	SOURCE	INCLUDED (I) / EXCLUDED (E)	JUSTIFICATION / EXPLANATION OF CHOICE
	Equipment Operation	E	No change in the quantity of emissions as a result of the project
	Equipment First Fill, Recharge, and Servicing	E	No change in the quantity of emissions as a result of the project
	Equipment Disposal	E	No change in the quantity of emissions as a result of the project
Refrigerants (CFCs, HCFCs, HFCs, low-GWP alternatives)	Refrigerant Production	E	No change in the quantity of emissions as a result of the project
	Refrigerant Transport	E	No change in the quantity of emissions as a result of the project
	Equipment Manufacture	E	No change in the quantity of emissions as a result of the project
	Equipment Operation	I	Change in the quantity of refrigerant emissions is a direct result of project activity
	Equipment First Fill, Recharge, and Servicing	I	Change in the quantity of refrigerant emissions is a direct result of project activity
	Equipment Disposal	I	Change in the quantity of refrigerant emissions is a direct result of project activity

5 Baseline Determination

Baseline emissions are calculated based on equipment charge size, emission rates, and refrigerant GWPs.

Project Proponents that install new or additional advanced refrigeration systems at an existing facility or in new construction, completely replace an existing refrigeration system with an advanced refrigeration system in an existing facility, and those that manufacture and sell new Stand-Alone Commercial Refrigeration equipment shall use default baseline values, the determination of which are discussed in the sections below.

Project Proponents that retrofit existing equipment shall use historical, system-specific data to establish these values, as described in Section 7.1. This historical data can be generated from manufacturer specifications, regulatory compliance reporting, and/or other verifiable operating documentation.

5.1 Charge Size

Charge size varies by system type. The average charge size for Large Commercial Refrigeration is 1.16 kg refrigerant per thousand British thermal units (Btu) per hour (Btu/hr.) (ARMINES, 2009; Arthur D. Little, Inc., 2002; and Baxter, 2003). The refrigerant charge size for Remote Condensing Units ranges from ~1.67 kg to 2.19 kg per ton of refrigeration (rated cooling capacity; Refrigerated Solutions Group, 2024) for the models most likely to be replaced, which averages to 1.9 kg per ton of refrigeration.[8] Based on research commissioned by ACR, Stand-Alone Commercial Refrigeration equipment varies by product type ranging from 0.4 kg to 1.9 kg as displayed in Table 4 (P&S Market Research, 2018).

Table 4: P&S Market Survey Data on Charge Size for Stand-Alone Commercial Refrigeration

STAND-ALONE COMMERCIAL REFRIGERATION EQUIPMENT	CHARGE RANGE (KG)
Vertical closed refrigerators (Canada and Mexico only)	1.2 – 1.4
Vertical closed freezers (Canada and Mexico only)	1.5 – 1.9

[8] Refrigerated Solutions Group (2024) indicates a charge size of 2.5 lb./ton of refrigeration plus 0.5 to 1 lb. per 2 horsepower (HP) additional charge for equipment without a head pressure control valve, which are the equipment types more likely to be the (baseline) systems being replaced. (Conversion factor used 1 ton of refrigeration = 4.71 HP, 2 significant figures are used.)

STAND-ALONE COMMERCIAL REFRIGERATION EQUIPMENT	CHARGE RANGE (KG)
Vertical open refrigerators (Canada and Mexico only)	1.0 – 1.2
Horizontal open refrigerators (Canada and Mexico only)	0.70 – 0.90
Horizontal open freezers (Canada and Mexico only)	0.90 – 1.1
Deli case refrigerators (Canada and Mexico only)	0.40 – 0.80
Drink dispensers	0.70 – 1.0
Ice machines	0.60– 1.1
Soft serve ice cream and frozen beverage machines	1.05 – 1.20
Food prep tables	0.40 – 0.70
Blast chillers	1.1 – 1.4

The average charge size for each Stand-Alone Commercial Refrigeration equipment type and the averages for Large Commercial Refrigeration and Remote Condensing Units being replaced are provided in Table 5 for use in Equation 1.

Table 5: Baseline Default Assumptions for Charge Size

APPLICATION	EQUIPMENT	REFRIGERANT CHARGE SIZE
Large Commercial Refrigeration	See Table 1	1.16 kg refrigerant per thousand Btu/hr.
Remote Condensing Units	See Table 1	1.9 kg per ton of refrigeration
Stand-Alone Commercial Refrigeration – Small Retail Food (Canada and Mexico only)	Vertical closed refrigerators	1.3 kg
	Vertical closed freezers	1.7 kg
	Vertical open refrigerators	1.1 kg
	Horizontal open refrigerators	0.80 kg
	Horizontal open freezer	1.0 kg

APPLICATION	EQUIPMENT	REFRIGERANT CHARGE SIZE
	Deli case refrigerators	0.60 kg
Stand-Alone Commercial Refrigeration – Refrigerated Food Processing and Dispensing	Drink dispensers	0.85 kg
	Ice machines	0.85 kg
	Soft serve ice cream and frozen beverage machines	1.13 kg
	Food prep tables	0.55 kg
	Blast chillers	1.3 kg

5.2 Annual Amortized Emission Rate

The U.S. EPA Inventory states that refrigerant emission (leak) rates caused by servicing and normal operations range from 1% to 30% annually depending on the type of application and end-use (U.S. EPA, 2024a). Even with active leak detection and aggressive maintenance efforts, it is difficult to eliminate leaks completely. Consequently, to maintain proper performance, refrigeration equipment and systems require periodic servicing to replace the lost refrigerant. Refrigerants are also released at first fill and when refrigeration equipment and refrigerants are disposed of at the end-of-life.[9]

This Methodology uses equipment lifetimes and emissions data from the U.S. EPA Inventory Annex 3, Part A, Table A-113 (U.S. EPA, 2024a), weighted by market penetration rates for different refrigerants, and generates annual amortized emission rates reflecting the refrigerant loss over the equipment lifetime for each application type and one sub-application type (Large Commercial Refrigeration, Remote Condensing Units, Stand-Alone Commercial Refrigeration, and Stand-Alone Commercial Refrigeration – refrigerated food processing and dispensing). First-fill and disposal emission rates are from one-time emissions at the beginning and end, respectively, of equipment lifetimes. The emission rate from annual servicing and other leaks are multiplied by the equipment lifetime. First-fill, disposal, and annual servicing and other leaks over the lifetime of the equipment are summed, and this number divided by the equipment lifetime and multiplied by the market penetration rate[10] for each refrigerant used in the application or sub-application; the products of multiplication for each refrigerant are then summed to calculate the annual amortized emission rate for each application or sub-application.

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[9] Per the U.S. EPA Inventory, 10% to 68% of unrecovered refrigerants (relative to the full charge size of the refrigeration equipment) leaks at disposal; remaining refrigerants are assumed to be recovered.

[10] Normalized to 100% where U.S. EPA, 2024a has market penetration rates >100%

These inputs and resulting values are displayed in Table 6. The Annual Amortized Emission Rate is used in Equations 1 and 2.

Table 6: Annual Amortized Refrigerant Emission Rates

APPLICATION AND SUB-APPLICATION	LIFETIME (YEARS)	REFRIGERANT EMISSION RATES (%)			ANNUAL AMORTIZED EMISSION RATE (%)[11]
		FIRST FILL	ANNUAL SERVICING & OTHER LEAKS	DISPOSAL	
Large Commercial Refrigeration – Retail Food Refrigeration	18	2%	21%	10%	22%
Large Commercial Refrigeration – Cold Storage Warehouses	23	1%	11%	10%	12%
Remote Condensing Units	20	0.5%	11%	15%	12%
Stand-Alone Commercial Refrigeration (Canada and Mexico)	10	1%	1%	25%	3.6%
Stand-Alone Commercial Refrigeration – Refrigerated Food Processing and Dispensing (Canada, Mexico and U.S.)	10	1%	1%	68%	7.9%

5.3 Baseline Refrigerant GWP

Per the U.S. EPA Inventory, the refrigeration industry has historically relied primarily on R-404A, R-407A, R-407F and R-134a for Large Commercial Refrigeration and Remote Condensing Units. Stand-

[11] The appropriate number of significant figures is shown for each column, but annualized emission rate quotients may not appear to compute due to rounding occurring only at the final calculation.

Alone Commercial Refrigeration units (as defined in Table 1) have typically relied on R-134a, R-450A. R-513A, R-290, R-448A, and R-449A. Tables 7 through 11 list the default baseline assumptions in projects involving new commercial refrigeration systems, by jurisdiction and vintage for use in Equations 1 and 2.

With the introduction of U.S. EPA SNAP rules 20 and 21 (Protection of Stratospheric Ozone, 2015; Protection of Stratospheric Ozone, 2016; U.S. EPA, 2024b), several states have introduced legislation to ban use of refrigerants listed in SNAP rules 20 and 21 and encourage a transition to alternatives listed in SNAP rule 21. With states introducing their own legislation and regulations prohibiting refrigerants with different effective dates, the GWPs of the default baseline refrigerants (baseline GWPs) are state and date specific. Baseline GWPs are based on acceptable alternates (per SNAP rules 20, 21, and 23) for a particular vintage year or part of that year (Protection of Stratospheric Ozone, 2021; U.S. EPA, 2024b).

Table 7 provides the default baseline GWPs for new Stand-Alone Commercial Refrigeration equipment, by jurisdiction, for vintage years through 2025.

Table 7: Baseline GWPs for New Stand-Alone Commercial Refrigeration Equipment by Jurisdiction (through 2025)

APPLICATION	U.S. STATE(S)/ COUNTRIES	BASELINE GWP[12]	
		2021	2022-2025
Stand-Alone Commercial Refrigeration – Refrigerated Food Processing and Dispensing (U.S.)	California,[13] Colorado,[14] Delaware,[15] Maryland,[16] Massachusetts,[17] New Jersey,[18] New York,[19] Vermont,[20] Washington[21]	773 (A) 1,306 (B)	1,278 (D)
	Maine, Rhode Island, Virginia[22]	1,962	1,278
	All other U.S. states and territories	1,962	1,294 (E)
Stand-Alone Commercial Refrigeration (Canada and Mexico)	Canada	1,425 (C)	1,425
	Mexico	1,962	1,962 (F)

[12] AR5 100-year GWP values per ACR Standard.
[13] (An act to add Section 39734, 2018)
[14] (Colorado Greenhouse Gas, 2023)
[15] (Prohibitions on Use, 2021)
[16] (Prohibitions on Use, 2020)
[17] (Prohibitions on Use, 2020)
[18] (An Act concerning, 2020)
[19] (Hydrofluorocarbon Standards, 2020)
[20] (An act relating, 2019)
[21] (Hydrofluorocarbon Greenhouse Gas Emissions, 2019)
[22] (An Act to Limit, 2021; Prohibition of Hydrofluorocarbons, 2022; Regulations for Control, 2021)

The following refrigerants[23] and market penetrations[24] (U.S. EPA, 2024a for U.S.; ODSHAR, 2016 for Canada; and Gobierno de Mexico, 2022 and SEMARNAT, 2019 for Mexico) were used to calculate baseline GWPs for Stand-Alone Commercial Refrigeration applications:

(A) Through June 6, 2021: R-513A (75%) for medium-temperature units and R-426A (25%) for low-temperature units

(B) After June 6, 2021: average of R-448A, R-449A, R-449B (75%) for medium-temperature units and R-426A (25%) for low-temperature units. U.S. EPA listed R-448A, R-448B, and R-449A as SNAP-acceptable refrigerants for medium-temperature units as of June 7, 2021. As a result of this mid-year effective date, the states with regulations have two different GWP values (A and B) for 2021.

(C) Baseline GWP for medium-temperature units: 1,400 (75%). Baseline GWP for low-temperature units: 1,500 (25%) (ODSHAR, 2016).

(D) R-448A (50%) and R-449A (50%) (U.S. EPA, 2024a). R-134a is banned in states with SNAP regulations, and the market share of each in the U.S. EPA Inventory for all states is 15%, so the market share of each is assumed to remain proportional.

(E) R-134a (70%), R-448A (15%) and R-449A (15%) (U.S. EPA, 2024a)

(F) R-134a (75%), and R-404A (25%). The use of each of these refrigerants is confirmed through Gobierno de Mexico (2022) and SEMARNAT (2019), and the market penetrations are assumed to be the same as those noted in Methodology v. 2.1 for the U.S.

[23] For refrigerant blends, the GWP and the percentage of each gas were used to calculate the refrigerant blend GWPs, which are rounded to the nearest number.
[24] Where U.S. EPA Inventory market penetrations added up to >100%, each market penetration was normalized to 100%.

Table 8 provides the default baseline GWPs for new Large Commercial Refrigeration systems and Remote Condensing Units, by jurisdiction, for vintage years through 2025.

Table 8: Baseline GWPs for New and Replacement Large Commercial Refrigeration Systems and Remote Condensing Units by Jurisdiction (through 2025)

APPLICATION	U.S. STATE(S)/ COUNTRIES	BASELINE GWP	
		2021	2022-2025
Large Commercial Refrigeration and Remote Condensing Units	California, Colorado, Delaware, Maryland, Massachusetts, New Jersey, New York, Vermont, Washington	1,923 (G)	1,688 (retail food refrigeration, J) 1,507 (cold storage warehouses, K) 1,794 (Remote Condensing Units, L)
	Maine, Rhode Island, Virginia	2,934 (H)	
	All other U.S. states and territories	2,934	1,912 (retail food refrigeration, M) 1,640 (cold storage warehouses, N) 1,794 (Remote Condensing Units, O)
	Canada	2,200 (I)	2,200
	Mexico	2,934	3,952 (Large Commercial Refrigeration, P) 3,416 (Remote Condensing Units, Q)

The following refrigerants[25] and market penetrations[26] (U.S. EPA, 2024a for U.S.; ODSHAR, 2016 for Canada; and Gobierno de Mexico, 2022 and SEMARNAT, 2019 for Mexico) were used to calculate baseline GWPs for new and replacement Large Commercial Refrigeration and Remote Condensing Unit applications:

[25] For refrigerant blends, the GWP and the percentage of each gas were used to calculate the refrigerant blend GWPs, which are rounded to the nearest number.
[26] Where U.S. EPA Inventory market penetrations added up to >100%, each market penetration was normalized to 100%.

(G) R-407A

(H) R-407A (50%) and R-404A (50%)

(I) GWP limit for centralized refrigeration systems that are generally used for storing and displaying food, beverages, and other perishables in convenience stores and supermarkets, using HFCs as refrigerants (ODSHAR, 2016)

(J) R-407F (94.29%) and R-407A (5.71%) (U.S. EPA, 2024a). R-404A is prohibited in states with SNAP regulations, and the market share of R-404A in the U.S. EPA Inventory for all states is 10%, so that market share is added to the market share of the SNAP-acceptable refrigerant (R-407F) with the lowest GWP (for conservativeness).

(K) R-407F (90%) and R-717 (10%) (U.S. EPA, 2024a). R-507 is prohibited in states with SNAP regulations, and the market share of R-507 in the U.S. EPA Inventory for all states is 3.33%, so that market share is added to the market share of the SNAP-acceptable refrigerant (R-717) with the lowest GWP (for conservativeness).

(L) R-407A (79.21%) and R-134a (20.79%) (U.S. EPA, 2024a)

(M) R-407F (84.43%), R-404A (9.85%), and R-407A (5.71%) (U.S. EPA, 2024a)

(N) R-407F (90%), R-717 (6.67%), and R-507 (3.33%) (U.S. EPA, 2024a)

(O) R-407A (79.21%) and R-134a (20.79%) (U.S. EPA, 2024a)

(P) R-404A (83%) and R-507A (17%). The use of each of these refrigerants is confirmed through Gobierno de Mexico (2022) and SEMARNAT (2019). Market penetrations are calculated as the remainder when the percentages of R-404A and R-507A in Stand-Alone Commercial Refrigeration and Remote Condensing Unit applications are subtracted from the percentage of each refrigerant's use in the three sub-applications in Mexico's commercial refrigeration sector[27] (see section 3.2, page 31 in SEMARNAT, 2019).

(Q) R-134a (20%) and R-404A (80%). The use of each of these refrigerants is confirmed through Gobierno de Mexico (2022) and SEMARNAT (2019), and the market penetrations are assumed to be essentially the same (but rounded) as those noted in O (above) for the U.S.

U.S. EPA finalized a rule (U.S. EPA, 2023b) on October 5, 2023 to restrict use of certain HFC refrigerants. This rule phases in GWP limits for refrigerants that can be used in new refrigeration equipment

[27] "The R-404A is the most consumed substance in commercial refrigeration (with 80%), followed by the R-507A (13%) and HFC-134a (4%)" (SEMARNAT, 2019). For a conservative accounting of the 3% remaining, we assign that 3% to HFC-134a (R-134a). In other words, the percentages of each refrigerant used in commercial refrigeration are calculated/estimated as 80% R-404A, 13% R-507A, and 7% R-134a.

starting January 1, 2025 and is applicable to refrigerant systems eligible under this Methodology starting January 1, 2026.

Tables 9 and 10 provide baseline GWP limits and compliance dates for these restrictions applicable for new refrigeration systems and equipment manufactured in or imported into the U.S. in 2026 and beyond. The U.S. EPA rule also establishes GWP limits on equipment sold, distributed, and exported that take effect three-years after the dates applicable to manufacturing and import limits.

Table 9 provides the default baseline GWPs for U.S. new Stand-Alone Commercial refrigeration equipment (food processing and dispensing), by charge size or equipment type, for vintage years 2026 and beyond.

Table 9: Baseline GWPs for U.S. New Stand-Alone Commercial Refrigeration Equipment by Charge Size or Equipment Type (2026 and Beyond)

REFRIGERANT CHARGE SIZE (G) AND/OR EQUIPMENT TYPE	U.S. STATE	BASELINE GWP		
		2026	2027	2028
≤500 g Refrigerant	States with SNAP regulations[28]	1,278	150	150
	All other U.S. states and territories	1,294		
>500 g Refrigerant	States with SNAP regulations	1,278	R-448A (1,273) or R-449A (1,282)	R-448A (1,273) or R-449A (1,282)
	All other U.S. states and territories	1,294		
Ice Cream Makers within the Scope of UL 621, Edition 7[29]	States with SNAP regulations	1,278	1,278	R-448A (1,273) or R-449A (1,282)
	All other U.S. states and territories	1,294	1,294	

[28] California, Colorado, Delaware, Maine, Maryland, Massachusetts, New Jersey, New York, Rhode Island, Vermont, Virginia, Washington
[29] (Underwriter Laboratories, 2010)

Table 10 provides the default baseline GWPs for U.S. new and replacement Large Commercial Refrigeration systems and Remote Condensing Units, by charge size or part of system, for vintage years 2026 and beyond. These limits and effective dates apply to manufacturing and importing equipment.

Table 10: Baseline GWPs for U.S. New and Replacement Large Commercial Refrigeration Systems and Remote Condensing Units by Charge Size or Part of System (2026 and Beyond)

APPLICATION	SUB-APPLICATION	REFRIGERANT CHARGE SIZE (KG) AND/OR PART OF SYSTEM	U.S. STATE	BASELINE GWP	
				2026	2027 AND BEYOND
Large Commercial Refrigeration	Retail food refrigeration	≥90.7 kg, excluding higher-temperature side of cascade system	States with SNAP regulations[30]	1,688	150
			All other U.S. states and territories	1,912	
		<90.7 kg, or higher-temperature side of cascade systems	States with SNAP regulations	1,688	300
			All other U.S. states and territories	1,912	
	Cold storage warehouses	≥90.7 kg, excluding higher-temperature side of cascade system	All U.S. states and territories	150	150
		<90.7 kg, or higher-temperature side of cascade system	All U.S. states and territories	300	300

[30] California, Colorado, Delaware, Maine, Maryland, Massachusetts, New Jersey, New York, Rhode Island, Vermont, Virginia, Washington

Remote Condensing Units	n/a	≥90.7 kg, excluding higher-temperature side of cascade system	All U.S. states and territories	150	150
		<90.7 kg, or higher-temperature side of cascade systems	All U.S. states and territories	300	300

The GWP limits from 2026 and beyond for Canada and Mexico remain unchanged from 2025 as shown in Table 11.

Table 11: Baseline GWPs for Canada and Mexico by Application (2026 and Beyond)

APPLICATION	BASELINE GWP (2026 AND BEYOND)	
	CANADA	MEXICO
Large Commercial Refrigeration	2,200	3,952
Remote Condensing Units	2,200	3,416
Stand-Alone Commercial Refrigeration	1,425	1,962

6 Quantification of GHG Emissions Reductions and Removals

The following sections and equations are used to quantify baseline GHG emissions, with-project GHG emissions and GHG emissions reductions and removals.

6.1 Baseline GHG Emissions

Project Proponents that install new or additional advanced refrigeration systems at an existing facility or in new construction, completely replace an existing refrigeration system with an advanced refrigeration system at an existing facility, and those that manufacture and sell new Stand-Alone Commercial Refrigeration equipment shall use the default charge rates, annual emission rates, and GWP values listed in Tables 5 through 11. Project Proponents that retrofit existing equipment shall use historical, system-specific data as described in Section 7.1.

The following equation is used to calculate baseline GHG emissions.

Equation 1: Baseline GHG Emissions

$$\mathbf{BE} = \sum_{i}[(\mathbf{QBR}_{j,i} \div \mathbf{1000}) \times \mathbf{AER}_{j,i} \times \mathbf{GWP}_{j,i}] \times \mathbf{10}$$

WHERE

BE	Baseline emissions over the Crediting Period (MT CO_2e)
$QBR_{j,i}$	Quantity of refrigerant *j* (i.e., charge size of equipment) used in baseline system *i* from Table 5 or historical records (kg)
1,000	Conversion of kg to MT
$AER_{j,i}$	Annual amortized emission rate of refrigerant *j* used in baseline system *i* from Table 6 or historical records (%)

$GWP_{j,i}$	GWP of baseline refrigerant *j used* in baseline system *i* from Tables 7 through 11 or historical records
10	Number of years in the Crediting Period

6.2 With-Project GHG Emissions

The following equation is used to calculate with-project GHG emissions.

Equation 2: With-Project GHG Emissions

$$\mathbf{PE} = \sum_{i} [(\mathbf{QAR}_{k,i} \div \mathbf{1000}) \times \mathbf{AER}_{k,i} \times \mathbf{GWP}_{k,i}] \times \mathbf{10}$$

WHERE

PE	Project emissions over the Crediting Period (MT CO_2e)
$QAR_{k,i}$	Quantity of alternative refrigerant *k* (i.e., charge size of equipment) used in project system *i* (kg)
1,000	Conversion of kg to MT
$AER_{k,i}$	Annual amortized emission rate of alternative refrigerant *k,* used in the project system *i* set equal to emission rate for baseline system (%)[31]
$GWP_{k,i}$	GWP of alternative refrigerant *k* used in the project system *i*
10	Number of years in the Crediting Period

[31] For secondary loop systems, the parameter $AER_{k,i}$ should be 16% for the primary refrigerant and, for the heat transfer medium, equal to the emission rate for the baseline system. PE must be calculated separately for the primary refrigerant and heat transfer medium and added together for a summed PE. The 16% annual amortized emission rate is calculated using almost all the same inputs (i.e., lifetime, market penetrations, first-fill and disposal emission rates) as those used for Large Commercial Refrigeration – retail food refrigeration *except* for annual service and other leaks, which is 15% per ICF (2020) and SCE & Foster-Miller, Inc. (2004).

6.3 GHG Emissions Reductions and Removals

The following equation is used to calculate the GHG emissions reductions achieved by the project.

Equation 3: GHG Emissions Reductions

$$ER = BE - PE$$

WHERE

ER	Emissions reductions over the Crediting Period (MT CO_2e)
BE	Baseline emissions over the Crediting Period (MT CO_2e)
PE	Project emissions over the Crediting Period (MT CO_2e)

6.4 Leakage

By installing an advanced refrigeration system in place of a standard system, a project is not changing overall market demand for refrigeration systems or refrigerants. Thus, there would be no market leakage associated with this project type. Regarding activity-shifting leakage, implementation of a project at an existing facility may result in the recovery of refrigerant used in the system that was replaced or retrofitted. However, disposal emissions are accounted for in the annualized emission rates and, per eligibility conditions in Chapter 2, refrigerant in the original equipment must be recovered and managed in accordance with relevant rules and regulations. Thus, there is no leakage effect for this Methodology.

7 Monitoring and Data Collection

Each GHG Project shall include in its GHG Project Plan details on the project's monitoring, quality assurance/quality control (QA/QC), reporting, and verification procedures sufficient to meet the requirements of the *ACR Standard*. The project shall collect all data required to be monitored and do so in a manner which meets the requirements for accuracy and precision of this Methodology and/or the *ACR Standard*. Information must be collected and made available for verification.

Data collection and monitoring includes documentation of the following:

- Identification of the equipment/systems installed and/or sold, including application and description aligning with Table 1.
- Equipment or system details, including:
  - Equipment manufacture and sale dates or installation date and date the system was fully operational;
  - Equipment manufacture and sale locations and installation locations, as applicable;
  - Btu/hr or ton of refrigeration as needed for the third column of Table 5;
  - Equipment type and/or part of system as needed for the first column of Table 9 and third column of Table 10; and
  - Refrigerant charge size, refrigerant type, and other installation/charge technical specifications for the refrigeration equipment or system.
- Parameters monitored for quantification (see Section 7.1).
- For projects in which existing refrigeration equipment is decommissioned or retrofitted, documentation showing proof of recovery and management of the displaced refrigerant. This documentation shall include the following:
  - Job order or other technical report submitted by the certified technician that recovered the refrigerant in accordance with relevant rules and regulations (see Chapter 2); and
  - Job order or other technical report submitted by the certified technician should include equipment name and type (per Methodology application and sub-applications), equipment model number, equipment refrigerant full charge size, refrigerant name, amount of refrigerant recovered, date of recovery, and what was done with the recovered refrigerant (e.g., stored at same location, transferred to a different location for same owner, sent/sold for reclamation to a certified reclaimer, or sent/sold for destruction).

7.1 Parameters Monitored

ACRONYM	UNIT	PARAMETER	POTENTIAL EVIDENCE/SOURCE	FREQUENCY OF MONITORING
$QBR_{j,i}$	kg	Quantity of refrigerant *j* (i.e., charge size of equipment) used in baseline system *i*	Project Proponents that install new or additional advanced refrigeration systems at an existing facility or in new construction or completely replace an existing refrigeration system with an advanced refrigeration system at an existing facility, shall use the default value from Table 5. Project Proponents that retrofit existing refrigeration systems shall use information from installer specifications of existing system or service technician reports.	Once during Reporting Period
$AER_{j,i}$	%	Annual amortized emission rate of refrigerant *j used* in baseline system *i*	Project Proponents that install new or additional advanced refrigeration systems at an existing facility or in new construction or completely replace an existing refrigeration system with an advanced refrigeration system at an existing facility shall use the default value from Table 6. Project Proponents that retrofit an existing refrigeration system shall use the average leak rate based on the previous five years of operation[32] of the retrofitted baseline system prior to project implementation. The quantity of all refrigerant recharged over the five previous years is determined and divided by the product of 5 and the full charge size to calculate the annual leak rate. This historical data can be	Once during Reporting Period

[32] "The previous five years" shall start five years before the date the Site is fully operational and end on the day before the date the Site is fully operational. In other words, if the advanced refrigeration system at a Site becomes fully operational on September 3, 2024, the period over which the average leak rate is calculated is September 3, 2019 through September 2, 2024.

ACRONYM	UNIT	PARAMETER	POTENTIAL EVIDENCE/SOURCE	FREQUENCY OF MONITORING
			sourced from refrigerant recharge records as recorded by technicians in databases or job orders or other verifiable operating documentation.	
$GWP_{j,i}$	unitless	GWP of baseline refrigerant *j* used in baseline system *i*	Project Proponents that install new or additional advanced refrigeration systems at an existing facility or in new construction or completely replace an existing refrigeration system with an advanced refrigeration system at an existing facility shall use the default value from Tables 7 through 11. Project Proponents that retrofit an existing refrigeration system shall determine the GWP value based on the refrigerant historically used, sourced from regulatory compliance reporting and/or other verifiable operating documentation, and associated GWPs, sourced according to the *ACR Standard*.	Once during Reporting Period
$QAR_{k,i}$	kg	Quantity of alternative refrigerants[33] *k* (i.e., charge size of equipment) used in project system *i*	Manufacture specifications for stand-alone equipment and installer specifications for other refrigeration systems.	Once during Reporting Period
$AER_{k,i}$	%	Annual amortized emission rate of alternative refrigerant[34] *k* used in project system *i*	Set equal to $AER_{j,i}$.	Once during Reporting Period

[33] In the case of secondary loop systems, quantity of the heat transfer medium as well as the primary refrigerant.
[34] And, in the case of secondary loop systems, annual amortized emission rate equal to the emission rate for the baseline system for the heat transfer medium, and equal to 16% for the primary refrigerant.

ACRONYM	UNIT	PARAMETER	POTENTIAL EVIDENCE/SOURCE	FREQUENCY OF MONITORING
$GWP_{k,i}$	unitless	GWP of alternative refrigerant[35] *k* used in project system *i*	Project Proponents shall determine the GWP value based on the refrigerant used in the project system, per manufacture specifications for stand-alone equipment and installer specifications for other refrigeration systems and associated GWPs, sourced according to the *ACR Standard*.	Once during Reporting Period

[35] And, in the case of secondary loop systems, GWP of the heat transfer medium as well as the primary refrigerant.

8 Validation and Verification

Prior to ERT issuance, projects must be validated and verified by an ACR-approved Validation and Verification Body (VVB) in accordance with the *ACR Standard* and the *ACR Validation and Verification Standard*.

Projects must be validated and verified within the timelines established by the *ACR Standard*.

For Project Proponents with multiple projects at the same facility ("Site"), an in-person site visit by a VVB is required to be conducted, at minimum, every five project Reporting Periods or five years, whichever is earlier. For projects with a Site not previously validated, an in-person site visit by the VVB is required during project verification.

For projects that aggregate multiple Sites, VVBs shall select and conduct in-person site visits as required by the *ACR Standard* for aggregated projects.

In addition to the scope set out by the *ACR Standard* and the *ACR Validation and Verification Standard,* validations and verifications shall assess the following for conformance to the Methodology:

- Eligibility requirements;
- Regulatory surplus test and performance standard;
- Project physical boundary;
- Project temporal boundary;
- GHG assessment boundary;
- Calculations of baseline emissions, with-project emissions, and emissions reductions;
- Original underlying data and documentation as relevant and required to evaluate the GHG assertion;
- Data management systems and QA/QC procedures; and
- Roles and responsibilities of participating entities (e.g., Project Proponent, facility owner).

The Project Proponent must provide sufficient documentation and data to enable required validation and verification activities.

9 Periodic Reviews

ACR may require revisions to this Methodology to ensure that monitoring, reporting, and verification systems adequately reflect changes in advanced refrigeration system activities. This Methodology may also be periodically updated to reflect regulatory changes, emission factor revisions, or eligibility criteria. Before beginning a project, the Project Proponent shall ensure that they are using the latest version of the Methodology.

10 Definitions

If not otherwise defined here, the current definitions in the latest version of the *ACR Standard* apply.

Ammonia	A pungent, colorless gas consisting of one nitrogen atom and three hydrogen atoms. Ammonia can be used as a low-GWP refrigerant.
Advanced refrigeration system	A refrigeration system deploying advanced technology that uses low-GWP, SNAP-acceptable refrigerants.
Appliance	Any device which contains and uses a refrigerant, and which is used for household or commercial purposes, including any refrigerator, chiller, or freezer.
Blast chiller	Commercial refrigeration equipment, other than a blast freezer, that is capable of the rapid temperature pull-down of hot food products from 135 °F to 40 °F within a period of four hours (U.S. DOE, 2005).
Blast freezer	Commercial refrigeration equipment that is capable of the rapid temperature pull-down of hot food products from 135 °F to 40 °F within a period of four hours and capable of achieving a final product temperature of less than 32 °F (U.S. DOE, 2005).
Carbon dioxide	A chemical compound composed of one carbon atom and two oxygen atoms. Carbon dioxide can be used as a low-GWP refrigerant.
Cascade refrigeration system	Similar to a secondary refrigeration system, a cascade system 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.
Chlorofluorocarbon	A class of compounds of chlorine, fluorine, and carbon that are commonly used as refrigerants.
Cold storage warehouses	Facilities that use commercial refrigeration equipment to store meat, produce, dairy products, and other perishable goods. Such facilities do *not* sell food, beverages, or other perishable goods directly to consumers. This is a sub-application of the Large Commercial Refrigeration application.

Commercial freezer	A unit of commercial refrigeration equipment in which all refrigerated compartments in the unit are capable of operating below 32±2 °F (U.S. DOE, 2005).
Commercial refrigerator	A unit of commercial refrigeration equipment in which all refrigerated compartments in the unit are capable of operating at or above 32±2 °F (U.S. DOE, 2005).
Deli case refrigerator	Commercial refrigerator used for refrigerating and displaying deli products such as meats, cheeses, and prepared foods.
Door angle	Door angle means, for equipment with flat doors, the angle between a vertical line and the line formed by the plane of the door, when the equipment is viewed in cross-section. For equipment with curved doors, it means the angle formed between a vertical line and the and the straight line drawn by connecting the top and bottom points where the display area glass joins the cabinet, when the equipment is viewed in cross-section.
End-of-life	Referring to the period in which refrigeration equipment and products and refrigerant are disposed of.
End-of-life emissions	Emissions resulting from the disposal of refrigeration equipment and systems and any unrecovered refrigerant.
End-use *or* End-use category	Processes or classes of specific applications within major industrial sectors where a substitute is used to replace an ozone-depleting substance. The specific definition varies by sector, but examples are motor vehicle air conditioning, electronics cleaning, flooding fire extinguishing systems, and polyurethane integral skin foam. In order of increasing specificity, a particular system is part of an industrial use sector, an end-use, and an application. (U.S. EPA, 2008)
Food prep table	Commercial refrigerator with an open-top refrigerated area, that may or may not include a lid, for displaying or storing merchandise and other perishable materials in pans or other removable containers for customer self-service or food production and assembly. The unit may or may not be equipped with a refrigerated storage compartment underneath the pans or other removable containers that is not thermally separated from the open-top refrigerated area. (U.S. DOE, 2005)

Fully operational	With respect to the Start Date, for new Sites, this means the date on which the advanced refrigeration system has fully charged all racks and the Site is officially open, as evidenced by documentation like a press release for a grand opening or a certificate of occupancy. For existing Sites that are completely replacing or retrofitting their refrigeration with an advanced refrigeration system, or that are adding additional refrigeration that is an advanced refrigeration system, this means the date on which the system has fully charged all racks and the Site has started storing or preparing food or other perishable items in the refrigerated units or areas.
GHG source, sink, or reservoir	GHG source – Physical unit or process that releases a GHG into the atmosphere. GHG sink – Physical unit or process that removes a GHG from the atmosphere. GHG reservoir - Physical unit or component of the biosphere, geosphere, or hydrosphere with the capability to store, accumulate, or release a GHG removed from the atmosphere by a GHG sink or captured from a GHG source.
Higher-temperature side of cascade system	The primary side of the cascade refrigeration system that transfers heat to a conventional condenser that carries the entire heat output of the system and may be passive, fan, or water-cooled.
Horizontal open freezer	Commercial freezers without doors and an air-curtain angle greater than or equal to 80° from the vertical (U.S. DOE, 2005).
Horizontal open refrigerator	Commercial refrigerators without doors and an air-curtain angle greater than or equal to 80° from the vertical (U.S. DOE, 2005).
Hydrocarbon	A class of compounds containing only hydrogen and carbon (e.g., propane, isobutene, propylene). Certain hydrocarbons can be used as low-GWP refrigerants.
Hydrochlorofluorocarbon	A class of compounds of hydrogen, chlorine, fluorine, and carbon that are commonly used as refrigerants.

Hydrofluorocarbon	A class of compounds that contain hydrogen, fluorine, and carbon that are commonly used as refrigerants, solvents, aerosol propellants, and foam blowing agents.
Hydrofluoroolefins	A class of compounds composed of hydrogen, fluorine, and carbon. This class of compounds can be used as low-GWP refrigerants. Some hydrofluoroolefins (HFO) refrigerants are comprised of a mix of HFOs, referred to as an "HFO blend."
HFC refrigerant	Refrigerant comprised of either a mix of hydrofluorocarbons (HFCs), referred to as an "HFC blend", or a single HFC.
Large Commercial Refrigeration	Equipment used to store and/or display chilled and frozen goods for commercial sale such as in food retailers, supermarkets, convenience stores, cold storage warehouses, bakeries, and restaurants. For the purposes of this Methodology, this includes commercial refrigeration units with an initial charge of 50 lbs. (22.7 kg) or more of refrigerant. This application includes the sub-applications of retail food refrigeration and cold storage warehouses.
Low-GWP	For the purposes of this Methodology, any SNAP-acceptable substitute refrigerant with a GWP <15 and zero (0) ozone-depletion potential (ODP) is considered low-GWP for new, additional, and complete replacement projects. However, for retrofit projects, any SNAP-acceptable substitute refrigerant (U.S. EPA, 2024c) with 0 ODP and GWP less than 1300 is considered low-GWP.
Medium-temperature unit	Stand-Alone Commercial Refrigeration Equipment that maintains refrigerated products at temperatures above 32°F (0°C) (U.S. EPA, 2021).
Ozone-depletion potential	The amount of degradation a chemical can cause to the stratospheric ozone layer relative to the degradation that the same amount of CFC-11 (trichlorofluoromethane) can cause. The ODP of CFC-11 is 1.0.
Project activity	Projects that avoid the emissions of CFC, HCFC, HFC, or other high-GWP gases and blends through the deployment of an advanced refrigeration system using a SNAP-acceptable, low-GWP refrigerant in Large Commercial Refrigeration, Remote Condensing Unit or Stand-Alone Commercial Refrigeration systems. See Chapter 2 Eligibility Conditions.

Refrigerated food processing and dispensing	Refrigerated food processing and dispensing equipment dispenses and often processes a variety of food and beverage products. All refrigeration components are integrated in this equipment, and for the smallest equipment types, the refrigeration circuit is entirely brazed or welded. These systems are fully charged with refrigerant at the factory and typically require only an electricity supply to begin operation. This sub-application of the Stand-Alone Commercial Refrigeration application includes, but is not limited to, equipment that process and/or dispense chilled and frozen beverages (carbonated and uncarbonated, alcoholic and nonalcoholic), frozen custard, gelato, ice cream, Italian ice, sorbet, frozen yogurt, milkshakes, "slushies," smoothies, and whipped cream.
Refrigeration equipment	An appliance, or component parts of a system, that use(s) refrigerant to provide cooling under controlled conditions.
Remote Condensing Unit	Remote Condensing Units are composed of compressors, condensers, and receivers assembled into a single unit. The condenser (and often other parts of the system) is located outside the space or area cooled by the evaporator, typically ejecting heat to the outdoor ambient environment. Remote Condensing Units are commonly installed in convenience stores, specialty shops (e.g., bakeries, butcher shops), supermarkets, restaurants, and other locations where food is served or sold. Only Remote Condensing Units at retail food refrigeration facilities are eligible for crediting under this Methodology. They typically have refrigerating capacities from 1 to 20 kW (0.3 to 5.7 ton of refrigeration).
Retail food refrigeration	Retail food refrigeration includes equipment designed to store and display chilled or frozen goods for retail sale. (U.S. EPA, 2024c) This is a sub-application of the Large Commercial Refrigeration application. This equipment category includes multiplex or centralized systems which operate with racks of compressors installed in a machinery room. Two main design classifications are used: direct and indirect systems. In these systems, the refrigerant circulates from the machinery room to the sales area, where it evaporates in display-case heat exchangers, and then returns in vapor phase to the suction headers of the compressor racks. Another direct design, often referred to as a distributed refrigeration system, uses an array of separate compressor racks located

	near the display cases rather than having a central compressor rack system. Indirect retail food refrigeration systems include secondary loop systems and cascade refrigeration. Indirect systems use a "chiller" (not to be confused with the "chiller" end-use) or other refrigeration system to cool a secondary fluid that is then circulated throughout the store to the cases.
Retrofit *or* Retrofit project	A project that includes the conversion of an existing refrigeration system to achieve system compatibility and that may include changes in lubricants, gaskets, filters, driers, valves, o-rings, or equipment components for that purpose. The following actions disqualify a project as a retrofit: i. Assembling a system for the first time from used or new components; ii. Increasing the cooling capacity, in Btu/hr., of an existing system; or iii. Replacing 75 percent or more of evaporators (by number) and 100 percent of the compressor racks, condensers, and connected evaporator loads of an existing system. For retrofit projects, any SNAP-acceptable substitute refrigerant (U.S. EPA, 2024c) with 0 ozone-depleting potential and GWP less than 1300 is considered low-GWP.
Secondary loop refrigeration system	An advanced refrigeration system where a heat transfer medium (e.g., glycol) is used in conjunction with a primary refrigerant.
Significant New Alternative Policy	U.S. EPA's SNAP program implements section 612 of the amended Clean Air Act of 1990, which requires U.S. EPA to continuously review alternatives to find those that pose less overall risk to human health and the environment. Through these evaluations, SNAP generates lists of acceptable and unacceptable substitutes for each of the major industrial use sectors. The intended effect of the SNAP program is to promote a smooth transition to safer alternatives.
Small retail food	Refrigerators, freezers, reach-in coolers (open or with doors) where all refrigeration components are integrated and, for the smallest types, the refrigeration circuit is entirely brazed or welded. These systems are fully charged with refrigerant at the factory and typically require only an

	electricity supply to begin operation. This is a sub-application of the Stand-Alone Commercial Refrigeration application.
Stand-Alone Commercial Refrigeration	Refrigerators, freezers, reach-in coolers (open or with doors), and refrigerated food processing and dispensing equipment where all refrigeration components are integrated and, for the smallest types, the refrigeration circuit is entirely brazed or welded. These systems are fully charged with refrigerant at the factory and typically require only an electricity supply to begin operation. For projects located in the U.S., only the sub-application refrigerated food processing and dispensing is eligible under this Methodology. For projects located in Canada and Mexico, all Stand-Alone Commercial Refrigeration equipment (including the sub-applications of refrigerated food processing and dispensing and small retail food) is eligible under this Methodology.
Ton of refrigeration	A unit of power used to describe the heat extraction capacity of a refrigeration equipment and is equal to 12,000 Btu/hr.
Vertical closed freezer	Commercial freezer with hinged or sliding doors and a door angle less than 45° (U.S. DOE, 2005).
Vertical closed refrigerator	Commercial refrigerator with hinged or sliding doors and a door angle less than 45° (U.S. DOE, 2005).
Vertical open refrigerator	Commercial refrigerators without doors and an air-curtain angle greater than or equal to 0° and less than 10° from the vertical (U.S. DOE, 2005).

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