



**ENERGY AND ATMOSPHERE - GREEN
BUILDING TECHNOLOGY TRAINING PROGRAM
FOR ENERGY AND GREEN BUILDING SPECIALISTS**

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ENERGY SPECIALIST CURRICULUM





**FUNDAMENTAL REFRIGERANT
MANAGEMENT - CREDIT**

FOR ENERGY AND GREEN BUILDING PROFESSIONALS

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LEARNING OBJECTIVES

- Intent of Enhanced Refrigerant Management
- Behind the intent
- Step by Step Guidance
- Requirements
- Required Documentation
- Referenced Standards
- Connection to Ongoing Building Performance
- Terms and definitions



EA- CR(1) - DESIGN

INTENT

To eliminate ozone depletion and global warming potential, and support early compliance with the Montreal Protocol, including the Kigali Amendment, while minimizing direct contributions to climate change.

POTENTIAL TECHNOLOGIES & STRATEGIES

This credit addresses the two main threats to the environment posed by refrigerants: their ozone depletion potential (ODP) and global warming potential (GWP). As is well known, chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and other ozone-depleting substances commonly used in refrigerants contribute to the depletion of the stratospheric ozone layer. Yet refrigerants released into the atmosphere also contribute to global climate change, having a disproportionately large effect compared with other greenhouse gases. For example, HCFC-22 contributes to warming at 1,780 times the potency of an equal amount of carbon dioxide.

ENHANCED REFRIGERANT MANAGEMENT

REQUIREMENTS

Do not use refrigerants, or use only refrigerants (naturally occurring or synthetic) that have an ozone depletion potential (ODP) of zero and a global warming potential (GWP) of less than 50.

IMPLEMENTATION

Documentation	Option 1	Option 2
Confirmation that only no or low-impact refrigerants are used	X	
Equipment type		X
Refrigerant charge calculations (for VRF systems only)		X
Equipment control capacity		X
Provide refrigerant equipment schedule or GreenCheck certification (commercial refrigeration systems)		X
Equipment identity		X
Refrigerant type		X
Refrigerant charge (data supporting documentation, if applicable)		X
Equipment EIR (data supporting documentation, if applicable)		X
Load test results (commercial refrigeration systems only)		X

BEHIND THE INTENT

This credit addresses the two main threats to the environment posed by refrigerants: their ozone depletion potential (ODP) and global warming potential (GWP). As is well known, chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and other ozone-depleting substances commonly used in refrigerants contribute to the depletion of the stratospheric ozone layer. Yet refrigerants released into the atmosphere also contribute to global climate change, having a disproportionately large effect compared with other greenhouse gases. For example, HCFC-22 contributes to warming at 1,780 times the potency of an equal amount of carbon dioxide.

However, trade-offs also exist between the above concerns and energy use. Alternatives to CFC and HCFC refrigerants, such as HFC-410A, have a lower GWP when directly released, but their use may require more energy—which also affects climate. Conversely, variable refrigerant flow (VRF) systems may improve energy efficiency but have a higher refrigerant charge.

Careful consideration of the refrigerant requirements of energy systems and appliances can improve performance and reduce operating cost. Refrigerants vary in operating pressure, material compatibility, flammability, and toxicity. Operating pressure and material compatibility are particularly critical factors to take into account when refrigerants in existing equipment are replaced.

The refrigerant impact calculation addresses the overall effect of each refrigerant's ODP and GWP combined by accounting for these interrelated factors.

BEHIND THE INTENT +

While the Montreal Protocol provided for the phase-out of CFC and HCFC refrigerants due to their ozone depletion potential, it led the industry shift toward the usage of hydrofluorocarbons (HFCs), which are potent greenhouse gases. In the Kigali Amendment to the Montreal Protocol, adopted in 2016, 197 countries committed to cut the production and consumption of HFCs by more than 80 percent over the next 30 years.

Alternatives to HFCs have been developed to provide lower-GWP refrigerant options, although the availability of low-GWP refrigerants varies between applications. The transition to lower-GWP refrigerant options requires an increased focus on safety, as many "next generation" refrigerants can pose flammability and/or toxicity risks if not properly managed.

BEHIND THE INTENT +

ASHRAE Standard 15-2019: Safety Standard for Refrigeration Systems provides essential guidance to manufacturers, design engineers and operators who need to stay current with new air conditioning and refrigerating requirements. The selection of refrigerants and their operating systems should be based on a holistic analysis of multiple criteria, including safety, environmental impacts, energy efficiency and cost.

In addition to protecting human health, effective refrigerant management during processes of design, manufacturing, operation, systems servicing, and end of life helps to reduce global emissions.

The majority of refrigerant emissions happen at end of life, so the effective disposal of refrigerants currently in circulation (including CFCs, HCFCs and HFCs) is essential. A robust refrigerant management plan provides a framework for building owners and operators to properly manage these chemicals and minimize direct contributions to climate change.



STEP-BY-STEP GUIDANCE

STEP 1. GATHER INFORMATION ON SYSTEMS AND REFRIGERANTS IN PROJECT

Identify all HVAC/R equipment that contains refrigerants and record the refrigerant charge and type for existing and new units. Project teams may incorporate the credit requirements and equations into project specifications if needed. Projects that retain CFCs past initial occupancy even if using a phase-out plan to meet the requirements of EA Prerequisite Fundamental Refrigerant Management, are ineligible for this credit.

- Small systems with less than 0.5 pound (225 grams) of refrigerants, such as individual water fountains or stand-alone refrigerators, do not need to be included in credit calculations.
- Unit charge information is often not available for new equipment until contractor submittals are provided (particularly for split systems) because the charge depends on the length of refrigerant piping runs.
- If a district energy system (DES) serves the project, data for the refrigerant-using equipment in the DES must be collected.

STEP 2. SELECT ONE OPTION

Choose the appropriate option for the project.

- Option 1 is for projects that have no refrigerants and projects with refrigerants that have an ODP of zero and a GWP of less than 50 (see Further Explanation, Designing for No Refrigerants or Low-Impact Refrigerant Use). These projects achieve the credit; no additional steps are required. ➔
- Option 2 is for projects whose refrigerants exceed the Option 1 limit.

Option 2. Refrigerant Impact Calculation

STEP 1. CALCULATE REFRIGERANT IMPACT OF PROPOSED SYSTEMS

To determine the environmental effects of HVAC/R systems containing refrigerants, apply the following assumptions. Assume the ODP and GWP values listed in Table 1.



STEP-BY-STEP GUIDANCE

Table 1. Ozone depletion and global warming potential of common refrigerants			
Refrigerant	ODP	GWP	Common building applications
Chlorofluorocarbons			
CFC-11	1.0	4,880	Centrifugal chiller
CFC-12	1.0	10,900	Refrigerant, chiller
CFC-114	0.95	10,900	Centrifugal chiller
CFC-202	0.055	2,800	Centrifugal chiller, heat exchanger
CFC-113	0.22	4,880	Low-temperature refrigeration
Hydrochlorofluorocarbons			
HCFC-22	0.055	1,800	Air conditioning, chiller
HCFC-123	0.02	76	CFC-11 replacement
Hydrofluorocarbons			
HFC-134a	0	1,320	Ultra-low-temperature refrigeration
HFC-404a	0	1,320	CFC-12 or HCFC-22 replacement
HFC-407A	0	1,320	Insulation agent, centrifugal chiller
HFC-408A	0	1,320	Low-temperature refrigeration
HFC-409A	0	1,320	HCFC-12 replacement
HFC-450A	0	1,320	Air conditioning
HFC-507A	0	1,320	Low-temperature refrigeration
Natural refrigerants			
Carbon dioxide (CO ₂)	0	10	
Ammonia (NH ₃)	0	0	
Propane	0	3	

Assume equipment life according to Table 2. For any HVAC/R equipment not listed, assume an equipment life of 10 years. Different values for equipment life may be substituted, with manufacturer documentation.

For existing equipment, apply the default equipment life according to Table 2. The equation is based on refrigerant impact assessed over the life of the equipment; estimated remaining equipment life should not be substituted because it would provide inaccurate results.



STEP-BY-STEP GUIDANCE

Assume equipment life according to Table 2. For any HVAC&R equipment not listed, assume an equipment life of 10 years. Different values for equipment life may be substituted, with manufacturers' documentation.

For existing equipment, apply the default equipment life according to Table 2. The equation is based on refrigerant impact spread over the life of the equipment; estimated remaining equipment life should not be substituted because it would provide inaccurate results.

Equipment	Default equipment life
Window air conditioner, heat pump	10 years
Unitary, split, packaged air conditioner, package heat pump	15 years
Reciprocating and scroll compressor, reciprocating chiller	20 years
Absorber chiller	25 years
Water-cooled packaged air conditioner	24 years
Centrifugal chiller	25 years

Assume that refrigerant leakage rate (Lr) is 2% per year and end-of-life refrigerant loss (Mr) is 10% for all equipment types; no alternative values may be substituted for these percentages (See Further Explanation, Examples).

Refrigerant charge (Rc) is the ratio of the total refrigerant used in a piece of equipment to the total cooling capacity of that equipment, expressed in pounds per ton or kilograms per kW. For example, if a packaged air-conditioning unit uses 7 pounds of refrigerant and its cooling capacity is 5 tons, the refrigerant charge is 1.4.

STEP 2. INCORPORATE DESIGN CRITERIA INTO PROJECT PLANS AND SPECIFICATIONS

If calculations were performed during design, use the results to specify the maximum refrigerant charge for the HVAC equipment. When the project is under construction, review equipment submittals from the mechanical contractor to verify that the equipment and refrigerant charge meet the design specifications.

REQUIREMENTS

NC, SCHOOLS, RETAIL, DATA CENTERS, WAREHOUSES & DISTRIBUTION CENTERS, HOSPITALITY, HEALTHCARE

Option 1. No Refrigerants or Low-Impact Refrigerants (1 point)

Do not use refrigerants, or use only refrigerants (naturally occurring or synthetic) that have an ozone depletion potential (ODP) of zero and a global warming potential (GWP) of less than 50.

OR

Option 2. Calculation of Refrigerant Impact (1 point)
Comply with ASHRAE Standard 15-2019: Safety Standard for Refrigeration Systems, or USGBC- approved equivalent, as applicable to the project scope.

REQUIREMENTS +

Develop and implement a refrigerant management plan that addresses leak detection, system retrofit, and end of life disposal for all HVAC&R systems containing more than 0.5 pound (225 grams) of refrigerant.

Select refrigerants that are used in heating, ventilating, air-conditioning, and refrigeration (HVAC&R) equipment to minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change. The combination of all new and existing base building and tenant HVAC&R equipment that serve the project must comply with the following formula:

IP units	SI units
$LCGW_{IP} = LCDW_{IP} \times 10^3 \leq 100$	$LCGW_{SI} = LCDW_{SI} \times 10^3 \leq 13$
Calculation definitions for LCDWP + LCDOP x 10 ³ ≤ 100 (IP units)	Calculation definitions for LCDWP + LCDOP x 10 ³ ≤ 13 (SI units)
$LCDWP = (GDPH \times GL \times Life + MR) \times RC/Life$	$LCDWP = (GDPH \times GL \times Life + MR) \times RC/Life$
$LCDOP = (GDPH \times GL \times Life + MR) \times RC/Life$	$LCDOP = (GDPH \times GL \times Life + MR) \times RC/Life$
LCDWP: Lifecycle Ozone Depletion Potential (lb CFC 11/Ton-Year)	LCDOP: Lifecycle Ozone Depletion Potential (kg CFC 11/kW/year)

REQUIREMENTS +

LCOWb Lifecycle Direct Global Warming Potential (8-CDU,75m-Years)	LCOWb Lifecycle Direct Global Warming Potential (8a CO ₂ ,W-years)
LCOWp Global Warming Potential of Refrigerant (0 to 20,000 kg CO ₂ /kg)	LCOWp Global Warming Potential of Refrigerant (0 to 10,000 kg CO ₂ /kg r)
LCOWr Global Refrigerant Potential of Refrigerant (0 to 0.2 kg CFC U/kg r)	LCOWr Global Refrigerant Potential of Refrigerant (0 to 0.2 kg CFC U/kg r)
Lr Refrigerant Leakage Rate (L/yr)	Lr Refrigerant Leakage Rate (L/yr)
Mr End-of-life Refrigerant Loss (COW)	Mr End-of-life Refrigerant Loss (COW)
Rr Refrigerant Charge (0.2 to 320 kg of refrigerant per ton of gross AHRH rated cooling capacity)	Rr Refrigerant Charge (0.005 to 320 kg of refrigerant per kW of AHRH rated or Total Equivalent Certified cooling capacity)
Lr Refrigerant Life (10 years default based on equipment type, unless otherwise demonstrated)	Lr Refrigerant Life (10 years default based on equipment type, unless otherwise demonstrated)

For multiple types of equipment, calculate a weighted average of all base building HVAC&R equipment, using the following formula:

P-units	Si-units
$\frac{[(Lr \cdot LCOWp + LCOWr + 10^3) \times Q_{unit}]}{\text{Gtotal}}$	$\frac{[(Lr \cdot LCOWp + LCOWr + 10^3) \times Q_{unit}]}{\text{Gtotal}}$
100	< 13

Calculation definitions for P-units:
Gtotal = Gross AHRH rated cooling capacity of all mechanical HVAC or refrigeration units (Btu/hr)
Gtotal = Total gross AHRH rated cooling capacity of all HVAC or refrigeration

Calculation definitions for Si-units:
Gtotal = Equivalent Certified cooling capacity of all mechanical HVAC or refrigeration units (kW)
Gtotal = Total Equivalent Certified cooling capacity of all HVAC or refrigeration (kW)

REQUIRED DOCUMENTATION

Documentation	Option 1	Option 2
Confirmation that only no or low-impact refrigerants are used	X	
Equipment type		X
Refrigerant charge calculations (for VRF systems only)		X
Equipment cooling capacity		X
Provide refrigerant equipment schedule or GreenChill certification (commercial refrigeration systems)		X
Equipment quantity		X
Refrigerant type		X
Refrigerant charge (plus supporting documentation, if applicable)		X
Equipment life (plus supporting documentation, if applicable)		X
Leak test results (commercial refrigeration systems only)		X

✓ Confirmation that project HVAC & R systems comply with ASHRAE Standard 15

✓ Refrigerant management plan

REFERENCED STANDARDS

✓ U.S. EPA Clean Air Act, Title VI, Section 608, Refrigerant Recycling Rule: epa.gov/air/caa/

CONNECTION TO ONGOING BUILDING PERFORMANCE

LEED O+M EA credit Enhanced Refrigerant Management: Effective refrigerant selection and management, especially at the point of disposal, is a critical strategy for addressing climate change and minimizing the release of building-related emissions into the atmosphere. Additionally, careful consideration of refrigerants used in HVAC&R equipment can improve performance and reduce operating costs throughout the building life cycle.

TERMS AND DEFINITIONS

- ✓ Natural refrigerant a compound that is not manmade and is used for cooling. Such substances generally have much lower potential for atmospheric damage than manufactured chemical refrigerants. Examples include water, carbon dioxide, and ammonia.
- ✓ District energy system (DES) a central energy conversion plant and transmission and distribution system that provides thermal energy to a group of buildings (e.g., a central cooling plant on a university campus). It does not include central energy systems that provide only electricity.
- ✓ Upstream equipment a heating or cooling system or control associated with the district energy system (DES) but not part of the thermal connection or interface with the DES. Upstream equipment includes the thermal energy conversion plant and all the transmission and distribution equipment associated with transporting the thermal energy to the project building or site.

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