HVAC Industry Update

Industry Consensus on HFC Refrigerants

The industry continues to work through global and national associations to engage with non-governmental organizations (NGOs) and governments to ensure that the Kigali Amendment to the Montreal Protocol is used to transition away from high-GWP refrigerants in a way that is technically feasible, safe, and allows for servicing of existing equipment to ensure a useful life from equipment investments.

Refrigerant Regulatory Evolution

The global scrutiny on the GWP of all current generation refrigerants continues to increase, pushing the industry to next-generation options, including the introduction of new transitional refrigerants to help offset the increasing global demand for HVAC with the requirements to reduce greenhouse gas emissions.

Key Terms Defined:

- **ODP** – ozone depletion potential – degree to which a substance can degrade the ozone layer; all measurements relative to a similar mass of CFC-11, which is indexed at 1.0.
- **GWP** – global warming potential – degree to which a greenhouse gas (GHG) traps heat in the atmosphere; all measurements relative to a similar mass of carbon dioxide (CO₂), which is indexed at 1.0. The buildup of GHGs can cause climate change.
- **CFCs** – chlorofluorocarbons (e.g. R-11, R-12) – phased out by the Montreal Protocol in 1996 because of their very high ODPs. Significant impact on both ozone depletion and global warming due to the chlorine and fluorine atoms and very long atmospheric lives.
- **HFCs** – hydrofluorocarbons (e.g. R-123, R-134a, R-32) – also contain chlorine, but they do have high GWPs given their fluorine content. Now being phased down globally, but have phase-out dates scheduled under the Montreal Protocol.
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- **HFO blends** (e.g. R-452B, R-454B, R-513A, R-514A) – blends including an HFO. They are considered HFO blends if they contain an HFO and have ultra-low GWP and ODP.
- **Azeotropes** (e.g. R-1233zd) – next-generation refrigerants that are non-ozone-depleting with ultra-low GWPs and very short atmospheric lives (measured in days vs. years or decades).

National and regional regulations restrict the use of high GWP HFCs.

**Regulatory Timeline**

**HFCs**
- 2020: Use of virgin R-123 in new equipment ended.
- 2021: Use of virgin R-113 in new equipment ended.
- 2026: California HFC phase-down in chillers for GWP > 750.
- 2024: Petition for national VRF phase-down for GWP > 750.
- 2025: California HFC phase-down in Chillers to 25% for GWP > 750.
- 2026: Cuisine HFC phase-down in Chillers for GWP > 750.
- 2024: California HFC phase-down in new Chillers for GWP > 750.

**CFCs & HFCs**
- 1998
- 2000: Use of virgin R-11 in all equipment ended.
- 2000: Use of virgin R-113 in all equipment ended.
- 2000: Use of virgin R-123 in all equipment ended.
- 2000: Use of virgin R-12 in all equipment ended.
- 2040:
- 2060:

**Refrigerant Management Requirements**

Section 609 of the U.S. Clean Air Act defines proper management of refrigerants used in HVAC equipment, including maximum limits for fugitive emissions and proper handling requirements during service and repair of the equipment. It continues to evolve, generally with increasing stringency. The U.S. EPA revised its refrigerant management rule in 2016 to add HFCs, increase leak detection, repair and record keeping requirements. The rule was partially rolled back in 2020 following litigation, but the EPA is expected to restore the provisions based on a recent petition from states and cities.

Future Availability

The U.S. EPA allows for continued use of recycled, recovered and stockpiled supplies of all refrigerants indefinitely, regardless of phase-out date.

Global HFC Phase-Down Effective January 1, 2019

A look at the global phase-down schedule established by the Kigali Amendment to the Montreal Protocol, which became official on November 17, 2017 when it received its 20th ratification. Europe is shown separately as they are leading the global phase down with actions already taken.

More information available at: [http://ozone.unep.org/sites/default/files/FAQs_Kigali_Amendment.pdf](http://ozone.unep.org/sites/default/files/FAQs_Kigali_Amendment.pdf)

American Innovation & Manufacturing Act of 2018

The AIM Act is a bipartisan bill enacted December 17, 2020. It directs the EPA to address the environmental impact of hydrofluorocarbons (HFCs) by phasing down production and consumption, maximizing reclamation and minimizing releases from equipment, and facilitating the transition to next-generation technologies through sector-based restrictions. [https://www.epa.gov/climate-hfcs-reduction](https://www.epa.gov/climate-hfcs-reduction)

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Non-Article 5 Countries: European Union (EU) Other Non-Article 5 Nations Article 5 Countries: Group 1 Group 2

10% 20% 30% 40% 50% 60% 70% 80% 90% 100% 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 Group 1: Article 5 parties not part of Group 2 Group 2: Bahrain, India, the Islamic Republic of Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia and the United Arab Emirates
Considerations When Selecting Refrigerants

**Flammability**

With the transition to lower-GWP refrigerant options, flammability has emerged as a new variable for consideration, especially in higher operating pressures.

In 2010, a new flammability category was created within ASHRAE 34. Subclass 2L captures refrigerants with a Burning Velocity (BV) of less than 10 cm/second and a high Minimum Ignition Energy (MIE), indicating higher difficulty to ignite.

2L refrigerants have faced challenges in application due to being perceived as Class 2 refrigerants. Codes and standards are now in the process of being updated to include more reasonable requirements that reflect the less flammable nature of 2L refrigerants compared to Class 2 flammability. ASHRAE 15 and ASHRAE 34 were updated to reflect this change in 2019, and UL 60335-2-40 was updated in 2017. These changes have been making their way into UMC and IMC code over subsequent years, with full adoption still pending for certain equipment.

Trane is committed to offering non-flammable solutions whenever possible, and the lowest possible flammability when slightly flammable solutions are required.

**Toxicity**

This is, perhaps, one of the most misunderstood properties of refrigerants. Specifically, it is important to distinguish between toxicity and safety; they are not the same. Because refrigerants displace oxygen, the greatest safety risk associated with all refrigerants is exposure leading to asphyxiation. Occupants are significantly less likely to be exposed to unsafe levels of low pressure refrigerants because – in the event of a leak – air would leak into the machine rather than being expelled into the space.

ASHRAE 34 classifies a refrigerant’s toxicity based on its operational exposure limit (OEL). OEL refers to the time-weighted average concentration of refrigerant to which “nearly all workers can be repeatedly exposed without adverse effect” over the course of “a normal eight-hour workday and a 40-hour workweek”.

- Class A refrigerants have an OEL ≤ 400 ppm
- Class B refrigerants have an OEL > 400 ppm

R-123 has an OEL of 50 ppm. This means you should see no negative effect if you are exposed to 50 ppm of R-123 for 8 hours/day, 40 hours/week. For chiller applications, rarely do mechanical rooms see > 2 ppm, and this exposure typically occurs during servicing for very short periods of time.

To avoid confusion with building code definitions, ASHRAE 34 was updated to indicate toxic, highly toxic or neither as defined in the International Fire Code (IFC), Uniform Fire Code (UFC) and OSHA regulations. None of the refrigerants shown in the table are considered toxic or highly toxic by the IFC, UFC or OSHA, or in the NFPA 1 (National Fire Protection Association) Fire Code.

**Operating Pressure by Refrigerant**

This graphic compares the operating pressures of each refrigerant:

- **Low Pressure**: pressures below 100 psig (6.9 bar)
- **Medium Pressure**: pressures between 100 and 250 psig (6.9 and 17.2 bar)
- **High Pressure**: pressures above 250 psig (17.2 bar)

**Environmental Impact by Refrigerant**

Below are the theoretical efficiencies of common refrigerants, with all variables held constant for comparison:

**Refrigerant Choices**

This table compares various properties of both current and next-generation refrigerants. The efficiencies and capacity changes shown are based on the theoretical properties of the refrigerant alone, with all design variables held constant for objective comparison.

**How Do You Protect Your Investment?**

Choose the best refrigerant for each application based on a balance of safety (toxicity, flammability, asphyxiation and physical hazards), environmental impacts (lowest GHG emissions) and total cost of ownership (energy efficiency of the entire system).

The Trane Technologies EcoWise® portfolio of products designed to lower environmental impact with next-generation, low-GWP refrigerants and higher efficiency operation is part of our climate commitment to increase energy efficiency and reduce the GHG emissions related to our operations and products.