United States Environmental Protection Agency

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The GreenChill Advanced Refrigeration Partnership

# Keep it Cool: GreenChill's Guide to Refrigeration Management for Small and Independent Grocers

U.S. Environmental Protection Agency
Stratospheric Protection Division

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# 1. Introduction

Supermarkets and other types of retail food establishments around the world rely on refrigeration technologies to keep their produce fresh, their milk cold, and their ice cream frozen. For the most part, commercial refrigeration systems used by retail food establishments today contain thousands of pounds of refrigerant—commonly either a hydrochlorofluorocarbon (HCFC) or hydrofluorocarbon (HFC) refrigerant, which depletes the ozone layer and/or contributes to climate change when released into the Earth's atmosphere.

The purpose of this document is to provide store owners and managers who have limited technical experience in the area of commercial refrigeration with the background and resources to effectively manage their store's commercial refrigeration system. Specifically, this guide provides helpful information on the following:

- ❖ **Questions for Your Technician –** This section identifies important questions to ask your service technician related to system installation, routine maintenance, leak events, and system retirement (Section 2);
- ❖ **System Design –** This section provides an overview of the key components of a commercial refrigeration system, describes common system designs, discusses considerations for refrigerant selection, and identifies smart design techniques (Section 3);
- ❖ **Servicing and Maintenance –** This section provides background on how to prevent leaks, detect leaks, and respond to leaks throughout the lifetime of the system (Section 4);
- ❖ **Regulatory Requirements –** This section identifies relevant regulations that are pertinent to the management of commercial refrigeration systems (Section 5);
- ❖ **Useful Resources –** This section provides links to useful resources that provide additional detail on key aspects of refrigeration management (Appendix A); and
- ❖ **Checklists and Templates –** These sections provide useful checklists and templates to support leak prevention and monitoring best practices (Appendices B–D).

**Key Benefits of Refrigeration Management**

*Proper management of your commercial refrigeration system will inevitably result in fewer refrigerant emissions and consequently have the following key benefits:*

- ✓ **Reduced Refrigerant Costs –** Fewer emissions will reduce the need to purchase refrigerant to refill your system.
- ✓ **Reduced Potential for Refrigeration Failure –** Proactive maintenance and timely repairs will reduce the likelihood for operating temperatures to be compromised and food to perish.
- ✓ **Reduced Emissions of Ozone-Depleting Substances (ODS) and/or Greenhouse Gases (GHGs) -** Fewer emissions will reduce the impact of your system on ozone depletion and/or climate change.

# 2. Questions for Your Technician

EPA certified service technicians play a vital role in the success of your refrigerant management program. Being engaged with your service technician and asking the right questions can help ensure your refrigeration system is running smoothly, costs are contained, and regulations are followed. Below is a list of questions that you should ask your technician during servicing trips throughout the lifetime of your refrigeration system (i.e., installation, routine maintenance, leak events, and retirement). The sections that follow provide additional background information on best practices in refrigeration management.

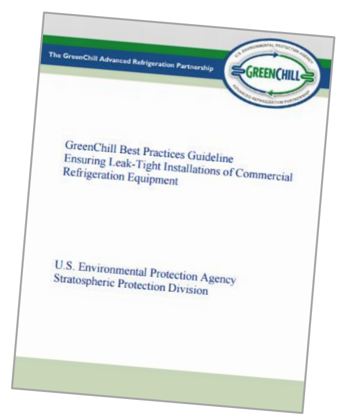
## *Installation*

- **How can I reduce my refrigerant charge?** *At the time of installation, it may be possible to reduce the system's refrigerant charge by strategically positioning system components. For example, the condenser should be installed as close as possible to the compressors. Alternative piping designs, such as suction and liquid loop piping, can also reduce your system's refrigerant charge. Your installation contractor should be able to advise you on potential options appropriate for your store.*

- **How much refrigerant does my system need?** *The amount of refrigerant your system needs will vary seasonally. However, that does not mean it is acceptable to unnecessarily overcharge your system. Talk with your technician about the appropriate amount of refrigerant for your system.*

- **Can you provide a record detailing the amount of refrigerant charged into the system during installation?** *Knowing your system's full charge is critical to benchmarking and evaluating your system's performance. It is also required under EPA's National Recycling and Emission Reduction Program (See text box on Leak Records and Documentation) for select refrigerants. Ask your installation contractor to provide a detailed record that includes the amount added to each low- and medium-temperature rack.*

- **Has my system been tested for leaks in accordance with GreenChill's Best Practices Guideline for Leak Tightness at Installation?** *Your installation contractor should complete and sign the Installation Leak Tightness Testing: Verification Form to verify that he/she tested the remote commercial refrigeration system per GreenChill's Guideline prior to the store's opening.*



## *Routine Maintenance*

*Image of broken clamp caused by vibrations*

- **Did you observe any vibration?** *Most vibrations occur on or near the compressor discharge lines. Areas with excessive vibration are prone to leaks. Eventually, the constant movement can cause a rub-through and/or broken lines or fittings. Ask your technician what can be done to reduce or eliminate vibrations.*

- **Are any valve caps or seals missing?** *Certain valves require caps and proper seals (e.g., o-rings) to ensure leak tightness. Ask your technician to replace any missing caps or seals.*

*Image of a Schrader valve with no caps*

- **Did you observe any corrosion on rack components?** *Copper evaporator coils and steel rack components may corrode over time and develop leaks. Corroded parts should either be removed or painted with a rust-inhibiting paint to help prevent further corrosion. Ask your technician to use cleaning agents that are compatible with your system's components, as some cleaning agents can cause corrosion.*

- **Did you observe any oil seepage?** *Oil seepage can indicate a leak in the system. Ask your technician to use soap bubbles or an electronic leak detector to identify and repair the leak.*

*Excessive corrosion on rack components*

- **Has there been a drop in the refrigerant level of the receiver?** *A drop in the receiver level from a previous reading may indicate a leak in the system. Ask your technician to compare current receiver levels with those logged during previous inspections. GreenChill's Receiver Refrigerant-Level Chart can help you and your technician keep track (See Appendix B).*

- **Do any of my system components need upgrades?** *Some existing system components may need to be replaced with parts that are more leak-resistant (e.g., suction stepper valves, loop piping systems, and remote manifolds). Such components may cost more upfront, but can save money overtime.*

## *Leak Events*

- **Where was the leak located?** *Knowing and documenting leak locations can help identify problem areas in your store. Recurring leaks in the same location may indicate the need to replace a part or component.*

- **Did you inspect the entire system to make sure all leaks were found and repaired**? *In many cases the first refrigerant leak found may not be the only leak in the system. Ask your technician to compare the quantity of refrigerant lost with the leak rate of the leak found. If the leak found is too small to justify the quantity of refrigerant lost, the technician should assume there is another leak in the system and resume the leak search.*

**Leak Records and Documentation**

During each leak event, it is important to document leak repair efforts and maintain records over time. Important items to document include:

- ✓ Date of service
- ✓ Identity and location of the appliance
- ✓ Type of service performed
- ✓ Location of repairs
- ✓ Results of verification tests
- ✓ Quantity and type of refrigerant added (if any)

EPA's National Recycling and Emission Reduction Program have specific recordkeeping and reporting requirements. To ensure compliance, see 40 CFR Part 82, Subpart F.

- **What is the cause of the leak and how was it addressed?** *Knowing the cause of the leak and taking steps to address the root of the problem can lower costs over the long run. Simply topping-off the system with additional refrigerant is not an acceptable way to address leaks.*

- **Was there a drop in receiver levels after the repair was made?** *Once the repair is made, ask your technician to check the receiver level to ensure no additional refrigerant was lost. A drop in receiver level is an indication that there are probably more leaks in the system.*

- **Was the system charged with additional refrigerant as a safety buffer?** *It is common practice for service technicians to charge additional refrigerant to a system as a safety buffer. This practice should be avoided since it will add to the potential loss in a future leak event and is an unnecessary cost.*

- **Am I in compliance with all relevant leak repair regulations?** *Commercial refrigeration systems must comply with applicable federal, state, and local leak repair regulations. Make sure you are familiar with current leak repair requirements and take appropriate measures to ensure compliance.*

## *Retirement*

- **What should I do with my system's refrigerant?** *Not only is it illegal to vent refrigerant, but it's also harmful to the environment and human health. Per EPA regulations, all refrigerant must be recovered. Once it is recovered, options may include recycling the refrigerant for use in your store's new system, reclaiming the refrigerant, or destroying the refrigerant.*

- **Is your refrigerant recovery equipment certified by an EPA-approved equipment testing organization?** *Persons involved in the disposal of refrigeration and air conditioning equipment must certify to their EPA Regional Office that they have acquired (built, bought, or leased) and are properly using refrigerant recovery equipment certified by an EPA-approved equipment testing organization. EPA-certified refrigerant recovery equipment will ensure maximum recovery of refrigerant from your retired system.*

- **Can you show me the certification label on your refrigerant recovery equipment?** *Asking to see the certification label on the recovery equipment will help ensure compliance with EPA's regulations and the maximum amount of refrigerant is recovered from your system. The label should say, "This equipment has been certified by AHRI/UL to meet EPA's minimum requirements for recycling and/or recovery equipment intended for use with [appropriate category of appliance—e.g., HCFC appliances containing less than 200 pounds of refrigerant, all high-pressure appliances, etc.]."*

# 3. System Design

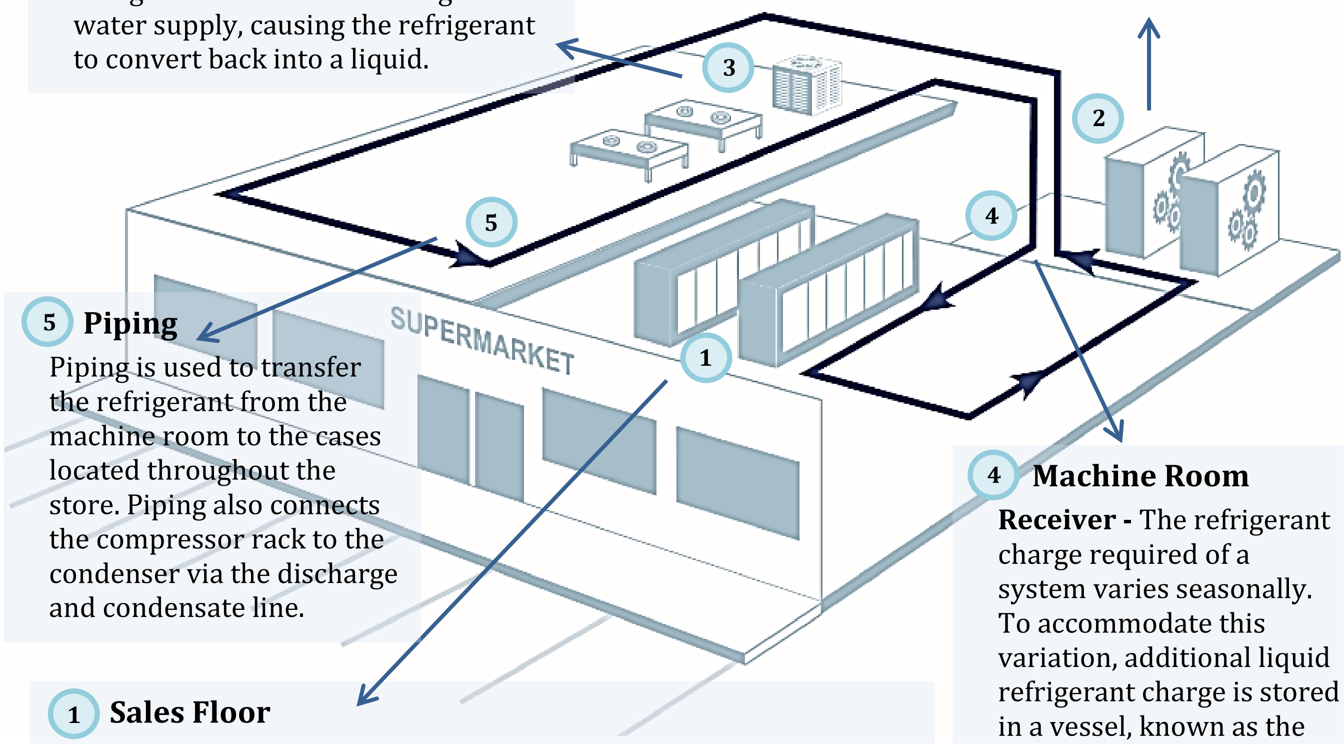
In a supermarket, refrigeration systems cool display cases and walk-in coolers that house food products and other perishable goods. Each system is designed to accommodate the refrigeration needs of the specific retailer as well as the confines of the building. While most systems are custom designed, they all consist of the same key components, including compressors, condensers, receivers, display cases, expansion valves, evaporators, and piping. Figure 1 below presents an overview of the key components of a commercial refrigeration system and their common location within a supermarket.

**The Source and Cause of Refrigerant Leaks**

Leaks can occur in a variety of locations throughout a supermarket, including the compressor racks, display cases, walk-in evaporators, condensers, piping, and remote headers. Leaks are generally caused by the inevitable wear and tear on a refrigeration system as well as poor design and improper installation, servicing, and/or maintenance practices. Specifically, common causes of leaks include:

- Poor brazing techniques
- Improperly tightened fittings
- Valve caps and seals missing
- Material incompatible with oil or refrigerant
- Vibration
- Thermal expansion and contraction
- Corrosion
- Metal-to-metal contact of tubing
- Improper support of tubing

**Figure 1: Supermarket System Overview**




**3 Rooftop**

**Condenser -** Typically located outside, the condenser transfers the heat from the high-pressure vapor refrigerant to the surrounding air or a water supply, causing the refrigerant to convert back into a liquid.

**2 Machine Room**

**Compressors -** Often located in a machine room at the back of a store, compressors pump the low pressure vapor refrigerant from the evaporators and compress it to a high pressure and temperature.

**5 Piping**

Piping is used to transfer the refrigerant from the machine room to the cases located throughout the store. Piping also connects the compressor rack to the condenser via the discharge and condensate line.

**4 Machine Room**

**Receiver -** The refrigerant charge required of a system varies seasonally. To accommodate this variation, additional liquid refrigerant charge is stored in a vessel, known as the receiver, located downstream of the condenser.

**1 Sales Floor**

**Display Cases -** Located throughout the sales area, display cases are used to store refrigerated and frozen products.

**Expansion Valve** - The expansion valve, located inside the display cases, controls the flow of the refrigerant to the evaporator.

**Evaporators -** Located inside the display cases, evaporators are used to remove heat from the conditioned space within the display cases. Inside an evaporator, liquid refrigerant boils, or evaporates, absorbing heat as it changes to a vapor.

## *System Design Options*

Although the core components of a retail food refrigeration system remain consistent across all systems, the specific design of a system can vary significantly. Historically, centralized direct expansion (DX) systems have been the most commonly used system design in commercial applications. However, due to a growing effort to reduce refrigerant charge sizes and leak rates as well as to transition to alternative refrigerants, many retailers are choosing to adopt advanced design options. The most commonly used system designs are generally defined below.

- **Centralized DX Systems:** A centralized DX system is comprised of several compressors that are mounted together and located in a centralized, single machine room. The compressors share suction and discharge refrigeration lines that run throughout the retail space, feeding refrigerant to the cases and coolers.
- **Distributed DX Systems:** Similar to a centralized DX system, a distributed DX system is comprised of several compressors that feed refrigerant directly to the cases and coolers located throughout a supermarket. However, instead of having a central compressor system in one machine room, a distributed system uses an array of compressor racks that are strategically located near the refrigerated cases.
- **Secondary Loop Systems:** A secondary loop system also is comprised of a centrally located compressor rack; yet, rather than circulating the primary refrigerant throughout the retail space, the compressors are connected to a chiller system that is used to cool a secondary fluid. This secondary fluid is then circulated through the store to cases and coolers.
- **Cascade Systems:** A cascade system consists of two independent refrigeration systems that share a common cascade heat exchanger. The high temperature system typically uses an HFC refrigerant, ammonia, or propane in a DX or secondary loop design, while the low temperature system uses a carbon dioxide compressor to raise $CO_2$ gas from low-temperature conditions up to an intermediate temperature; the high temperature system is then used to condense the gas before circulating it through the store to cool low temperature cases and freezers.
- **$CO_2$ Transcritical Systems:** A $CO_2$ transcritical system is similar in design to a centralized DX system but uses $CO_2$ as the primary refrigerant and operates at a high pressure to accommodate the low critical temperature of $CO_2$.

## *Refrigerant Selection*

In addition to understanding the various system design options available, it is important to understand the different refrigerant types that can be used in your system. Commercial refrigerants generally fall into one of four categories, as summarized below in Table 1. With chlorine-containing refrigerants (i.e., CFCs, HCFCs) no longer permitted for use in new systems due to the United States' commitments under the *Montreal Protocol* (see Section 5), most retailers today use HFC refrigerants. In light of anticipated and recent regulations that will prohibit the use of certain HFCs in supermarket applications (see Section 5), many retailers are adopting lower-global warming potential (GWP) HFC blends and/or system designs that can accommodate non-fluorinated refrigerants. While these regulations do not prescribe refrigerant selection or require stores to retrofit existing systems, careful examination of the available refrigerant options is recommended in order to make an informed decision on which refrigerant is best for your system.

**Table 1: Summary of Refrigerant Options for Retail Food Applications**

| *Category* | *Examples* | *ODS*[a] | *GWP* | *Status of Use* |
|---|---|---|---|---|
| Chlorine-Containing Refrigerants | CFC-12, R-502, HCFC-22 | Yes | Yes | • CFC-12, R-502, and HCFC-22 no longer permitted for use in new systems.[b] |
| HFC Blends | R-404A, R-507A, R-407A, R-407F | No | Yes | • Predominately used today in both new and existing systems.<br>• R-404A, R-507A and other select blends will no longer be permitted for use in new systems as of January 1, 2017.[c] |
| HFO/HFC Blends[d] | R-448A, R-449A | No | Yes | • Recently approved for use.<br>• Other refrigerants under development. |
| Non-Fluorinated Refrigerants | R-290 (propane), R-717 (ammonia), R-744 ($CO_2$) | No | No | • Used as a primary refrigerant in limited applications.<br>• Used as a secondary fluid in combination with HFC blends. |

[a] ODS = ozone-depleting substance

[b] July 30, 1992; 57 FR 33754; December 10, 1993; 58 FR 65018

[c] July 20, 2015; 80 FR 42870

[d] HFOs (hydrofluoroolefins) are unsaturated HFCs (i.e., chemicals that contain a carbon-carbon double bond).

## *Smart Design Techniques*

Regardless of the system and refrigerant type, the design techniques listed below should be considered to help reduce the environmental impact of your system. As highlighted in Section 2, make sure to talk with your system provider and installation technician to discuss other design techniques to ensure you maximize the efficiency and effectiveness of your system.

- ✓ Install the condenser as close as possible to the compressors to minimize the system's refrigerant charge.
- ✓ To reduce your system's refrigerant charge, use split condenser piping along with automated switching techniques to enable the condenser to operate on only one of the two circuits during cold weather months. Apply industry accepted techniques and controls to permit pump out of stranded refrigerant from the inactive condenser circuit.
- ✓ Compressor racks should be positioned as close as possible to the display cases and walk-ins within the store. They should also be positioned in such a way so that they are easily accessible by maintenance and service personnel.

- ✓ Oversized receivers can lead to overcharged systems. To minimize the charge, carefully select the vessel size to appropriately accommodate your system. Additionally, if possible, use a vertical receiver, which requires less charge than a horizontal receiver.
- ✓ Alternative piping designs, such as suction and liquid loop piping, can be used to reduce the linear feet of piping required by your system as well as the number of fittings. This in turn reduces both the charge size and leak potential of the system.
- ✓ A variety of practices can be used to reduce the energy consumption of display cases, including the use of LED lights, electronically commutated motors (ECMs), and no-heat glass doors. Reducing the energy consumption of cases reduces the required refrigerant load, which in turn reduces the amount of refrigerant charge required of the system.

# 4. Servicing and Maintenance

Once your refrigeration system has been designed and installed, regular servicing and maintenance is required to keep your system operating effectively.  While some refrigerant leaks are inevitable, preventative practices, leak monitoring, and clearly defined reaction plans can help to reduce leak occurrences and minimize the impact of your system on the environment, as discussed in the sections below. See Appendix C for a checklist of recommended maintenance measures.

## *Preventative Practices to Avoid and Minimize Refrigerant Leaks*

- ✓ **Clean Equipment:** A clean and uncluttered mechanical room provides a safe and accessible environment for service technicians. Dirty refrigeration compressor racks, condensers, remote headers, and walk-in evaporator coils make it difficult for technicians to spot leaks. Compressor racks and their components should be free of oil and dirt. In addition, corrosion on steel components should be removed and components painted with a rust-inhibiting paint to help prevent future corrosion. Equipment should be thoroughly cleaned once a year, or more frequently in response to the accumulation of oil and dirt.

*Clean machine room at a Farm Fresh store*

- ✓ **No Overcharging:** The amount of refrigerant required of your system varies throughout the year, with more refrigerant required during the winter to permit flooding of the condenser to maintain a minimum operating system head pressure.  While some excess refrigerant is needed to accommodate these seasonal variations, the refrigerant charge should not exceed the required amount in order to minimize the potential for refrigerant emissions.

- ✓ **Component Upgrades**: System components should be replaced with parts that are more leak-resistant or have a reduced number of potential leak sources. For example, discharge-piloted evaporator pressure regulating (EPR) valves may be replaced with suction stepper valves, which eliminate the high-side control line, provide better temperature control, and are generally more reliable. Suction and liquid manifolds may be replaced with loop piping systems or remote manifolds to reduce the number of fittings subject to rack vibration.

**Other Recommended Actions to Reduce Leak Potential**

- Replace flared connection components with brazed connection components.
- Replace valves with bolted connections with hermetic one-piece valves with no mechanical joints.
- Replace valves with control lines with valves that don't require control lines.
- Ensure the proper cap is in place on all valve stems designed to be capped, as well as access Schrader valves. The caps should also have the proper seal or o-ring in place to ensure leak tightness.
- Replace fragile cap tube-type control lines with steel lines or armored flexible lines.
- Tighten bolts on flanges used to connect valves and filter-drier covers to the proper torque and use a new gasket in reassembly.
- Use an approved thread sealant to prevent leakage from threads or from corrosion around threads.
- Protect tubing by creating a space separation or using a cushioning material.
- Ensure equipment located in vulnerable environments has epoxy or phenolic coatings on fin-tube surfaces, refrigerant piping, or other components that are subject to corrosion. Vulnerable equipment may include service deli cases that are in contact with vinegar-containing products and rooftop condensers that are located near the coastline or a chemical plant.
- Ensure chemical compatibility of cleaning agent with components and materials.
- Eliminate liquid hammer by mounting a sealed vertical tee ahead of the solenoid valve.

## *Detecting Leaks*

- ✓ **Regular Leak Inspections:** Leak inspections should be routinely performed to proactively check for refrigerant leaks. To perform a leak inspection a certified service technician should check receiver levels, compare refrigerant levels to data from the previous visit, and walk through the store with portable leak detection device, making sure the device is appropriate for the type of refrigerant used in the refrigeration system. Checks should be done at least once every three months (as required by CFR 40, Part 82, Subpart F), but preferably every one to two months, depending on the size and type of the system. See Appendix D for a supermarket walk-thru checklist and Appendix B for an example monthly refrigerant receiver level chart.

- ✓ **Leak Detection Systems:** In addition to performing regular leak inspections, you may also use an automated leak detection system. Leak detection systems are either direct or indirect. A direct detection system directly measures the refrigerant in an air sample taken near a refrigeration system or one of its components. An indirect system measures changes in receiver refrigerant levels, the weight of the condenser/receiver assembly, or system temperature. Leak detection systems vary in both sophistication and cost; the decision to install one may depend on the size and type of refrigeration system in use.

**Leak Detection Sensors**

*What sensors should I use?*

There are two main types of leak detection sensors: semiconductor detectors and infrared (IR) analyzers. Semiconductor sensors are a cost-effective way of detecting larger leaks (i.e., >50 ppm). While IR systems are more expensive, they are able to detect significantly smaller leaks (i.e., 1-10 ppm).

*Where do I monitor for leaks?*

Since you cannot monitor for leaks everywhere, sensors should be placed strategically throughout your store in high probability areas, including the compressor room, walk-in coolers/freezers, and aisles with refrigerated cases. In your compressor room, install one sensor at each end of each compressor rack. In your walk-ins, place the sensors underneath the evaporators, making sure the sensors are placed away from the door to avoid frost build-up. In the aisles, sensors may be placed inside or outside cases, in kick rails, at each end of the aisle, or behind and in between two aisle cases.

- ✓ **Alarm Systems:** If a leak detection system is used, the monitoring system needs to be tied to an alarm system that proactively notifies store management of potential leaks. Levels of redundancy or checks in the alarm system procedure should also be in place to ensure that the alarm does not go unnoticed. For instance, an alert could be linked to horns or a strobe system in the store, the manager's office, or a third party service. Also, it is important to make sure that the alarm threshold is set as low as possible to maximize the capability of the technology.

- ✓ **Locating a Leak:** Once a leak is detected—whether through continuous monitoring or through a regular leak inspection—a handheld leak detector will be needed to further locate the source of the leak. It is important that the right portable leak detector is used to accurately locate your system's leak. Similar to the leak monitoring systems, there are a variety of technologies available for portable leak detectors. Make sure the leak detector used in your store is sophisticated enough to detect all leaks and is appropriate for the type of refrigerant used in your system.

*Example Leak Detector (Source: GreenChill webinar on Achieving Leak Reduction Goals through Effective Refrigerant Management, 2016)*

## *Responding to Leaks*

| *Preparing for Leaks* | *Repairing a Leak* | *Leak Repair Verification* |
| --- | --- | --- |
| All supermarkets should have policy in place for responding to refrigerant leaks. The policy should establish a maximum response time that is as short as reasonably possible (e.g., two to four hours). The policy should also ensure that service technicians follow all relevant federal, state, and local codes and regulations. | When repairing a leak, adding more refrigerant to the system (i.e., topping off the system) is not a viable solution to addressing a leak. Even once the leak is repaired, technicians should also check for other leaks in the system: especially when there is a discrepancy between the quantity of lost refrigerant charge and size of the identified leak. | Technicians should check the system to verify it is leak-free after making the repair. The verification should include a check of the repaired area as well as the receiver level to ensure that no additional refrigerant was lost. A drop in receiver level is an indication that there could be more leaks in the system. |

### Example Policy Language on Responding to Refrigerant Leaks

***Service hours***

Service shall be provided on a seven day a week, twenty-four hour a day basis. Response time shall be less than two hours if possible but not exceeding four hours for emergency calls. Emergencies shall be considered those requests that could cause product loss, refrigerant loss or loss of sales. Non-emergency calls such as prep room areas and HVAC may be handled on a non-overtime basis provided response time does not exceed twenty-four hours. The twenty-four hour response time shall be waived the week preceding the following holidays: Christmas, New Years, Easter, Memorial Day, Independence Day, Labor Day, and Thanksgiving.

***Codes, laws, regulations and policies***

The Contractor and his employees shall conform to all federal, state, and local codes, laws, and regulations including OSHA and the EPA regulations governing refrigerants. The Contractor and his employees shall also obey any store policies while working in the store. No Company employee is authorized to direct a Contractor or any of his employees to disregard any relevant code, law, or regulation in the performance of this contract.

# 5. Regulatory Requirements

As a signatory of the *Montreal Protocol on Substances that Deplete the Ozone Layer*, the U.S. government is responsible for phasing out the production and consumption of ozone-depleting substances (ODS) in the United States. In response to the Montreal Protocol, Congress amended the Clean Air Act (CAA) in 1990, adding provisions to protect the stratospheric ozone layer. The CAA amendments require that the Environmental Protection Agency (EPA) develop and carry out regulations for the responsible management and phaseout of ODS in the United States, consistent with the Montreal Protocol obligations. In addition to adhering with the core obligations of the protocol, Title VI of the CAA encompasses other requirements for stratospheric ozone protection, as highlighted below.

**What is the Montreal Protocol?**

The *Montreal Protocol on Substances that Deplete the Ozone Layer* is an international agreement that requires nations that are Parties to the Protocol to reduce and eventually eliminate their production and consumption of ODS. The protocol, which entered into force on January 1, 1989, was established in response to growing concerns about the harmful effects of chlorofluorocarbons (CFCs) and other halogen-containing industrial chemicals on the ozone layer. In addition to being the world's first and only international treaty to achieve universal ratification by all 197 countries in the United Nations, the protocol is credited with avoiding millions of skin cancer-related deaths, cataract cases, and a range of other damaging impacts on plants, marine ecosystems, and materials.

## *The National Recycling and Emission Reduction Program*

Under Section 608 of the CAA, also known as the *National Recycling and Emission Reduction Program*, EPA has established regulations that prohibit the knowing release of refrigerant during the maintenance, service, repair, or disposal of air-conditioning and refrigeration equipment. The purpose of the program is to prohibit any person from intentionally venting ODS refrigerants (e.g., CFCs and HCFCs) and their substitutes, such as HFCs, into the environment; reduce the use and emissions of these refrigerants; maximize the recapture and recycling of refrigerants; and ensure safe disposal of refrigerants. To this end, owners and managers of commercial refrigeration equipment must comply with the leak repair, reporting, and recordkeeping requirements set forth by Section 608 of the CAA, as codified in CFR 40, Part 82, Subpart F.

## *The Significant New Alternatives Policy (SNAP) Program*

Under Section 612 of the CAA, EPA has established a process for the review of ODS substitutes under the Significant New Alternatives Policy (SNAP) program. Under SNAP, substitutes for ODS that are used in various industrial, commercial, and military sectors—including refrigeration and air conditioning—are evaluated to ensure they offer lower overall risks to human health and the environment. In reviewing the proposed alternatives, consideration is given to the climate impacts of the substitutes as part of the review of environmental impacts. The list of acceptable substitutes for use in retail food refrigeration applications can be found on EPA's website.

# Appendix A. Useful Resources

## *Regulatory Resources*

- The Montreal Protocol on Substances that Deplete the Ozone Layer
  ozone.unep.org/en/treaties-decisions/montreal-protocol-substances-deplete-ozone-layer

- Clean Air Act, Title VI
  www.epa.gov/clean-air-act-overview/title-vi-stratospheric-ozone-protection

- CFR 40, Part 82
  www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr82_main_02.tpl

- EPA's Ozone Layer Protection Regulatory Programs
  www.epa.gov/ozone-layer-protection/ozone-protection-under-title-vi-clean-air-act

- EPA's Stationary Refrigerant and Air Conditioning Page
  www.epa.gov/section608

- EPA' Significant New Alternatives Policy (SNAP) Program
  www.epa.gov/snap

- California Air Resources Board Refrigerant Management Program
  www.arb.ca.gov/cc/rmp/rmp.htm

## *Technical Resources*

- Opportunities for Green Design: Commercial Refrigeration Technologies
  www.epa.gov/greenchill/commercial-refrigeration-technologies

- GreenChill Best Practices Guideline Ensuring Leak-Tight Installations of Commercial Refrigeration Equipment
  www.epa.gov/greenchill/greenchill-best-practices-guideline-ensuring-leak-tight-installations-commercial

- GreenChill Best Practices Guideline: Commercial Refrigeration Leak Prevention & Repairs
  www.epa.gov/greenchill/greenchill-best-practices-guideline-commercial-refrigeration-leak-prevention-repairs

- Report of the Refrigeration, Air Conditioning, and Heat Pumps Technical Operations Committee (RTOC)
  http://www.ozone.unep.org/Assessment_Panels/TEAP/Reports/RTOC/RTOC-Assessment-report-2010.pdf

- Best Practice Guide: Code of Conduct for Carbon Reduction in Retail Refrigeration Sector
  www.ior.org.uk/app/images/pdf/Best%20practice%20guide%2022nd%20June%202011.pdf

- UNEP Manual for Refrigeration Servicing Technicians
  www.unep.org/pdf/7443-e-Ref_manual_servicing_technicians.pdf

- Construction and Demolition: How to Properly Dispose of Refrigeration and Air-Conditioning Equipment
  www.epa.gov/sites/production/files/documents/ConstrAndDemo_EquipDisposal.pdf

## *Industry Resources*

- GreenChill Partnership
  https://www.epa.gov/greenchill

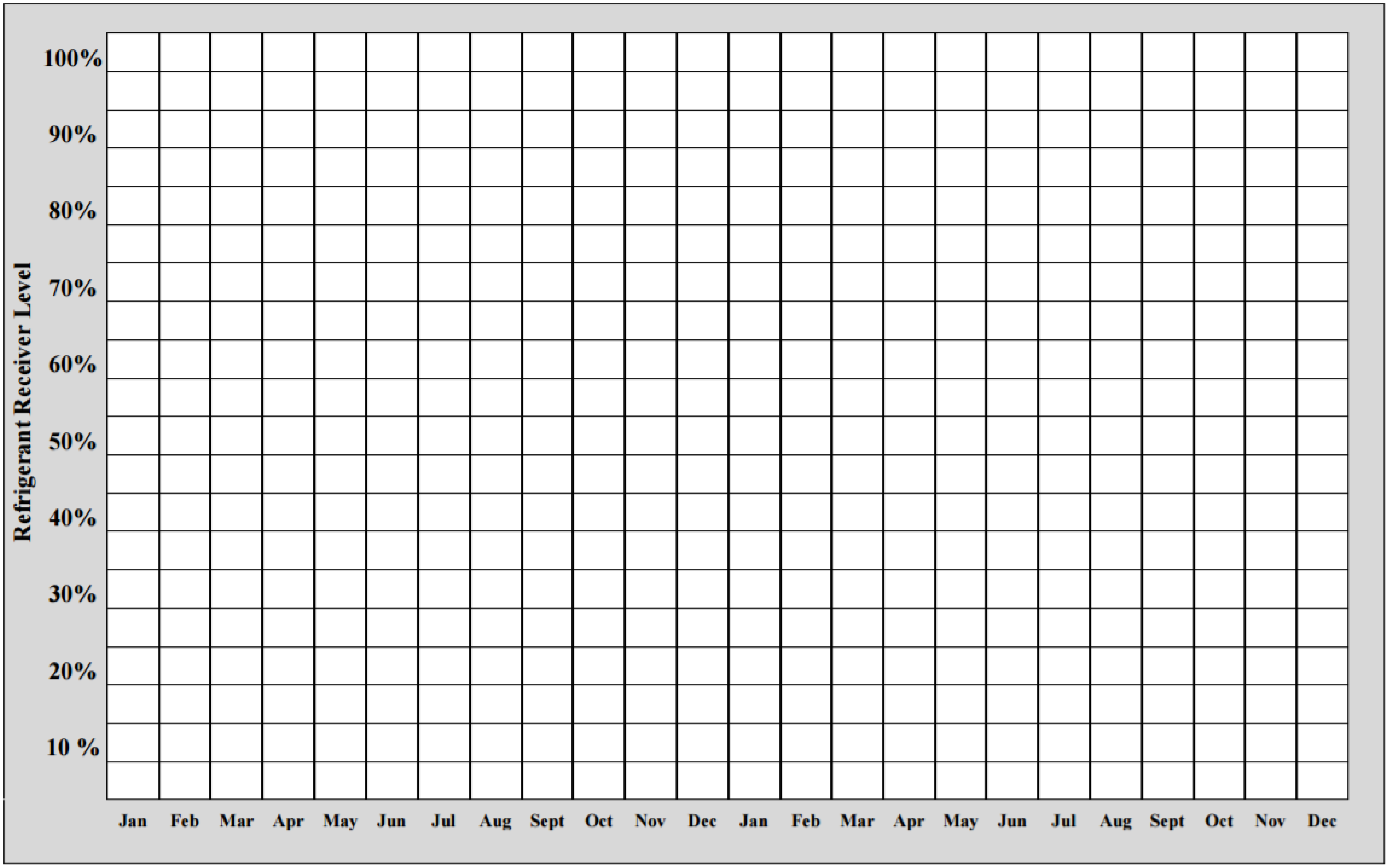
- Food Marketing Institute
  www.fmi.org/

- The Institute of Refrigeration
  www.ior.org.uk/

- REAL Zero
  www.realskillseurope.eu/

# Appendix B. Monthly Refrigerant Receiver Level Chart

**Store #______________________** **Rack #__________________________**



# Appendix C. Leak Prevention Maintenance Checklist

*This checklist identifies several maintenance measures that can help prevent refrigerant leaks in commercial refrigeration systems.*

- ☐ Identify and log the refrigerant level of the receiver of each rack. A drop in the receiver level from a previous reading may indicate a leak in the system.
- ☐ Visually check the compressor racks, piping, and valves in the mechanical room for any oil seepage. If oil seepage is observed, use soap bubbles or an electronic leak detector to identify any refrigerant leak and pinpoint the exact location.
- ☐ Check the control line temperature of all high-pressure switches at a point that is about 12 inches from the compressor connection. If the temperature is above the mechanical room ambient temperature, it may indicate a leak in the control line, fitting, or control bellows.
- ☐ Check the pressure relief valves of each system for refrigerant release. Each relief valve should have a balloon, blow-off cap, or other telltale way to signal that a relief valve has discharged.
- ☐ Visually check all air-cooled condensers for oil seepage underneath the unit and on finned coil surfaces.
- ☐ Check condenser fan blades for cracking or tearing of the metal, especially at the point where the fan blade is riveted to the hub.
- ☐ Check for imbalance in the condenser fan blades and wear in the motor mounts/bolts. Excess vibration in the blades can result in motor mount failure. This can cause the spinning motor to drop and tear the tube sheet, resulting in a high-pressure leak.
- ☐ Visually check piping and fittings to ensure that there is no pipe chafing and no excessive stress on piping or fittings from thermal or mechanical pipe movement during operation.
- ☐ Work with equipment suppliers to verify that equipment is leak-tight when it leaves the factory, and provide feedback to suppliers if leaks are found in factory-built equipment or subsystems.
- ☐ If permanent leak detectors are installed, ensure their proper function.
- ☐ Using an electronic leak detector at its most sensitive setting:
    - Slowly move the probe over all mechanical room components.
    - Walk through the sales area of the store and the entire length of the discharge air stream of each refrigerated case.
    - Check each walk-in cooler, freezer, and refrigerated prep area in the store.
    - Check subsurface refrigeration access pits, starting with riser pits.
    - Check accessible overhead refrigeration lines by following the path of the lines.

# Appendix D. Supermarket Walk-Thru Checklist

*This checklist should be used to routinely check your store for refrigerant leaks. To complete the leak inspection, you will need a hand-held electronic leak detector capable of measuring refrigerant leaks of ½ oz per year. The leak detector should be checked and calibrated at least once a year and preferably more often. Remember, the only way to solve refrigerant leaks is to repair them; topping-off your system is not a viable solution!*

- ☐ **Receiver Levels:** Identify and log the refrigerant level of the receiver of each refrigeration system using the GreenChill Monthly Refrigerant Receiver Level Chart (see Appendix B). Be sure the refrigeration systems are not in heat reclaim, gas defrost, split condenser, or winter flooding mode, or any other condition that could affect receiver level. Compare the current refrigerant level with levels logged during previous checks. A drop in the receiver level from a previous reading may indicate a leak in the system. **REMEMBER** A significant drop in refrigerant level must be the result of a significant leak. Do not stop at the first leak found, especially if it is a seeping connection or valve stem leak. Continue searching until a significant leak is found.
- ☐ **Oil Seepage:** Visually check the compressor racks, piping, and valves in the mechanical room for any oil seepage. If oil seepage is identified, use soap bubbles or an electronic leak detector to identify any refrigerant leak and pinpoint the exact location.
- ☐ **Mechanical Room:** Using an electronic leak detector at its most sensitive setting, slowly move the probe over all components in the mechanical room. Temporarily turn off the mechanical room ventilation to reduce air movement. If the detector indicates a leak within the space, slowly reduce the sensitivity and progressively move to the leak location until found.
- ☐ **High-Pressure Control Lines:** Check the control line temperature of all high-pressure switches about 12 inches from the compressor connection. If the temperature is above the mechanical room ambient temperature, it may indicate a small leak in the control line, fitting or control bellows.
- ☐ **Pressure Relief Valves:** Check the pressure relief valves of each system for refrigerant release. Each relief valve should have a balloon, blow-off cap, or other telltale way to signal that a relief valve has discharged. Under normal conditions, a relief valve should never discharge. If it has, the cause must be found and corrected and the relief valve replaced as they are only designed for one release and may seep refrigerant if left in place.
- ☐ **Air-Cooled Condensers:** Visually check all air-cooled condensers for oil seepage underneath unit on finned coil surfaces. Check return bends and manifold assemblies for oil seepage. If a view of return bends is blocked by a cover, either remove the cover to inspect or use an electronic leak detector to probe the area under the cover. If the condenser is suspected of leaking, the refrigeration system should be turned off temporarily along with the condenser fans so the leak may be pinpointed using soap bubbles or an electronic leak detector.

- ☐ **Condenser Fan Blades and Motor Mounts:** Check condition of condenser fan blades for cracking or tearing of the metal, especially at the point on the assembly where the fan blade is riveted to the hub. If cracking or tearing is present, disconnect the motor and replace the blade as soon as possible. Check motor mounts of each fan motor assembly for signs of deterioration and replace or repair immediately.
- ☐ **Sales Area:** Walk through the sales area of the store with an electronic leak detector at its most sensitive setting. Probe the entire length of the discharge air stream of each refrigerated case. If a leak is detected, unload the case and check the evaporator coil, all valves, connections, and interconnecting piping until the leak is pinpointed.
- ☐ **Refrigerated Walk-Ins & Prep Rooms:** Check each walk-in cooler, freezer, and refrigerated prep area in the store with an electronic leak detector at its most sensitive setting. If the leak detector indicates a leak, slowly reduce the sensitivity and progressively move to the leak location until found.
- ☐ **Underground Refrigerant Piping:** Check sub-surface refrigeration access pits starting with the riser pits with an electronic leak detector at its most sensitive setting. If refrigerant is detected, reduce sensitivity to determine whether the leak is in that pit. If the leak is not in that pit, move to the next pit in the underground piping network. A drop in the leak detector reading may indicate that the leak is in the piping between the two pits. If it increases, continue checking each pit in the piping network until the leak is pinpointed in a pit connection or it is determined that the leak is in the interconnecting piping between two pits. If the leak is found to be in the interconnecting piping and the piping is not accessible, turn off each system that has lines passing through the pipe duct, one by one. This will increase the pressure in the suction lines and should trigger an increased leak rate reading on the electronic leak detector when the offending system is turned off. If this does not provide positive results, the next step is to pump down each system one by one. This will decrease the pressure in the liquid lines and should result in a decreased leak rate reading on the electronic leak detector when the offending system is pumped down. If the above steps do not yield positive results and there is a high degree of confidence that one of the systems in the pipe duct is leaking, it will be necessary to isolate each individual line and pressure test each to 300 psig using dry nitrogen for 24 hours. Once the leaking line is found, it will be necessary to replace the line or reroute the line overhead.
- ☐ **Overhead Refrigerant Piping:** Check accessible overhead refrigeration lines by following the path of the lines using an electronic leak detector set at its most sensitive setting. If the lines are insulated, it may be necessary to probe under the insulation to pinpoint the leak. Be sure to properly reseal the insulation to preserve its integrity.