



Alternative Ice Sheet Primary Refrigerant Option Guideline

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Statement of Facts

Ice sheet refrigerant is a complex subject that requires a strong comprehension of chemistry and physics. This resource is not intended to direct any ice sheet owner towards one specific existing or emerging refrigerant product. The information is presented to highlight the complexities of the different options available in today's marketplace. However, there are some common facts that need to form the basis of any selection process. They include, but are not limited to:

- The refrigerant being selected should align with the projected lifecycle of the plant – correctly designed and maintained systems are sealed units which should have little to no refrigerant loss.
- A typical lifecycle of an ice sheet facility is 35-50 years. There should be some expected change to existing regulations that govern use or harm to the environment as part of the selection process.
- Refrigerant use will vary from region to region based on commitment to energy reduction, environmental risk acceptance, and availability.
- Selecting any refrigerant requires an evaluation as to how much reliance on a refrigeration contractor will be required to maintain the system throughout its lifecycle.
- Rarely do governments demand that any chemical be immediately removed due to changes in governance.
- There is an abundance of information circulating on different products that speculate on the future use of some refrigerants. The ORFA will remain diligent in their efforts to track relevant information that is applicable to Ontario and/or Canada to assist our members in their understanding of any changes to the refrigerant landscape.
- Industry marketing materials are always designed in the best interest of the supplier and as such require careful research and fact checking to ensure the information remains accurate and complete. The ORFA will always lean on the proven philosophy of "buyer beware". Although slightly more costly, by keeping the engineering design of any new system separate from the provider

of the refrigerant will help ensure the interest of the equipment owner is the priority.

The ice sheet industry has a long history of being a testing ground for new products and services. Being first may seem like leadership but this can only truly be applied if the purchaser had performed their due diligence during the selection process.



Introduction

Ammonia has long since been the primary refrigerant of choice for many of Ontario's ice sheet refrigeration plants. It is a natural substance that meets the expected qualities of a "good refrigerant" as outlined in the ORFA Basic Refrigeration course. Ammonia is not perfect. It has associated risks and hazards but so do all other refrigerants available in the marketplace. As ice sheet refrigeration plants age or are built close to condensed areas that make access convenient but may present higher human risk is having ice sheet refrigeration plant owners consider other types of primary refrigerants. It is important to note that changes in refrigerant use is not restricted to ice sheet operations. Addressing a specific application/market (food retail) that is very different from ice rinks. As such, it is important for members researching refrigerant options to understand how the information is being presented and does it truly effect our industry.



What Makes Any Primary Refrigerant a Risk?

The evolution of refrigeration equipment and associated safety devices has made ice sheet refrigeration plants very safe. Evaluating any event involving a refrigerant unplanned release can be traced back to several common factors which include but are not limited to:

1. Lack of training of the plant “user” resulting in human error.
2. Lack of investment by the “owner” and/or “user” in maintaining the plant equipment and safety devices as recommended by the manufacturers.
3. Operating equipment past its natural life expectancy – no asset management plan.

Refrigeration Governance

The ORFA Basic Arena Refrigeration (BAR) course focuses on the different codes, regulations and Acts that direct ice sheet refrigeration operations. The primary governing document is the Operating Engineers Regulation (OE) which focuses on the plant’s safe operation while the Boiler and Pressure Vessels Regulations guides equipment design and related responsibilities. Both of these legal documents reference the different types of refrigerants but do not vary in the responsibilities associated with safe operation responsibilities based on type of refrigerant. Operating and maintaining the plant in a safe and serviceable condition remains the same regardless of the design or substances being used to create the refrigeration effect. It is essential that ice sheet refrigeration plant owners are well informed about regional, provincial, and national regulated responsibilities. In addition, understanding what is happening around the world in respect to other countries shift in use or deregulation may give an indication as to how Canada may move some time in the future.



The Phasing Out of HCFC - 22

Over the past 15+years, environmental agencies around the world have been jointly working on the phasing out of HCFC 22 (often referred to as Freon 22 by practitioners) as a refrigerant. This man-made chemical has been identified as a significant contributor to ozone depletion if it escaped. The manufacturing of Freon 22 has been halted. The continued use of Freon 22 as a refrigerant continues to be legally acceptable. However, the unplanned release of Freon 22 into the atmosphere will result in significant consequences. This is resulting in ice sheet plant owners considering their future use of this originally installed refrigerant as the equipment ages.



Advancement in Alternative Refrigerants and Equipment Options

As ice sheet refrigeration plants age and require updating and new buildings are constructed, owners are researching alternatives from traditional refrigerants. Owners who are focused on being viewed as environmentally friendly while assessing the associated risk of proximity of installation are exploring new designs and options that are available

in the marketplace. 744 (C02) is one such option, while R-513A is being offered as an option for those seeking to switch from HCFC 22. The most significant advancement is low charge chillers that are providing high performance with less refrigerant which significantly reduces the risks associated with an unplanned release.



Primary Refrigerant Selection FAQ's:

Q. What refrigerant(s) provide the highest risk?

A. As stated in the opening comments of the resource, **all** refrigerants have risk. An evaluation of incidents involving a refrigerant will always arrive at the same root cause – operator error. This may be a lack of planned maintenance or worker training on a task being performed or a combination of both. Some refrigerants present less risk than others should it escape. Considering these values during the selection process based on region, location of the plant and the design of the facility may be warranted.

Q. Do all refrigerants operate at the same levels of efficiency?

A. Testing has proven that under similar operating conditions some refrigerants may require as much as 30% more horsepower to provide the necessary cooling effect. Canada's weather temperature

swings will add another variable to be considered when selecting a refrigerant and related equipment. In addition, the level of heat recovery that will be available from the selected refrigerant may form an important part of the selection process.

Q. Are all refrigerants price comparable?

A. Like any chemical or product in the marketplace there is a wide range of price points attached to the different refrigerants that will need to be considered when selecting a refrigerant.

Q. What is the status of R-22 (HCFC-22) with respect to ice rinks?

A. R-22 can no longer be installed in new refrigeration systems in Canada or the US. Furthermore, regulations prohibit the manufacture or importation of R-22, however, existing systems containing R-22 can legally continue to be operated and serviced using reclaimed R-22 or converted to operate on alternative refrigerants.

Q. Is there any requirement for owner/operators to remove existing systems?

A. No, there are no regulations in Canada or US that require premature replacement of existing systems, regardless of refrigerant.

Q. What is the difference in a refrigerant phase out versus a phase down.

A. Under the Montreal Protocol, R-22 was phased out, meaning in short it could no longer be manufactured or imported.

More recent regulations, for example the Kigali amendment, call for a phase-down from a baseline using a total carbon equivalent (GWP weighted) basis.

To meet the phase down goals, the overall trend in the HVACR industry will require new construction to consider lower GWP refrigerant options where feasible, while still allowing consideration of other factors such as performance, safety, energy efficiency and total cost.

Q. What does GWP mean?

A. Global Warming Potential, or GWP, is a relative measure of a refrigerant's radiative forcing (ability to trap heat in the atmosphere).

Q. How is the refrigerant GWP limit impacting ice rink refrigeration systems?

A. Understanding the GWP for any refrigerant requires careful research. A plant owner's trying to make a decision today while speculating how it may impact the future. There seems to be a wide discrepancy as to how the GWP targets are being set in Canada and the US. It will be important to ensure that the right application of governance is being considered for a specific region.

Currently in Canada, ice rinks are not specifically separated out but are considered part of the general refrigerant chiller category under the Ozone-Depleting Substance and Halocarbon Alternatives Regulations, which starting in 2025 sets a GWP limit of up to 750 for refrigerants in these types of systems for both existing as well as new construction.

The state of California has always been aggressive in their environmental objectives. However, their decisions do not always make their way to other regions. Using these types of guidelines to try and determine the potential impact over the lifecycle or a refrigerant should form part of an engineer's analysis.

Q. From a Regulatory perspective is there a difference between "natural" and "synthetic" refrigerants?

A. The terms "natural" vs "synthetic" are marketing language, not engineering or legal definitions that influence regulation development. It is a refrigerant's chemical, physical, and environmental properties such as Acute Toxicity Exposure Limits, Flammability Classifications and GWP values that influence industry standards and testing methodology. There is no regulated operational or maintenance responsibility differences based on a type of refrigerant.

Q. What are some compliant refrigerants that meet these new GWP based current regulations?

A. R-717 (ammonia), R-744 (CO₂), and R-513A all meet the current < 750 GWP regulatory restrictions. Other options being considered include R-717, R-744, and <150 GWP HFO refrigerants. Producers of refrigerant have started to work on newer refrigerants that align with various climate objectives.

Q. Are there any new regulations impacting safety and day to day operation of rink refrigeration systems?

A. Local jurisdictions have added additional safety-based regulations including such things as on-site engineers and increased frequency of system testing, inspections and reporting when using some refrigerants. In Ontario, the Operating Engineers Regulation (OE) focuses on the safe operation of an ice sheet plant regardless of refrigerant. The Boiler Pressures Vessels regulations focuses on the equipment and safety devices associated with new construction or retrofits. It is essential that all stakeholders have a working knowledge of these governing resources. Other regions will have similar guidance to conform to.

Q. What is "interim" refrigerant referring to?

A. As indicated, the development of different refrigerants is fluid. Many are in the early stages of being field tested or may be under review in some regions. This does not imply that they are unacceptable for use at this point in time. Selecting a well-informed independent engineer will assist in understanding options, limitations, and the current acceptance of any new refrigerant.

Q. What is the EU F-gas Regulation?

A. The Montreal Protocol (and the Kigali amendment) are international treaties, each country or region delegates regulatory authority to a particular body for specific rule making. For Canada, its Environment Canada thru the ODSHAR, in the states it is the US EPA's Clean Air Act, and in Europe it is the EU F-gas Regulations. They all attempt to accomplish the same thing by achieving the treaty goals but may differ slightly in specific details (such as timelines).

Q. Who is ASHRAE?

A. The **American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)** is an American professional association seeking to advance heating, ventilation, air conditioning and refrigeration (HVAC&R) systems design and construction.

Q. What are A2L refrigerants?

A. The A2L designation is based on ASHRAE Standard 34 which assigns all refrigerants a letter (A = lower toxicity, B=higher toxicity) and a number (1=nonflammable, 2/2L= lower flammability,

3=higher flammability). Most legacy and new refrigerants are classified as A1 (R-22, R-507, R-134a, R-513A, R-744) except for ammonia (B2L).

Sometimes referred to as 'mildly flammable' the 2L refrigerants have very low GWP and will likely be used in the future where and when needed, but only in new systems designed to safely handle them.

Q. What is the best way to stay informed?

A. There was a time that the world-wide-web was viewed as the future for education, awareness, and accurate information time has proven that it can be both a positive and negative resource.

- ASHRAE - [A Conversation on Refrigerants](#)
- Chemical and Engineering News - [CFC replacements are a source of persistent organic pollution in the Arctic](#)
- R744 News - [Canadian Researchers Find Elevated Levels of HFO-1234yf By Product in Arctic Ice](#)
- Fact Check: <https://globalfact.org/wp-content/uploads/2020/09/GF-TFA-MvF-OnePager-090320.pdf>
- TFA: [TFA as an atmospheric breakdown product - Fluorocarbons](#)

Balancing information from manufacturers, suppliers, trade groups, consultants with real time practical application by industry practitioners will be an important part of any research process.

Organizations such as ORFA try to present information in a digestible format designed to promote further investigation.

Regulations continue to evolve so be sure to stay connected and check in frequently to get accurate and up to date information from a variety of reliable sources that you know and trust.

Additional Resources Available as a Benefit of Membership

The ORFA has a wide selection of information relating to safe use and maintenance of ice sheet refrigerants located in the Refrigeration Plant safe Operation section of the on-line Resource Library located at www.orfa.com