



REFRIGERANTS: CHANGES ARE COMING

NOW IS THE TIME FOR FACILITY MANAGERS TO START LOOKING TO THE FUTURE

EXECUTIVE SUMMARY:

Facility managers count on efficient, safe refrigerant solutions to provide cost-effective comfort to building occupants. Today, future refrigerant options are being discussed. Alternative refrigerants are under development; a few are already on the market. With an upcoming refrigerant transition, now is the time for facility managers to learn about what's changing and why. Facility managers who educate themselves now will be in a better position to make the best equipment choices in the future based on refrigerant safety, efficiency, reliability, cost, and availability.

CONTENTS:

Know the Environmental Drivers.....	2
Refrigerant Key Terms	2
Consider Safety.....	3
Understand Current and Potential Regulations	3
Be Aware of the Global Context	3
Learn About Issues and Options.....	4
Give Yourself Time to Decide	4
Make an Informed Decision	5

Concerns about climate change have led to worldwide efforts to reduce greenhouse gas emissions. One result has been new attention to the global warming potential (GWP) of hydrofluorocarbon (HFC) refrigerants. Today, the HVAC&R industry is investing billions of dollars to develop alternative solutions and technologies. As a result, the refrigerant landscape is becoming more complicated than in the past. New refrigerants could increase operating costs by reducing equipment efficiency; the alternatives could also raise installed costs due to additional safety measures needed for refrigerant options that are flammable. There are also the very practical issues of refrigerant price and availability, and the availability of trained service technicians familiar with the new refrigerants.

Today, we are at the beginning of a refrigerant transition – one that will include development of a new generation of alternative refrigerants for a wide range of applications, from chillers, rooftops, and retail food refrigeration to aerosols, foam blowing, automobile air conditioning, and vending machines. Although most facility managers don't face a decision about new refrigerants today, it is worthwhile to start learning about refrigerant choices, since those choices will affect decisions about new HVAC&R equipment. This white paper offers a quick guide that will help facility managers understand the complexities of the transition and the factors that could impact facility operations and budgets.

Know the Environmental Drivers

Refrigerants first became an environmental issue because refrigerants that contain chlorine – like CFCs (i.e., R-11, R-12) and HCFCs (i.e., R-22, R-123) – damage the Earth's ozone layer. HFC refrigerants (i.e., R-410A, R-404A, R-134a), which contain no chlorine and have zero ozone depletion potential, were not affected by the CFC and HCFC phase-outs.

Today, the environmental spotlight is shifting to the GWP of refrigerants. Greenhouse gases like HFCs trap the sun's heat, bringing unwanted changes to the Earth's environment.

When scientists speak of the global warming impact of refrigerants, they generally differentiate between the direct effect and the indirect effect.

For refrigerants, the direct effect is indicated by the GWP rating, which measures how much a given mass of greenhouse gas contributes to global warming. It is important to realize that the direct effect occurs only when refrigerant leaks into the atmosphere. Improvements in manufacturing, technology, and design – along with changes to service practices, education,



**MORE
EFFICIENT
REFRIGERANTS
ENABLE HVAC&R
EQUIPMENT TO
CONSUME LESS
ENERGY AND
PRODUCE
FEWER
EMISSIONS.**

Those emissions typically have far greater global warming impact than direct emissions of the refrigerant caused by leaks.

REFRIGERANT KEY TERMS

GWP – Global warming potential is a measure of the degree to which greenhouse gases, including refrigerants, trap heat in the atmosphere.

CFCs – Chlorofluorocarbons are compounds that contain chlorine and damage the Earth's ozone layer when released into the atmosphere. CFCs were widely used as refrigerants until they were phased out under the Montreal Protocol. CFCs commonly used in air conditioning included R-11 and R-12.

HCFCs – Hydrochlorofluorocarbon refrigerants also contain chlorine, though far less than CFCs, and are also being phased out under the Montreal Protocol. HCFCs commonly used in air conditioning include R-22 and R-123.

HFCs – Hydrofluorocarbon refrigerants do not contain chlorine, but they do have high GWP. These are today's technology of choice and include R-410A and R-134a for commercial applications.

SNAP – The Significant New Alternatives Program of the U.S. Environmental Protection Agency evaluates refrigerants and classifies them as acceptable or unacceptable for different applications. A refrigerant classified as unacceptable cannot be used for that application.

and training – have significantly reduced the potential for such leaks. So the direct effect of refrigerants in equipment is very small, often 5 percent or less of the refrigerant’s total global warming impact.

The indirect effect of refrigerants used in equipment is much larger than the direct effect. The indirect effect is a measure of emissions that result from generating the electricity used by the equipment. Some refrigerants enable equipment to operate more efficiently, so that it uses less electricity. That’s important. The largest source of carbon dioxide emissions in the United States is coal-burning power plants, according to the Natural Resources Defense Council (NRDC). Those plants emit 2.2 billion tons of carbon dioxide every year – roughly 40 percent of total U.S. emissions. More efficient HVAC&R equipment means fewer emissions from fossil-fuel power plants.

The indirect effect can have an enormous negative impact on the environment. For example, the indirect effect for a centrifugal chiller can be 95 percent or more of its total carbon footprint.

While technologies exist to generate electricity from non-polluting sources, it takes time to get them in place due to their cost. Today, high efficiency not only improves the bottom line, but can also help the environment.

Consider Safety

The next generation of refrigerants includes some that are classified as being mildly flammable. These alternatives can be used safely, but facility managers considering them need to consider the prospect of occupant concerns, local code approvals, handling, servicing, storage, and possibly extra costs for protective gear and other equipment as well as the potential impact on property insurance. And some equipment, mechanical rooms, and buildings may have to be modified to handle flammable refrigerants.

Some organizations may have concerns about using refrigerants that are even mildly flammable or toxic. The good news is that some new refrigerant choices are non-flammable.

“Regarding safety, most refrigerant choices today are non-flammable, indicated by an ASHRAE safety class 1,” says Eric Youngdale, global market manager for Opteon brand refrigerants for the Chemours Company.

Understand Current and Potential Regulations

A variety of proposed regulations – in Asia, Europe, and North America – could contribute to confusion among some facility managers, who may fear that refrigerants could suddenly be banned by government action, with little advance warning. It’s important to take a close look at government proposals to understand their likely impact on refrigerants used in chillers and other HVAC&R equipment.

For example, the White House has secured a commitment from key chemical manufacturers – companies that account for 95 percent of U.S. HFC production – to rapidly introduce new refrigerants into the market. Those chemical manufacturers are committing to accelerate work on alternatives, but they are continuing production of HFCs. And the commitment is voluntary, not mandatory.



BE AWARE OF THE GLOBAL CONTEXT

Climate change is a worldwide topic, and many nations are considering actions to reduce the global warming impact associated with refrigerants. As an international consensus forms around refrigerant issues, it may show facility managers the direction that the United States is more likely to take.

There is a widespread international recognition of the importance of refrigerant containment. The goal, says Andrea Voight, director general of the European Partnership for Energy and the Environment (EPEE), is “making installations leak tight and ensuring that people working on these installations have the required competence to do so.” Both are crucial in mitigating the global warming impact of refrigerants. It is only if a refrigerant is released into the atmosphere that the gas itself directly harms the environment.

Another international trend is a push to reduce the use of high GWP refrigerants. “Globally, there is growing consensus about the need to address high-GWP products, with countries including China and India calling for action,” says Thomas Morris, commercial development director at Honeywell Refrigerants.

These actions abroad often aim at a gradual reduction in the use of HFCs. For example, the European Union’s F-gas Regulation, which went into effect Jan. 1, 2015, limits the amount of HFCs that can be placed on the market from this point forward. HFC phase down provisions intend to reduce by 79 percent the allowable amount of HFCs sold annually by 2030.

In addition, an international amendment to the Montreal Protocol is under discussion. The amendment “would cap and phase down the net global warming potential from HFCs currently being used by individual countries,” says Eric Youngdale, global market manager for Opteon brand refrigerants for the Chemours Company.

As facility managers look to the future, paying attention to the global context will help identify key principles of refrigerant choice.



REFRIGERANT DECISIONS SHOULD CONSIDER MANY FACTORS

including occupant and staff safety, energy use, refrigerant costs, chiller life, refrigerant and technician availability, code requirements, and many other issues.

The White House roundtable also produced commitments from other HVAC&R companies. Johnson Controls, for example, committed to develop steps to ensure that flammable refrigerants can be used safely and to work on measures to future-proof HVAC&R equipment decisions. Those steps include introducing low GWP refrigerant options, and offering products that can be easily converted to low-GWP options, as well as services to retrofit existing equipment. The objective is to provide customers with peace of mind about long-term equipment decisions.

There are other cases where a closer look at proposed government actions will show facility managers there is no need to panic. For example, EPA issues refrigerant regulations under the Significant New Alternatives Program (SNAP), which evaluates the overall risk to human health and the environment of both existing and new refrigerants and publishes lists of acceptable and unacceptable refrigerants. As part of the SNAP process, EPA examines refrigerants sector by sector, seeking industry input in its evaluation of options.

Under SNAP, EPA recently banned several common high-GWP refrigerants – including R-134a and R-404A – from certain industry applications. But those regulations affect sectors like motor vehicle air conditioning systems, retail food refrigeration equipment, and vending machines. The recent bans do not involve the use of either refrigerant in chillers, rooftop units, heat pumps, etc.

As part of its ongoing evaluation of refrigerant options under SNAP, EPA will be investigating changes in the SNAP status of HFC refrigerants used in chillers. But any regulation of those refrigerants must go through a rulemaking process that seeks input from industry representatives and the public. Based on past EPA rulings, facility managers can expect that any decision to curtail annual production and consumption allowances will allow enough time to have viable alternatives, both in new equipment. What's more, any change in the SNAP listing affects new equipment only and doesn't ban the use of refrigerant for existing equipment.

Facility managers who take the time to understand government regulations understand that there's no reason to rush into changing refrigerants.

Learn About Issues and Options

Now is the time to start getting educated about the transition and what it will mean to facilities. By learning about issues and options

now, facility managers can prepare themselves for tomorrow's refrigerant choices.

When CFC refrigerants were phased out, the choices for alternatives were straightforward for chillers and other HVAC&R equipment. The future will be more complex. The new refrigerant options will offer trade-offs on flammability, efficiency, availability, reliability, and cost. As manufacturers develop equipment that uses different alternative refrigerants, facility managers may have to evaluate several refrigerants to determine which is best suited to their needs.

Refrigerants need to be evaluated on such details as building-occupant and facility-staff safety, energy use, refrigerant costs, chiller life, refrigerant and service technician availability, local code requirements, and numerous other factors.

Taking an overly simple approach to these complex questions could have negative long-term consequences for facility managers. For example, everyone agrees that lower GWP refrigerants are desirable. But it's not the only factor to consider.

Take for example, a centrifugal chiller. The average efficiency has improved 40 percent during the last several decades, thanks to optimized aerodynamic designs, new heat exchangers, optimized controls, new bearing technology, and variable-speed drives. These energy efficiency gains are part of the big picture that should be considered in evaluating alternative refrigerants.

"It is important not to fall in the trap of considering the GWP of the refrigerant only," says Andrea Voight, director general of the European Partnership for Energy and the Environment (EPEE). "Indeed, some refrigerants may look very attractive at first sight because they have a very low GWP, but may simply not be suitable for all applications, climate zones, etc."

Give Yourself Time to Decide

While facility managers are well-advised to start learning about alternative refrigerants, there is no need to rush into a decision. Rather, the most prudent course is to monitor the progress of the HVAC&R industry as it works through a range of issues related to alternatives. Here are key developments to watch:

Codes – Equipment and mechanical room safety standards are being revised to address the new classes of flammability, so that they can

be incorporated into revised building codes. Building mechanical codes are reviewed and revised every several years. Once revised, these codes then need to be adopted by local jurisdictions. It can take up to five to 10 years before new codes are adopted and enforced.

Availability – New chemical plants are already being built to produce some next-generation refrigerants. But not all refrigerants will be produced in large volumes, and for those options facility managers will have to confirm there are adequate local supplies on hand.

Support – Industry experts note that technicians must be trained to service the new refrigerant technology, and some HVAC&R equipment will need to be modified to use the new refrigerants effectively. For facility managers, the key question is whether local support familiar with these new refrigerants will be available.

Refrigerant Performance – ASHRAE's Low-GWP Alternative Refrigerants Evaluation Program tested many low-GWP fluids. The industry is working on the equipment modifications needed to optimize performance around these new fluids. In the case of high pressure refrigerants typically used with scroll and rotary type compressors, the alternatives outperformed currently available refrigerants – yet all of these options have varying degrees of flammability that will have to be dealt with. For centrifugal and screw compressor platforms, trade-offs in performance or flammability need to be addressed, with implications for operating cost, and potentially installed cost. Much more work needs to be done to overcome the limitations of many potential alternatives.

“Selecting the right refrigerant requires considering the optimal balance of properties – performance, safety, environmental impact, and total cost of ownership – for each application,” explains Youngdale.

MAKE AN INFORMED DECISION

Current refrigerants offer proven solutions that offer efficiency and safety. But the move to lower GWP refrigerants is no cause for facility managers to be alarmed. Refrigerants with lower GWPs are being developed and commercialized. The industry is working to balance performance, safety, environmental impact, and total cost of ownership for each application. Some alternatives are close matches in properties and performance to the HFC refrigerants they are designed to replace.

But facility managers need to take the initiative if they are to choose the best refrigerants for their facilities. The first step is to gather information. Today there are many channels of information readily available. As facility managers do their own research, they should also look for industry expertise to help them analyze their options. Facility managers, says Eric Youngdale, global market manager for Opteon brand refrigerants for the Chemours Company, “need to maintain a dialogue with their equipment OEMs to ensure they have the best equipment and refrigerant strategy for the short and long term.” Finding a trusted partner like Johnson Controls can help facility managers ensure that they have correctly balanced all the factors involved in refrigerant decisions.



[The Johnson Controls Refrigerant Reservoir](#) is your single-stop resource for concise information about what is happening within the HVAC&R refrigerant and energy industry. Bookmark JohnsonControls.com/Refrigerants and check back often to stay current on the topic of refrigerants and energy.

If you have questions or comments, please contact BE-Refrigerants@jci.com.

Johnson Controls, the Johnson Controls logo, and York® are registered trademarks of Johnson Controls, Inc., or its affiliates, in the United States of America and/or other countries.

©2015 Johnson Controls, Inc.
P.O. Box 423, Milwaukee, WI 53201. PUBL-7820 (Rev 12/15)

www.johnsoncontrols.com

