



NORTH AMERICAN  
Sustainable  
Refrigeration  
Council

### Alternative Refrigerants for Commercial Refrigeration Applications and Current United States Approval Status

Category	Current Refrigerants (GWP <sup>1</sup> , Class <sup>2</sup> , Retrofit <sup>3</sup> )	Future Low GWP Alternative (GWP, Class)	US Approval Status <sup>4</sup>
Stationary Refrigeration (>50 lbs.) – Remote systems, Direct Expansion	R-22 (1810, ODS) R-404A (3922, A1) R-507A (3985, A1) R-407A (2107, A1, R) R-448A (1386, A1, R) R-449A (1396, A1, R) R-513A (630, A1, R) R-744 (1, A1)	R-454A (237, A2L) R-515A (287, A1) R-454C (146, A2L) R-455A (146, A2L) R-471A (140, A1) R-1234yf (1, A2L) R-1234ze (1, A2L) R-744/HVAC (1, A1)	<ul style="list-style-type: none"> <li>While R-22 (Ozone Depleting Substance) has been banned by the EPA under the Montreal Protocol, there remains a large number of installed systems that are still in the process of transitioning away from this refrigerant.</li> <li>EPA SNAP Rule 20 and 21 (partially reinstated) banned high GWP refrigerants such as R-404A and R-507A in new and retrofit applications, a number of states have adopted the SNAP rules.</li> <li>California has passed regulations limiting the GWP for systems &gt; 50 lbs. in new retail food facilities to less than 150 GWP and set GWP targets for existing stores to meet by 2030. The industry sees the potential for a similar restriction for new systems at the federal level starting as early as 2025, and is awaiting additional details from the EPA in the near future.</li> <li>Mid-range GWP alternative refrigerants, such as R-448A and R-449A, are “drop-in” or retrofit compatible options for some refrigerants, however due to GWP considerations, there are concerns about their future compliance and availability due to the phasedown of HFC refrigerants under the AIM Act.</li> <li>Technologies using Zero and Near-Zero GWP refrigerants, such as CO<sub>2</sub> (R-744), Propane (R-290), and Ammonia (R-717), are available in the US today, but are not retrofit compatible with synthetic refrigerant Direct Expansion (DX) systems and usually require full replacement of all equipment.</li> <li>CO<sub>2</sub> Transcritical (R-744) systems continue to make advancements in energy performance and reduction in cost, including new system architectures that fully integrate with the HVAC system to take advantage of heat reclaim benefits and take advantage of the R-744 system high operating pressure to improve efficiency.</li> <li>Indirect systems (ID), using secondary or cascade architectures with a primary refrigerant acting as a chiller on the high side to cool a secondary system on the low side (R-744, glycol,</li> </ul>
Stationary Refrigeration (>50 lbs.) – Remote systems, Secondary, Cascade, Indirect, Chillers	R-404A (3922, A1) R-507A (3985, A1) R-407A (2107, A1) R-407C (1774, A1) R-448A (1386, A1, R) R-449A (1396, A1, R) R-134a (1430, A1, R) R-513A (630, A1, R) R-290 (3, A3) <sup>5</sup> R-744 (1, A1) R-717 (0, B2L)	R-515B (287, A1) R-454C (146, A2L) R-471A (140, A1) R-290 (3, A3) R-1234yf (1, A2L) R-1234ze (1, A2L)	<ul style="list-style-type: none"> <li>Technologies using Zero and Near-Zero GWP refrigerants, such as CO<sub>2</sub> (R-744), Propane (R-290), and Ammonia (R-717), are available in the US today, but are not retrofit compatible with synthetic refrigerant Direct Expansion (DX) systems and usually require full replacement of all equipment.</li> <li>CO<sub>2</sub> Transcritical (R-744) systems continue to make advancements in energy performance and reduction in cost, including new system architectures that fully integrate with the HVAC system to take advantage of heat reclaim benefits and take advantage of the R-744 system high operating pressure to improve efficiency.</li> <li>Indirect systems (ID), using secondary or cascade architectures with a primary refrigerant acting as a chiller on the high side to cool a secondary system on the low side (R-744, glycol,</li> </ul>

<sup>1</sup> AR4, 100-year GWP, if not contained in AR4, AR5 100-year GWP used

<sup>2</sup> ASHRAE Standard 34 classifies new refrigerants based on flammability and toxicity. Toxicity Groups: A – Nontoxic, B – Toxic. Flammability Classes: 1 – No flame propagation (i.e., non-flammable), 2L – Lower flammability 2 – Flammable, 3 – Higher flammability

<sup>3</sup> Refrigerants that are retrofit compatible or “drop-in” to an existing system are denoted with an “R”

<sup>4</sup> Summary of current status of US EPA SNAP regulations, UL, ASHRAE, building codes, and applicable state and federal regulations

<sup>5</sup> Test market approval only

			<p>or other), have been popular alternatives to Direct Expansion (DX) systems. While ID systems significantly reduce leak rates, there can also be energy penalties due to the need for additional heat exchangers.</p> <ul style="list-style-type: none"> <li>● Food retailers are exploring options to convert existing high GWP DX systems to ID systems using mid-range GWP refrigerants available today (R-448, R-449, R-513A) on the high side, with the intention of replacing with lower GWP solutions as they become available.</li> <li>● While some Ammonia (R-717) chillers exist today, they are typically oversized for food retail applications, and are therefore cost prohibitive, as they were primarily designed for larger industrial uses. Use of B2L refrigerants like R-717 in public facing applications, or located in residential settings, can be cost prohibitive due to the toxicity concerns.</li> </ul>
Remote Condensing Units	R-404A (3922, A1) R-507A (3985, A1) R-407A (2107, A1) R-448A (1386, A1) R-449A (1396, A1) R-744 (1, A1) R-290 (3, A3)	R-513A (630, A1) R-450A (601, A1) R-454B (465, A1) R-454A (237, A2L) R-454C (146, A2L) R-455A (146, A2L) R-471A (140, A1) R-290 (3, A3) R-1234yf (1, A2L)	<ul style="list-style-type: none"> <li>● Remote condensing units have been typically used to serve new or specialty loads in addition to the refrigeration rack (DX or ID). While they are typically less energy efficient than a remote system, they are a good solution to ensure regulatory compliance by using less than 50 lbs. of refrigerant.</li> <li>● There is a growing interest in using remote condensing units to migrate away from an existing HFC remote system over time to comply with federal and state regulations. This modular approach can result in less upfront capital investment and is logistically less disruptive to store operations during remodels than replacing the entire refrigeration system at one time.</li> <li>● Increased energy use, future maintenance expense and product integrity concerns exist with remote condensing units due to limited capacity control to meet fluctuating refrigeration load.</li> <li>● While Food Retailer demand for Zero or Near-Zero GWP condensing units is high, there remain relatively few products available in the US market.</li> </ul>
Self-contained Refrigerated Cases – Stand-alone or Micro-Distributed Systems	R-448A (1386, A1) R-449A (1396, A1) R-513A (630, A1) R-290 (3, A3)	R-454A (237, A2L) R-454C (146, A2L) R-455A (146, A2L) R-290 (3, A3) R-1234yf (1, A2L) R-744 (1, A1)	<ul style="list-style-type: none"> <li>● Micro-Distributed systems (MDS) are gaining traction as an alternative to remote systems and offer potential benefits, such as regulatory compliance, reduced costs of installation, energy, maintenance and service, and increased flexibility in merchandizing.</li> <li>● The use of R-290 is promising, especially in the modular conversion of existing stores, but is currently limited by charge restrictions of 150 grams per circuit.</li> <li>● UL standard 60335-2-89 approved an increase in the allowable charge limits for A3s (R-290) and A2Ls in October 2021. EPA SNAP applications are under review and ASHRAE 15 is in the process of updating the standard to match UL. State and local building code updates will be necessary for most states.</li> </ul>