ENVIRONMENTAL CODE OF PRACTICE

for the elimination of fluorocarbon emissions from refrigeration and air conditioning systems

April 2015, Errata June 2021

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canada

Cat. No.: En14-207/2021E-PDF
ISBN: 978-0-660-39140-3
EC21105

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Errata (June 2021)

Please take note of the following corrections to the standing vacuum test or vacuum values of the Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems (April 2015).

Point 3 of Section 4.5 is modified to 300 microns instead of 75 µm Hg. The corresponding value in inches of mercury (in Hg) is deleted.

Point 3 of Section 4.8 is modified by changing the units after 500 to microns instead of µm Hg and by deleting the corresponding value in inches of mercury (in Hg).

Point 6 of Section 4.8 is modified to 300 microns instead of 75 µm Hg. The corresponding value in inches of mercury (in Hg) is deleted.

Point 7 of Section 4.9 is modified to 300 microns instead of 75 µm Hg. The corresponding value in inches of mercury (in Hg) is deleted.

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Preface

In 1987, Canada signed an international multilateral environmental treaty, the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol). This Protocol has universal participation, having been signed and ratified by 197 countries to date. Under the Montreal Protocol, parties have been phasing out the production and consumption of a wide range of chemicals that are known to contribute to the depletion of the ozone layer, including chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). The phase-out of these ozone-depleting substances (ODSs) has resulted in an increase in the use of halocarbon alternative substances such as hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), which are now known to be greenhouse gases. Alternative substances are available today, and thus a proactive approach to pollution prevention continues to be necessary.

At the federal level, Canada controls the production, import, export, sale, offer for sale and certain uses of ODSs through the provisions of the *Ozone-depleting Substances Regulations, 1998*. While the production and importation of virgin ozone-depleting substances are controlled and largely phased out, they continue to be found in systems such as commercial building chillers, domestic appliances and mobile air conditioning systems. The federal government enacted the *Federal Halocarbon Regulations, 2003,* to prevent and reduce the releases of halocarbons at federal facilities, at federal works and undertakings, as well as on federal and Aboriginal lands. Provinces and territories also have measures in place to minimize releases of ODSs.

The *Code of Practice for the Reduction of Chlorofluorocarbon (CFC) Emissions from Refrigeration and Air Conditioning Systems*, published in March 1991 (1991 code of practice), was the first edition of Environment Canada's code of practice. Its publication was part of an action plan implemented by Environment Canada that aimed to reduce CFC emissions by major industries. It covered the following three types of systems: commercial and industrial, residential, and mobile air conditioning. It was based mainly on a document published by the Commission of European Communities (Report EUR 9509 EN). Its development was also guided by the Refrigerants Order of the National Swedish Environmental Protection Board (draft; October 1988) and the Action Guidelines of the Heating, Refrigerating and Air Conditioning Institute of Canada, and it reflected input from various Canadian industrial and governmental bodies.

The *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*, published in 1996 (1996 code of practice), replaced the 1991 code of practice. It covered two additional types of systems: mobile refrigeration and heavy-duty mobile air conditioning. It also added a section on strategic planning. The 1996 code of practice reflects the national and global commitment to pollution prevention as well as the objectives of the National Action Plan for the Environmental Control of Ozone-Depleting Substances (ODS) and their Halocarbon Alternatives. It was expanded to include HCFCs and HFCs, and it was meant to be a guideline for manufacturers, contractors, service providers, environmental monitors and regulators.

The 2014 *Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*, issued under subsection 208(1) of CEPA 1999, replaces the 1996 code of practice. The 2014 Code of Practice covers the design, installation and servicing of stationary and mobile refrigeration and air conditioning systems. It also covers training requirements. The 2014 Code of Practice is a complement to federal, provincial and territorial measures with a goal to minimize and eliminate emissions of certain halocarbons by introducing best practices in the cooling industry.

1.0 Introduction

Pursuant to the *Federal Halocarbon Regulations, 2003,* this code applies to stationary and mobile refrigeration and air conditioning systems that use halocarbons and that are owned by the Government of Canada, a board or an agency of the Government of Canada, a crown corporation or a federal work and undertaking, or located on aboriginal and federal lands. In some jurisdictions, the code of practice is incorporated into regulations, resulting in some or all of the sections of the code becoming mandatory requirements. Under the *Federal Halocarbon Regulations, 2003,* a person who installs, services, leak tests or charges a refrigeration system or an air conditioning system or does any other work on the system that may result in the release of a halocarbon must do so in accordance with the current code of practice.

1.1 Refrigerants

Halocarbons are often used as refrigerants. Refrigerants are fluids that draw heat and create a cooling effect when they evaporate. They are sold as single chemical compounds and as blends, which are mixtures of two or more chemical compounds combined in a ratio to obtain a refrigerant with specific properties. Thermo-physical properties of refrigerants, such as critical temperature and pressure, normal boiling point, and viscosity, are taken into account when selecting a refrigerant in order to optimize the efficiency of the cooling system.

The *Federal Halocarbon Regulations, 2003*, like most provincial and territorial regulations, specify which halocarbons are controlled. The terms and expressions found in *this* Code have the same meaning as those defined in the *Federal Halocarbon Regulations, 2003*.

Types of Refrigerants

There are many refrigerants on the market today, and they are usually classified in the following three groups: 1) halocarbons, which include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) as well as unsaturated HFCs, which are commonly known as hydrofluoro-olefin (HFO) and hydrofluoro-ether (HFE); 2) hydrocarbons, such as propane, isobutane, isopentane and propylene; and 3) inorganic compounds, which include refrigerants such as water, air, carbon dioxide and ammonia.

Cooling Methods

There are various methods of cooling. The oldest method is evaporative cooling, which is simply the evaporation of water to cool the air or material around it. Later came the absorption refrigeration method, which removes heat by evaporating a refrigerant at a low pressure, and releases heat by condensing the refrigerant at a higher pressure. These methods are still used in certain applications, but vapour-compression refrigeration is now the most commonly used method. Vapour-compression and absorption refrigeration systems work on the same principle, but the former uses a compressor to generate the pressure differential necessary to circulate the refrigerant.

The basic components of vapour-compression systems are a compressor, a condenser, an evaporator and an expansion device. Components such as piping, control valves, pressure relief devices, receivers and filter-dryers are either part of the original system design or they can be added during installation or at a later date. Vapour-compression systems are common in a wide range of cooling capacities and for all sorts of applications.

1.2 Training

Environmental Awareness Training Programs

In Canada, a proposal to provide environmental awareness training for technicians in the refrigeration and air conditioning industry originated in the 1992 National Action Plan for Recovery, Recycling and Reclamation of CFCs. In 1998, the national action plan was updated with *the National Action Plan for the Environmental Control of Ozone-Depleting Substances (ODS) and their Halocarbon Alternatives,* which recommended updating the training program to reflect the content of the 1996 *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*.

An environmental awareness training program for workers in the stationary and mobile air conditioning and refrigeration sectors is available in all provinces. The training is a requirement to be considered as a certified person under the *Federal Halocarbon Regulations, 2003,* and under some provincial and territorial regulations.

The environmental awareness training complements, but does not replace, trade qualifications. In Canada, the provinces and territories are responsible for establishing trade qualifications requirements. Workers need to be trade qualified and licensed as required by the jurisdiction in which they work.

The Heating, Refrigeration and Air Conditioning Institute (HRAI) offers environmental awareness training through its SkillTech Academy and a network of delivery partners consisting mainly of community colleges. The HRAI website has a current list of delivery partners.

The Manitoba Ozone Protection Industry Association (MOPIA) offers environmental awareness training as required under Manitoba regulations. The successful completion of this training provides the participant with the ability to purchase and handle substances regulated in Manitoba. Some Canadian jurisdictions recognize the MOPIA training.

In Quebec, Emploi-Québec and the Commission de la construction du Québec offer the environmental awareness training required under Quebec regulations. The successful completion of this course provides the participant with the ability to purchase and handle substances regulated in Quebec. Some Canadian jurisdictions also recognize the training offered in Quebec.

In some provinces and territories other organizations can offer equivalent training.

The above-mentioned courses are theoretical. They prepare participants to comply with the *Federal Halocarbons Regulations, 2003* and the provincial ozone-depleting substances regulations, as technicians may have to work under the federal and one or more provincial or territorial jurisdictions. The training courses cover information on how ozone-depleting substances affect the ozone layer, and they focus on best practices related to activities that could lead to releases of halocarbons. They also include topics such as leak detection, use of appropriate containers, and refrigerant recovery, reuse, recycling and reclamation. An examination is administered at the end of the course.

Anyone associated with the design, installation, maintenance and purchasing of refrigerant and refrigeration and air conditioning systems may benefit from the environmental awareness training.

Part 1 – Stationary Refrigeration and Air Conditioning Systems (Stationary Cooling Systems)

2.0 Design

The term “cooling” is used throughout the document and refers to both refrigeration and air conditioning.

Good design includes a load calculation, the consideration of environmental impacts and energy efficiency, a life-cycle analysis, and the selection of the most efficient cooling system required for the task. Incorporating the input of all the major disciplines involved in a project into the design concepts will improve the overall project.

Load Calculation

A load calculation is an estimate of the amount of cooling that will be needed. The information input into the calculation dictates how precise the calculation will be. The refrigerant and cooling system should be selected to meet the calculated design cooling load. Consulting manufacturers’ specifications will facilitate equipment selection.

- For air conditioning systems, the load calculation takes into account the size of the building, the cooling requirements, the amount of insulation installed, the contributors to heating and cooling in the building, air changes, siting of the system in the plant and a host of other factors.
- For refrigeration systems, the load calculation takes into account the type and quantity of products to be cooled, the desired temperature, the contributors of heat gain to the system, and the frequency and length of time the doors are expected to be open, as well as other factors.

Environmental Impacts

Additional factors to consider in the selection of the appropriate cooling system include the environmental impacts of operating the system. The ozone-depleting potential and/or global-warming potential of a refrigerant can be considered at the design phase.

Energy Efficiency

The integration of energy efficiency and conservation into decision making, as well as knowledge about the different energy efficiency ratings and programs such as ENERGY STAR®, will positively affect the whole life cycle of a cooling system. The Leadership in Energy and Environmental Design (LEED)® program requires high levels of energy efficiency that should allow a reduction in the environmental footprint of a building. Many of these efficiencies will have an effect on reducing the cooling requirements of the building.

Life-Cycle Costing/Analysis

Life-cycle costing is a financial analysis tool that looks at the total costs of constructing, operating, servicing and decommissioning a system. The analysis is usually carried out very early in the conceptual stages of a design while there is the greatest opportunity for cost savings, and can reduce under- or over-designing.

General Considerations in the Selection of a Cooling System

The designer should consult the equipment manufacturers' and refrigerant manufacturers' specifications to select the appropriate system for the client's needs. A cooling system should be designed with safety in mind and operate within applicable jurisdictional requirements. It should be reliable, easy to inspect and service, and replacement parts should be readily available. The system’s material should also be compatible with the installed environment (for example, the material will not rust). To maximize the benefit of monitoring systems, the designer should inform the client that resources will be needed over the life of the system to collect, compile and analyze the data necessary for monitoring the system's performance and environmental impacts.

Manufacturers should ensure that the design of a cooling system includes a series of proven features that will minimize refrigerant leaks and premature failure; plant designers should select systems with such features. Consider incorporating the following components into a cooling system:

- Condensers and evaporators with a refrigerant charge that is as small as possible.
- Separate oil pump on compressor to lubricate the seal prior to starting.
- Chiller to cool the compressor lubricating oil to prolong the life of shaft seals on large open compressors.
- Vibration eliminators in sufficient quantity to ensure that vibration stresses do not exceed material endurance limit, especially at piping connections.
- Tubes and pipes adequately supported to protect against abrasion due to movement and to allow for thermal expansion.
- Filtration device in condenser tubing to reduce erosion caused by foreign particles.
- Receiver to enable pump-down of refrigerant during servicing. It can be an integral part of the system (for example, separate container attached or shell and tube condenser) or an auxiliary receiver that can hold the complete refrigerant charge and is isolatable and protected by a pressure-relief device.
- Access valves to allow charging and evacuating a system.
- Isolation valves to facilitate servicing of the compressor, condenser and evaporator.
- Clamps, fittings and components made of corrosion-free materials.
- Hoses with near-zero permeability and high temperature-resistance attached with heavy-duty clamps.
- Heavy-duty rotary shaft seals designed to withstand extreme temperatures, maintain seal lubrication while the system is idle for extended periods, and provide external protection against rusting shafts, dust and grit.
- Hermetic compressors.
- Self-reseating pressure-relief valves.
- Control panels with “alerts” built in so that corrective action can be taken before system failure; these panels should be able to be easily monitored by the operator.
- Safety controls to prevent freeze-up of water-chilling machines during operation.
- Compressor crankcases with the capability to pump-down to below atmospheric pressure before removing the oil.
- Oil separator on discharge line of compressor for high-pressure systems.
- Physical barrier for the system and its components to provide a high degree of protection.
- Accessibility for inspection, cleaning and repairing the system or its components.

System Owner Manual

A manual should be prepared for the system and all its assembled components including the alarms and the control instruments. The manual should be a compilation of all the manufacturers' manuals with explanations of how the components fit together.

Basic Requirements in System Design by Manufacturers of Cooling Systems

Manufacturers of cooling systems should perform the following activities:

- Evacuate and dry the system by deep vacuum evacuation during the manufacturing process to reduce the risk of contamination.
- Verify that stand-alone systems (for example, refrigerator) are leak-free before charging with refrigerant.
- Document the refrigerant name and charging quantity.
- Provide instructions on installation, operation, servicing and disposal of system.
- Use dry nitrogen or dry air meeting accepted standards in the industry as a holding charge when shipping a system that is not pre-charged.

3.0 Installation

The term "cooling" is used throughout the document and refers to both refrigeration and air conditioning.

3.1 Siting

Siting can have a significant impact on the performance of cooling systems, including reducing the potential for refrigerant releases.

Factors to consider when installing a cooling system:

- Accessibility of all indoor and outdoor components of the cooling system, including electrical outlets associated with the system.
- Keeping refrigerant lines as short as possible between indoor and outdoor units to minimize loss of cooling effect to the atmosphere. This could influence where mechanical rooms, chillers and other systems are located at a facility.
- Keeping the outdoor unit at a height above the indoor unit to prevent having to pump the refrigerant against gravity, which could reduce the efficiency of the system.
- Installing system components away from areas where noise could pose a problem. Variable speed drives can further reduce noise.
- Installing system components in a manner that prevents vibrations which would result in noise and/or stresses on the system.
- Shielding the system from weather conditions that could shorten its life or reduce its efficiency by making use of the natural environment (for example, using trees to create shade) or using a fence or a wall to protect the system from wind or snow.
- Providing adequate protection from debris, dust, moisture and physical damage.
- Identifying or labeling controls, switches and sensors.
- Affixing appropriate signs to the mechanical room (for example, for flammability).
- Installing a refrigerant alarm.

- Installing a refrigerant monitoring system in the mechanical room.
- Installing an emergency switch outside the mechanical room to cut off all electrical power when refrigerants that are flammable are used.
- Locating the system at a suitable distance from electrical devices, such as switches and relays, that may generate sparks.
- Installing a grounding system if applicable. Venting air purge outdoors.
- Allowing proper airflow and adequate ventilation in the area surrounding the system.
- Providing appropriate lighting in the area surrounding the system.

3.2 Compatibility

In order to prolong the system's life, enhance its efficiency, prevent leaks and ensure a safe environment, all system components need to be compatible. For example, mineral oil is not generally used with hydrofluorocarbons (HFCs); explosion-proof electrical components may be needed when using a refrigerant that is flammable.

Factors to consider when installing or servicing a system:

- Compatibility of the refrigerant, oil and the system, as well as the compatibility of the materials of the various system components.
- Characteristics of the fluid used in the system may cause scaling, corrosion or erosion failure. Careful selection of tubes, valves, and evaporator and condenser materials can help minimize catalytic corrosion. When a system contains non-ferrous materials, sacrificial anodes can be used to reduce corrosion pitting. Sacrificial anodes are effective only when the water is flowing through the system.
- Corrosion protection to prevent rusting of steel components.
- Air and moisture can cause acid generation and oil breakdown; attention must be given to material selection and the environment where the system will be located.

3.3 Selection of a Refrigeration and Air Conditioning System and its Components

The selection of a system can make a difference on the overall environmental performance. Certain components are integrated at the design phase, while others are installed on site. In addition to considering the cooling needs of the facility and the requirements in the applicable jurisdiction, contemplate choosing a system with the following components or adding them at the time of installation or service:

- Filter-dryer appropriately sized with the following properties:
  - filter to remove particulate matter,
  - desiccant to remove moisture and acid,
  - isolation valves and refrigerant recovery connections to allow for servicing.
- Strainer or strainers-driers to capture solid contaminants.
- Compressor with a sight glass to indicate oil level.

- Valves allowing isolation of major components of the system in order to minimize the risk of refrigerant loss during servicing.
- Self-reseating relief valve to release pressure and avoid damage to the system.
- High-efficiency air purge system.

3.4 Performance

The way each component is attached will influence the system's performance. Because leaks often occur at connection, it is important to carefully assemble system components to prevent releases to the environment.

The following are best practices regarding the system assembly:

- Installing the system and its components, including tubing and pipe diameters, bend radii and lengths, and all connections, in accordance with the manufacturer's specifications and current regulations.
- Installing the system in such a manner as to minimize the number of fittings and connections.
- Providing adequate protection of piping and piping connections against external abrasion due to movement.
- Providing adequate support of piping connections to avoid stresses on the system.
- Planning allowances for expansion and contraction, especially at anchors and bends. Insulated hangers could be used for non-ferrous pipe.
- Connecting certain components to the system via flexible fittings so that vibrations are absorbed.
- Labeling the system and its components. The labels should be permanent, weatherproof and displayed prominently. Information could include the following:
    - system manufacturer,
    - refrigerant type and quantity,
    - American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) refrigerant number,
    - ASHRAE/Workplace Hazardous Material Information System (WHMIS) safety designation,
    - oil type.
- Insulating pipes to prevent heat gain and condensation.
- Utilizing strainers or strainers-driers to capture solid contaminants.
- Deburring and removing metal filings from all cut pipes to prevent damage to the system's components.
- Cleaning all tubes and fittings prior to assembly.
- Ensuring that filler metal is compatible with the types of materials being joined when brazing and soldering.
- Using a lubricant for some compression fittings.
- Using these preferred methods of connections:
    - welding or brazing for pipe sizes greater than 19 mm (3/4") outside diameter;
    - compression-type fittings for small pipe sizes.

- Welding or brazing in new systems instead of using threaded connections.
- Adding vibration eliminators.

Valves

A valve is a pipe fitting that regulates, directs or controls the flow of a fluid by opening, closing or partially obstructing various passageways. The following are best practices regarding valves:

- Install isolation valves to facilitate servicing on all major components of the cooling system (for example, at the suction and discharge sides of a compressor).
- Use valves to protect gauges from pressure surges and to permit removal of these devices for repair or calibration.
- Mount the compressor on the system's frame in such a way as to prevent vibration and minimize stress on piping connections, including valves.
- Ensure that the compressor is accessible for leak testing and service.

4.0 Servicing

4.1 System Start-up

Before starting the system, the technician should be familiar with applicable regulations, this code of practice and the manufacturer's installation, operating and maintenance manuals. The objective of the start-up is to verify that all components and controls are in working order through functional performance testing. The following are good practices:

- Ensure that the system meets all specification requirements.
- Verify the installation of all components of the system, including piping, piping connections, anchors, hangers, vibration insulators and insulation.
- Ensure proper labeling of the system and its components.
- Confirm that electrical systems are properly wired. If operating on three-phase electrical power, confirm that the system shuts down if any one of the phases is opened.
- Ensure that mechanical room safety features and ventilation are adequate.
- Check and test all the system controls, detectors and actuators.
- Compile test results and prepare a start-up report.
- Create the service log for this system.

Refer to Section 4.9 – Charging and to the manufacturer's charging recommendations to complete the start-up. If the system is pre-filled, follow the manufacturer's recommendations for start-up.

4.2 Preventive Maintenance Plan

Developing a preventive maintenance plan for all air conditioning and refrigeration systems will prolong their life and benefit the environment. The plan should consider the regulatory requirements of the *Federal Halocarbon Regulations, 2003,* and those found in provincial and territorial regulations with regards to:

- environmental awareness certification,
- installation, servicing and charging,
- leak testing,
- service log,
- record keeping,
- reporting.

To enrich the preventive maintenance plan, manufacturers' recommendations should also be considered. The plan could contain the following:

- Procedure to ensure that immediate steps are taken to stop refrigerant release.
- Inventory of cooling systems other than small ones.
- Frequency of inspections and test equipment calibration.
- Procedure for tracking systems' repairs and complaints to identify trends and to take appropriate action.
- Resource allocations to carry out the planned preventive maintenance plan.
- Procedure for implementation of inspections' recommendations.

Ensure that the preventive maintenance plan is shared with employees and contractors.

4.3 Inspection

A frequent walk-around is a simple, cost-effective manner of minimizing cooling system failures and refrigerant releases. In addition to the recommended manufacturers' specifications, the following should be verified during an inspection:

- Air flow around the system is unimpeded.
- Area signs and system guards are in place and in working order.
- Noise and vibration.
- Air quality monitor in the mechanical room is functioning.
- Refrigerant storage area.
- Signs that zones in the occupied areas of buildings are being over or under cooled (for example, louvres sealed shut or improvised deflectors).
- Signs of oil leakage, damage and corrosion.
- Level on gauges and settings on sensors and controls.
- Level and flow of fluid in sight glasses. Bubbles in the refrigerant can be an indication of low refrigerant levels.
- Filter-dryer cores and/or desiccant.
- Belts on belt-driven compressors are not worn or damaged. Ensure belts are aligned and tension is appropriate.
- Ice build-up.
- Condensate pan drain.

- Schrader valves are capped to prevent dirt from entering. Metal caps with rubber inserts are preferred since they provide a good seal.
- Refrigerator and freezer doors are properly sealed.

To complete the inspection, it is recommended to prepare a list of items verified and the recommended actions.

4.4 Leak Testing

Under the *Federal Halocarbon Regulations, 2003,* a leak test must be performed before charging a cooling system. A leak test can also be done at any time to determine if a cooling system is losing refrigerant.

Provinces and territories may also have requirements regarding leak testing.

Frequency

The *Federal Halocarbon Regulations, 2003,* requires that a leak test be performed at least once every 12 months. Leak testing frequency could be increased for systems that operate under harsh conditions. Under these regulations, small air conditioning or refrigeration systems do not need an annual leak test (for example, sealed packaged units like window air conditioners, water coolers, vending machines and domestic refrigerators). Air conditioning systems that are designed for occupants in motor vehicles are also exempt from the 12-month provision.

Leak Testing Procedure

Under the *Federal Halocarbon Regulations, 2003,* CFCs are not to be used for the purpose of leak testing. Furthermore, it is a best practice not to use any halocarbon for leak testing purposes. Some cooling system components are more prone to leaks and should be given particular attention; for example, piping and device connections (valves, sight glass, gauges, etc.), gaskets, and seals.

A leak testing procedure typically includes the following steps:

1. Look for signs of staining or oil deposits.
2. Ensure that the mechanical room is not contaminated with refrigerant before leak testing.
3. Shield the area when leak testing in windy conditions (for example, using a tarp).
4. Leak test the components of the cooling system that come in contact with a halocarbon, using one or a combination of the following methods:
    - electronic leak detector with a suitable minimum detection level,
    - ultraviolet fluorescent dye leak detector,
    - bubble test (soap and water solution),
    - water immersion test for parts that have been removed.
5. Notify the owner if a leak is detected.
6. Affix a leak test notice as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.

7. Update the service log as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.
8. Repair the leak if one was detected.

Note that for some systems, the high and low sides equalize on shutdown. The static pressure normally is enough to locate leaks.

On hot-gas type systems, the low-pressure side could be pressurized before leak testing the evaporator, heat exchanger, thermostatic expansion valve or solenoid valve by short-circuiting hot gas to the low-pressure side. The pressure cannot exceed the pressure of the relief devices.

On sub-atmospheric systems, the evaporator water temperature can be raised a few degrees to facilitate leak testing.

4.5 System Leak Repair

Before initiating a repair, it is recommended to consult the system's record which could indicate that additional measures have to be considered.

It is recommended to proceed with the repair if it can be done immediately, for example, if the leak is simply due to a loose mechanical connection which requires tightening.

Otherwise, the procedure typically includes the following steps:

1. Isolate the leaking portion of the system and recover the halocarbon from that portion, or recover the halocarbon from the whole system.
    - The refrigerant is recovered into a container designed and manufactured to be refilled and to contain that specific type of halocarbon as prescribed in the *Federal Halocarbon Regulations, 2003*.
2. Repair the leak. For example, repair Schrader valves using tools that allow replacement of the valve core while the system is under pressure if the valve is leaking.
    - Brazing or welding is usually preferred for leak repair of piping.
    - Replace components that have rusted or leaking casings.
3. Conduct the standard test:
    - standing vacuum test to 300 microns for 15 minutes, or
    - standing pressure test at 1034 kPag (150 psig) of dry nitrogen for 24 hours.
4. Leak test the system.
5. Affix a leak test notice as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.
6. Charge the system.
7. Update the service log as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.
8. Run the system in accordance with the manufacturer’s recommendations (4 to 48 hours) and confirm the system is not leaking.

Note that if the leak cannot be repaired, the refrigerant has to be recovered and the system disposed of in accordance with applicable regulations.

4.6 Sealants

When a sealant is added in a system, it will seep out of any small holes or cracks and will solidify and seal the hole on contact with air. Because a sealant will continue to work on subsequent small holes and cracks, it may conceal the deterioration of a component of a system and lead to a larger leak in the future. Sealants with an ultraviolet dye can reveal locations where leaks were sealed.

Sealants should only be considered for use in remote locations and in emergency situations on mobile systems as well as for systems such as vending machines, ice cream display cases and water coolers. Affix a label to the system when a sealant is added.

4.7 Recovery, Reuse, Recycling and Reclaiming of Refrigerants

In accordance with applicable regulations, refrigerant recovered from a cooling system may be:

- reused,
- recycled,
- reclaimed, or
- disposed of.

It is prohibited to vent a halocarbon in Canada. The recovery equipment is expected to be in good working order before use. The extraction efficiency has to meet the standards set for the jurisdiction in which the work is performed.

If not contaminated, the recovered refrigerant can be reused in the same system.

Refrigerant Recovery Methods

There are two acceptable methods of recovering refrigerants from cooling systems: active recovery and adsorption recovery. There are two types of active recovery: in type 1, the active recovery equipment simply recovers the refrigerant. The refrigerant is returned to the same system or a similar system in the organization. In type 2, the active recovery and recycle equipment recovers refrigerants and improves their quality by removing particulate matter, moisture, acid and oil. The refrigerant is of superior quality to that removed by type 1. This method usually will not remove ultraviolet dyes and sealants. The adsorption recovery method transfers the refrigerant to a container with resin, which is then sent to the supplier to reclaim the refrigerant.

Recovery Equipment

Select the appropriate recovery equipment for the planned work and consider the following best practices:

- The equipment has been serviced by:
  - emptying oil containers,
  - changing compressor oil,
  - replacing dryers,
  - replacing filters before each service job, and
  - checking equipment including hoses for leaks.
- The equipment meets recovery standards for extraction efficiency.
- The equipment is not cross-contaminated with other refrigerants.
- The equipment is intended for the type of refrigerant being processed and will clean the refrigerant to meet the required specifications.

Refrigerant Recovery Containers

Recovery containers are grey and yellow, and when they are used to recover a refrigerant, they are labeled to identify the refrigerant they contain. Generally, they are not identifiable by the designated American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) refrigerant colour. There are several types of containers:

- Recovery drums are grey with a yellow cover and are used for liquid refrigerants.
- Recovery cylinders are grey with a broad yellow band on the top and have a two-way liquid/vapour valve.
- Ton tanks are grey with a broad yellow band around the end and are used to recover larger quantities of refrigerant from cooling systems to facilitate the reuse of a refrigerant following servicing.
- Molecular sieve or resin adsorption containers are not pressure cylinders and are approved for refrigerant recovery by Transport Canada. Recovery containers may be exposed to contaminants that could compromise their integrity.

The *Transportation of Dangerous Goods Act* has specifications for refrigerant recovery containers. Refer to Section 4.10 – Handling and Storage of Refrigerants for more information on refrigerant containers.

Recovery Procedure

A recovery procedure typically includes the following steps:

1. Ensure that the recovery containers used are appropriate and are in good condition. Pressure vessels are the preferred type of recovery container for all types of refrigerants, including liquid.
2. Fill the recovery container with only one type of refrigerant (do not mix refrigerants).
3. Place the recovery container on a portable weigh scale to avoid overfilling.

4. Allow a vapour space of at least 10% of the drum height when filling a drum with a low-pressure refrigerant if using a recovery drum for a liquid refrigerant.
5. Ensure that the designed maximum working pressure that is stamped on the cylinder or ton tank is never exceeded during recovery, even temporarily.
6. Consider that the weight-carrying capacity of a recovery container may be influenced by certain factors. Refrigerant/oil mixtures have a lower density than refrigerant alone, and therefore the weight-carrying capacity of a recovery container will be reduced. Usually a good practice is:
   - not to exceed 80% of the maximum net weight capacity, stamped on the upper portion of a recovery cylinder, for ambient temperatures of around 21°C (70°F); or
   - not to exceed 60% of the maximum net weight capacity if the ambient temperatures could reach 49°C (120°F).
7. Supervise the whole recovery operation; do not leave equipment unattended.
8. Open valves slowly on the recovery cylinder or ton tank.
9. Label the recovery container to indicate the type of refrigerant, including any information about additives that may be contained in the recovered refrigerant (for example, ultraviolet dye or sealant).
10. Track the weight of the recovered refrigerant.

According to the *Federal Halocarbon Regulations, 2003*, before dismantling, decommissioning or destroying a system, a label indicating that the refrigerant has been removed must be affixed. Some provincial and territorial regulations may have a similar requirement. If the recovered refrigerant is contaminated, it should be sent to be reclaimed or disposed of in accordance with the applicable regulations.

It is best practice to warm the system using the oil sump heater or with indirect heat to recover refrigerant from oil before it is removed. Open flame cannot be used. Oil in the crankcase can also be heated to vaporize residual refrigerant. For low-pressure systems, the evaporator temperature can be raised using hot water.

4.8 Cleaning

Repairing a system after it has been contaminated by a compressor failure or conversion of systems from HCFC/mineral oil to HFC/polyolester oil typically includes a thorough cleaning by flushing. Older servicing equipment may not be compatible with new refrigerants, and therefore new hoses, seals and O-rings may be necessary.

Generally, the procedure is as follows:

1. Recover refrigerant and oil.
2. Flush system.
   - Use procedures recommended by the manufacturer.
   - Use a non-ozone-depleting flushing agent approved for the refrigerant and oil being cleaned.

- Use a liquid flushing agent from a pressurized container, since flushing agents in open containers can be contaminated with the moisture in the air. Biodegradable flushing agents with boiling points in the order of 85 to 90°C (185 to 195°F) work efficiently and thoroughly.
- Flush system until the flushing agent is contaminant free. Note that flushing will remove both the refrigerant and oil.

3. Remove flushing agent.
    - Draw a vacuum to 500 microns to ensure that the entire flushing agent has been removed.
4. Change components.
    - Disassemble the system one section at a time and change components as necessary. Consider replacing the filter-dryer. It is best practice to replace any removed gaskets with new ones.
5. Reassemble system.
6. Conduct the standard test:
    - standing vacuum test to 300 microns for 15 minutes, or
    - standing pressure test at 1034 kPag (150 psig) of dry nitrogen for 24 hours.
7. Leak test the system.
8. Affix a leak test notice as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.
9. Charge the system.
10. Update the service log as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.
11. Run the system in accordance with the manufacturer's recommendations (4 to 48 hours) and confirm the system is not leaking.

Other Systems

Auxiliary receivers or specially approved ton tanks may be used to recover refrigerant from cooling systems to facilitate the reuse of the refrigerant after servicing. It is best to clean each section of a system separately. Consider taking the component to be cleaned off-site.

4.9 Charging

Generally, the procedure is as follows:

1. Ensure that the system is clean and free of moisture. If necessary, flush the system.
2. Ensure that charging equipment materials are compatible with the refrigerant.
3. Install either self-reseating or isolation valves at 15 to 30 cm (6 to 12") from the end of the charging lines.
4. Use quick disconnect fittings with one-way valves.
5. Install a new filter-dryer in the system.
6. Ensure that refrigerant containers are not connected to a system at a higher pressure.

7. Conduct the standard test:
    - standing vacuum test to 300 microns for 15 minutes, or
    - standing pressure test at 1034 kPag (150 psig) of dry nitrogen for 24 hours.
8. Leak test the system.
9. Affix a leak test notice as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.
10. Weigh refrigerant container to determine the quantity of refrigerant in the container.
11. Charge the system. Add refrigerant slowly to pressurize the system one component at a time.
    - Adjust the refrigerant charge to the correct pressure settings as indicated by the system manufacturer. Note that the charge of refrigerant in systems assembled with pre-charged components may need to be adjusted.
12. Measure the refrigerant charged using a scale or a volumetric charging device.
13. Run the system in accordance with the manufacturer's recommendations (4 to 48 hours) and confirm the system is not leaking.
14. Update the service log as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations. Note the quantity charged into the system and type of refrigerant. Also consider noting the quantity and type of oil and additive added to the system (if applicable).
15. Label the system with weatherproof, permanent labels indicating the date, refrigerant type and charge, and oil type and quantity. If an ultraviolet dye has been added to the charge, include this information on the label as well.

4.10 Handling and Storage of Refrigerants

Various types of containers are used to store virgin or recovered refrigerants in the liquid or gas state. They vary in size, shape and pressure rating. Refrigerant containers can be colour-coded to identify which refrigerant or blend they contain. All refrigerant containers should meet the Canadian Transport Commission specifications under the federal *Transportation of Dangerous Goods Act.*

Refillable refrigerant cylinders need to be visually inspected and re-qualified as stated in the applicable jurisdiction. Many of the refillable refrigerant cylinders sold in Canada are white with a label that is colour-coded and/or that indicates which refrigerant the cylinder contains.

According to the *Federal Halocarbon Regulations, 2003,* a refrigerant must be recovered into a container designed and manufactured to be refilled and to contain that specific type of halocarbon.

Refer to Section 4.7 – Recovery, Reuse, Recycling and Reclaiming of Refrigerants for information on refrigerant recovery containers.

Storage of Refrigerants and their Containers

Best practices for refrigerant containers usually include:

- protection from rusting,
- leak-free,
- storing upright and securely with all valves and bungs closed, and
- storing away from any source of heat or where temperatures could exceed 51°C (125°F).

It is recommended that storage, handling and servicing areas be:

- smoke-free,
- fenced, labeled and protected from vandalism and weather,
- well-ventilated, cool and dry, away from risk of fire, sources of direct heat and direct sunlight, and
- monitored when large quantities of refrigerant containers are stored.

In addition to general handling and storage practices, fire protection requirements for refrigerants that are flammable should be met, including the following:

- Cylinders should be stored at least 3 m (10 ft) from other buildings and be electrically grounded, and the grounding should be checked periodically for corrosion.
- All electrical equipment should be appropriately rated.
- The area should be labeled appropriately.

Handling and Transfer of Refrigerants

The following are best practices for handling and transfer of refrigerants:

- Handle refrigerant containers carefully, avoiding dragging, dropping and denting, and secure containers in place. When not in use, close container valves and screw on the valve outlet cover nut or cap.
- Use a pump and weigh scale when transferring refrigerant in order to prevent releases and to prevent overfilling the container. A pressure differential can be established between the containers using a pump or by heating the discharge container under controlled conditions. The discharge container can be indirectly heated by warm water or forced warm air to a maximum of 49°C (120°F). Do not use direct heating, with the exception of plug-in charging cylinders (dial-a-charge). Avoid mixing refrigerants in one container. Ensure the container is colour-coded and labeled accordingly.
- Handling procedures for refrigerants that are flammable are similar to those for other flammable substances:

    - Ensure that handling is conducted in a well-ventilated area.
    - Ensure that no ignition sources are within 3 metres.
    - Ground and bond all components, including charging rigs and cylinders.

- Wear required personal protective equipment such as gloves, glasses and non-static clothing.

4.11 Release Reports

The *Federal Halocarbon Regulations, 2003,* and most Canadian jurisdictions have halocarbon release reporting requirements for cooling systems. Some require that releases over a certain quantity, usually 10 kg, be reported to the authorities. Cooling system owners should be familiar with the halocarbon release reporting requirements in their applicable jurisdictions.

4.12 Record Keeping

According to the *Federal Halocarbon Regulations, 2003*, cooling system owners have to maintain a service log to record the installation, servicing, leak testing, charging or any other work done on the cooling system that could result in the release of a halocarbon. Records may also be kept on refrigerant storing containers. The service log has to be updated each time the system is leak tested and serviced. Templates are available upon request to OzoneProtectionPrograms@ec.gc.ca. Ideally, an up-to-date service log would be kept close to the system. A copy can be attached to service contracts for background information on the history of servicing and preventive maintenance. Consult the provincial or territorial regulations for other potential record keeping requirements.

Consumption Reports

Some jurisdictions require annual reports of refrigerant consumption.

Record Retention

The *Federal Halocarbon Regulations, 2003,* and some jurisdictions require cooling system owners to keep at the system site, for a specified period of time, all service logs, notices, records and reports.

4.13 Conversion of a System to an Alternative Refrigerant (Retrofit)

One of the best ways to reduce the environmental impact of ozone-depleting substance releases is to convert the cooling system to a system that uses a refrigerant with a significantly lower ozone-depleting potential.

Owners of multiple cooling systems should consider developing a long-term strategic plan for their upgrade.

When deciding whether or not it is beneficial to retrofit a cooling system, ensure that a person knowledgeable in the cooling industry participates in the decision-making process. Owners can consider taking the following steps:

- Consult the system manufacturer to assess the feasibility of a retrofit.

- Confirm that the cooling need is the same; if not, recalculate it.
- Assess the condition of the existing system.
- Perform a life-cycle cost analysis to determine if replacing the existing system with a more efficient one could result in a reduced cost over the life of the system.
- Consider the energy efficiency of the options being considered.
- Consider that HCFC (including R-22) and blends containing HCFCs will only be allowed to be imported until 2020.

If it is determined that retrofitting the existing cooling system is the best alternative, consider the following in the selection of an alternative refrigerant and oil:

- Consulting the system manufacturer and refrigerant manufacturers.
- Examining the ozone-depleting potential, global-warming potential and toxicity of the alternative.
- Reviewing the effects on system efficiency.
- Examining the compatibility with all system components.

Conversion of a system operating with CFC/HCFC refrigerant to HFC refrigerant may lead to:

- changing seals and gaskets,
- adjusting controls,
- changing to synthetic lubricants.

Conversion of a system operating with HFC refrigerant to hydrocarbons (HC) refrigerant may lead to:

- changing key components of the system,
- upgrading the facility to meet requirements for explosion proofing.

A conversion kit may be available from the manufacturer to assist in the conversion of a system. It may even be specific to the model and application. Retrofitting a system may be an opportunity for using improved components, such as high-efficiency motors or more efficient condensers.

Retrofit steps to follow:

1. Have a certified technician perform the retrofit. Under the *Federal Halocarbon Regulations, 2003,* and most provincial and territorial ozone-depleting substances regulations, the recovery of halocarbon refrigerants requires a certified technician.
2. Ensure the system is in working order.
3. Recover refrigerant and oil.
4. Clean and flush the system.
5. Perform the retrofit as instructed by the system manufacturer; replace all components that are not compatible. Conversion kits may be available, particularly for domestic systems.
6. Leak test the system.

7. Affix a leak test notice as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.
8. Charge the system.
9. Update the service log as prescribed in the *Federal Halocarbon Regulations, 2003,* or the applicable regulations.
10. Run the system in accordance with the system’s recommendations 4 to 48 hours and confirm the system is not leaking.
11. Ensure proper handling and disposal of refrigerant.
12. Label the system to indicate the type and amount of new refrigerant.

4.14 Shut Down

For a system, other than a small system, which will be shut down for an extended period of time, consider isolating the refrigerant in the system's receiver or recovering it to approved storage containers.

Where a system has had its refrigerant removed, and that system may be used again in the future, it can be charged with dry nitrogen or dry air to help prevent its contamination. Storing out of service cooling systems inside a heated building should be considered.

4.15 Decommissioning

When decommissioning, putting out of service or disposing of a system, the following steps need to be considered:

- Recovering the refrigerant and oil.
- Storing refrigerant in approved containers.
- Labelling the system to indicate that the refrigerant has been removed. Labels have to conform to the requirements of the applicable jurisdiction.
- Labelling refrigerant containers.
- Retaining proof that the refrigerant has been recovered from the cooling system.

Domestic appliances (for example, refrigerators) that contain a refrigerant should be handled with care and they may have to be brought to a pre-assigned site for the recovery of the refrigerant. In some cases, the refrigerant can be removed first, in accordance with the applicable regulations.

4.16 Disposal of Refrigerant

When a refrigerant is contaminated and can no longer be used, return it to a refrigerant wholesaler or an approved facility to be recycled, reclaimed or destroyed; it can also be sent to a hazardous waste disposal center. The oil has to be disposed of in accordance with the applicable regulations.

Part 2 – Mobile Refrigeration and Air Conditioning Systems (Mobile Cooling Systems)

Mobile systems include air conditioning and refrigeration systems (mobile cooling systems) in:

- refrigerated transport trucks and transport trailers (“reefers”),
- rail cars, intermodal containers, ships, aircraft,
- automotive vehicles,
- trains, buses, trucks, agricultural equipment, cranes and other.

The basic principles that apply to stationary cooling systems as described in this code of practice can also be applied to mobile cooling systems. This section covers aspects that are specific to mobile systems.

Mobile cooling systems have become more reliable and efficient in recent years; however, they are subjected to greater and more frequent vibration forces than stationary cooling systems. They operate in a more aggressive environment due to rain, dust, debris and road or marine salt. Therefore, these systems may be more prone to failure.

5.0 Design

The design of mobile cooling systems should:

- take into account the severe physical environment in which they operate,
- incorporate a high degree of physical protection without compromising accessibility, and
- include user-friendly control panels with self-diagnostic abilities and alarms.

6.0 Servicing

6.1 Preventive Maintenance

A regular preventive maintenance program is essential to the reliability of mobile cooling systems. It could be integrated into the vehicle maintenance safety inspection program.

The frequency of inspections could be increased for mobile cooling systems because they often operate under harsh conditions.

In addition to the manufacturers’ specifications, the following should be verified during an inspection of a mobile cooling system:

  - presence of dust, debris, insects, road salt, etc. on the system,
  - signs of physical damage of the system or its components,

- signs of oil deposits and corrosion (especially around clamps and metal connections).

A vehicle or an intermodal container equipped with a refrigeration system that is to be immobilized and operated for long periods should be parked in a shaded area to reduce the heat load on the refrigeration system.

Under the *Federal Halocarbon Regulations, 2003,* documentation shall be kept at a single location occupied by the owner. A notice can be affixed to the system to identify where the documentation is located. The records need to be available for inspection.

Refer to Environment Canada’s *National Code of Practice for Automotive Recyclers Participating in the National Vehicle Recycling Program* when disposing of a mobile cooling system.

6.2 Leak Testing

Leak testing mobile air conditioning systems using the refrigerant as the test gas, in accordance with internationally recognized standards, is acceptable provided that:

- visual inspection indicate no signs of oil deposits or any physical damage, and
- all refrigerant from the test be recovered immediately following the test, if there is a leak.

Annex – Definitions

Small air conditioning system - An air conditioning system that is not contained in a motor vehicle and that has a refrigeration capacity of less than 19 kW as rated by the manufacturer.

Small refrigeration system - A refrigeration system, other than one that is installed in, that is attached to or that normally operates in conjunction with a means of transportation, that has a refrigeration capacity of less than 19 kW as rated by the manufacturer.

www.**ec**.**gc**.**ca**

Additional information can be obtained at:

Environment Canada
Inquiry Centre
10 Wellington Street, 23rd Floor
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Fax: 819-994-1412
TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca