

# A Sea of Change in Small-Format Refrigeration

*Regulations bring natural refrigerants' viability to the forefront*

GWP EPA DOE

A2L CO<sub>2</sub>

Propane

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## *In recent years, the industry has made tremendous progress in developing equipment that is more environmentally friendly and energy efficient than their predecessors.*

**O**f all the commercial refrigeration sectors impacted by President Obama-era regulatory activities, the small-format retail and foodservice markets have arguably been hit the hardest. Comprised of small grocers, convenience stores and restaurants, these markets not only utilize the widest variety of equipment and system architectures, they are also faced with understanding new refrigerant requirements in each equipment class. The net result is a sea change to refrigeration architectures in these segments — one where natural refrigerants propane (or R-290) and CO<sub>2</sub> (or R-744) play an increasingly vital role.

With so many factors impacting these markets, it's easy to see why there's an unusually high degree of confusion and uncertainty. Making sense of it all is not easy, but many owner/operators are tasked with selecting the refrigeration platforms that will accomplish their short- and long-term operational objectives. And with numerous regulatory deadlines from both the Environmental Protection Agency (EPA) and the Department of Energy (DOE) approaching, these decisions must be made quickly.

In recent years, the industry has made tremendous progress in developing equipment that is more environmentally friendly and energy efficient than their predecessors. While recent actions from the Trump administration suggest that deregulation measures may yet be on the horizon, the specific extent of these changes is still largely unknown. As things currently stand, environmental regulations introduced by the previous administration remain in place, and the transition to equipment that utilize refrigerants with lower global warming potential (GWP) is still underway.

### **New natural refrigerant equipment and system architectures**

Because of this convergence of regulatory activity, operators can expect new equipment options and architectures from OEMs. It's also becoming more common for retailers and restaurant chains to state sustainability objectives — from the selection of eco-friendly refrigerants to lowering their overall carbon dioxide equivalency.

In response, many OEMs have taken the approach of integrating both EPA and DOE requirements in the same design cycle. This entails selecting a refrigerant that offers both lower-GWP levels and performance efficiencies to meet the new energy targets. Among these OEMs, some are developing new units in hopes of achieving compliance for future, potentially lower-GWP requirements. For those taking this “end game” approach and attempting to clear these regulatory hurdles once and for all, natural refrigerants

are currently the only options for achieving this objective. Here's a look at some of the new equipment and system architectures for R-290 and R-744.

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## **R-290**

### **Overview**

As a viable replacement to R-404A and HFC-134a, R-290 delivers well-documented performance efficiencies and superior thermodynamic properties, without compromising capacity. And in Emerson's independent test labs, R-290 consistently outperforms R-404A by delivering energy efficiency gains of more than 20 percent.

The caveats for R-290 use come down to its flammability (class A3), serviceability concerns and charge limits. While there are currently no certification requirements to service R-290 systems, operators may have difficulty finding technicians who are comfortable handling and servicing the equipment. In many instances, serviceability concerns are largely offset by equipment design — as many systems are self-contained and factory-sealed to enable “plug and play” installation and servicing.

The 150g charge limit currently restricts R-290 use to smaller systems that utilize fractional horsepower compressors or condensing units (see side bar: *A3s and A2Ls: Safety standards and charge limits*).

### **Applications**

**Stand-alone** — R-290 is most commonly found in self-contained display cases that feature a built-in condensing unit in each refrigeration fixture. These cases have been in service for more than a decade in Europe and have become increasingly popular in the U.S. in recent years.

**Integrated cases** — deployed as an alternative to centralized systems, these large refrigeration cases integrate multiple R-290 compressors on individual 150g circuits. And each compressor has its own supporting system components (e.g., fans, valves, piping, etc.). This is an instance where larger charge limits would greatly simplify equipment design and expand application potential.

**Micro-distributed architecture** — like stand-alone cases, each fixture is designed with its own condensing unit. The difference is, micro-distributed systems are designed to remove exhaust heat from the building through a shared heat rejection/water loop system that extracts the heat from each unit and diverts it to a condenser/cooler on the roof. While store comfort is optimized,



## Understanding the nature and timing of EPA and DOE deadlines

Throughout the next five years, there will be several EPA and DOE regulatory hurdles that stakeholders in these markets must clear. The EPA has set a phase-out schedule for the use of hydrofluorocarbon (HFC) refrigerants with a high GWP, while the DOE has established new energy consumption guidelines

for specific classes of refrigeration equipment. Unfortunately, compliance dates from each agency aren't necessarily in sync. For original equipment manufacturers (OEMs), understanding the overlap of these regulations presents an opportunity to comply with both regulatory initiatives in one design cycle.

### Five-year outlook:

EPA refrigerant and DOE energy reduction regulations in small-format refrigeration

	2017	2018	2019	2020	2021
<b>Supermarket (rack)</b>	<b>EPA 1/1/17</b> Phase out: R-404A, R-507A				
<b>Walk-in coolers and freezers (remote condensing units)</b>	<b>DOE 6/26/17</b> OEM deadline for certification of medium-temperature condensing units.	<b>EPA 1/1/18</b> Phase out: R-404A, R-507A		<b>DOE 1/1/20*</b> 20–40 percent (cooler) energy reductions  20–30 percent (freezer) energy reductions	
<b>Stand-alone coolers with &lt; 2,200 BTU</b>	<b>DOE 3/27/17</b> 30–50 percent energy reductions		<b>EPA 1/1/19</b> Phase out: R-404A, R-507A, R-410A, R-407A/C/F, HFC-134a		
<b>Stand-alone coolers with &gt; 2,200 BTU</b>	<b>DOE 3/27/17</b> 30–50 percent energy reductions			<b>EPA 1/1/20</b> Phase out R-404A, R-507A, R-410A, R-407A/C/F, HFC-134a	
<b>Stand-alone freezers</b>	<b>DOE 3/27/17</b> 30–50 percent energy reductions			<b>EPA 1/1/20</b> Phase out R-404A, R-507A, R-410A, R-407A/C/F	
<b>Ice machines</b>		<b>DOE 1/1/18</b> 5–15 percent energy reductions			
<b>Dispensing units</b>					<b>EPA 1/1/21</b> Phase out R-404A/ R-507A, R-410A, R-407A/C/F

\*These regulations have been recently withdrawn from publication in the Federal Register and are currently under review by the DOE.

It's important to note that the EPA has listed R-290 acceptable for use in new stand-alone units and ice machines, while R-744 is allowable in all the above classes. R-290 has a GWP of 3; R-744 has a GWP of 1. Other

synthetic refrigerant options are available, but none deliver ultra-low GWP levels, i.e., below 150 GWP, which is considered the hypothetical threshold for exemption from future regulatory action.

operators may expect higher first costs and a slight energy penalty due to the secondary heat exchange design. However, in warmer climates, the removal of exhaust heat from a facility — and the load reduction on the HVAC system — may offset this penalty.

**Ice machines** — the EPA recently listed R-290 as acceptable for use in ice machines<sup>4</sup>. The type of ice machine (cuber or flaker) is a key design consideration for OEMs, but component manufacturers are offering fractional horsepower compressors to integrate with both types and help with evaporator design.

## R-744

### Overview

R-744 systems have been deployed in Europe for nearly two decades, and have proved to be a very effective alternative to HFCs in both low- and medium-temperature applications. Only in recent years has the U.S. seen wider R-744 adoption in commercial refrigeration. Because R-744 has a high operating pressure (around 1,300 psig or 90 bar) and low critical point, refrigeration strategies must be designed to account for its unique characteristics.

While CO<sub>2</sub> is more common in large-format grocery stores, OEMs have begun manufacturing systems and components sized for smaller equipment. Current trends show that system costs proportionately rise with the development of smaller equipment and condensing units. However, these R-744 systems are considered “future proof” to global regulations and directives.

### Applications

**Small, centralized CO<sub>2</sub> systems** — appropriately sized for small-format applications, these systems are based on existing CO<sub>2</sub> architectures (such as cascade and transcritical booster). A typical small system relies on four compressors to supply the complete refrigeration needs of the retailer.

**Remote condensing units** — many OEMs are manufacturing CO<sub>2</sub> condensing units that can serve small-format needs, such as walk-in freezers and coolers. These recently developed solutions will likely become increasingly used in applications in the coming years.

### Stay informed to make the best decision for your operation

While there are still a lot of unanswered questions in the small refrigerated equipment space, natural refrigerants currently offer viable options for today’s operators selecting new refrigeration platforms. Over the next several years, regulatory agencies and governing bodies will hopefully bring additional clarity about

refrigerant use in available equipment architectures. As OEMs continue to design, test and certify these new equipment offerings, operators must stay informed of any changes in the marketplace to help them make decisions that align best with their business objectives.

## A3s and A2Ls: Safety standards and charge limits\*

In addition to natural refrigerants, the industry is also looking to the promise of synthetic A2Ls (mildly flammable) as ultra-low-GWP alternatives to HFCs. Today, there are global efforts underway to evaluate the refrigerant classifications, safety standards and charge limits of A2Ls and A3 (R-290), with flammability studies of both to determine their behaviors in real-world applications. Here’s a summary of these activities:

### Review A2L safety standards:

- U.S.: UL 1995, ASHRAE 15; target date is late 2017
- International: ISO 5149, IEC 60335, EN378; target date is late 2017

### Update building codes:

- Building codes for A2Ls are under review for adoption in the 2021 code cycle

### Evaluate charge limits:

- Raising the A3 charge limit from 150g to 300g–500g in the U.S.
- Raising the A2L charge limit from 500g to 1kg in the U.S.

### Flammable refrigerant study:

- \$5.2M partnership by AHRI, ASHRAE and DOE to study flammable refrigerant behavior in real-world applications

The first key point from this activity is this: If the safety standards activities conclude in 2017 and the governing bodies ratify them in 2018, the soonest these standards could be effective in the building codes is 2021.

Second, the potential to increase R-290’s charge limits up to 500g and A2Ls to 1kg has broad implications to the applications discussed herein. It would allow larger-horsepower compressors and systems to carry higher refrigerant charges, thus simplifying system design and expanding their applicability.

Finally, it’s important to note that the EPA has yet to list any of the ultra-low GWP A2Ls (or those with less than 150 GWP) as acceptable for use in commercial refrigeration.

\* Information presented herein may not represent the latest regulatory standards and/or updates.