



Refrigerant Update

THE NEXT TRANSITION HAS BEGUN

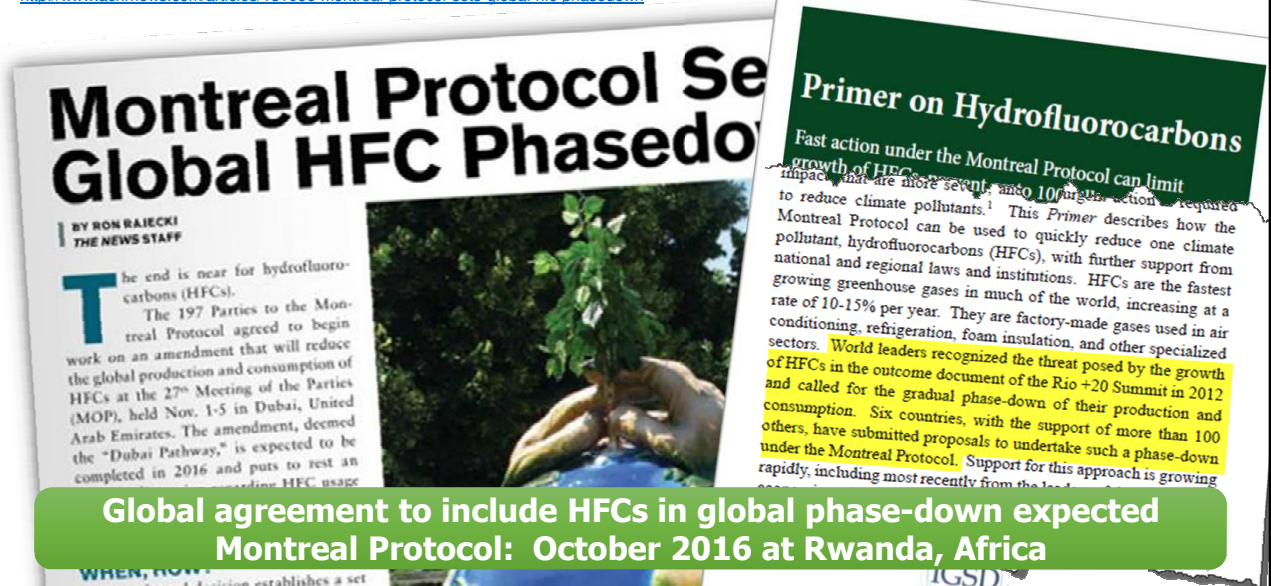


W. Ryan Geister
Systems Leader
Trane, An Ingersoll-Rand Company

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World Motivation Driving Actions

Montreal Protocol targets new global agreements on greenhouse gases (GHGs)
<http://www.achrnews.com/articles/131056-montreal-protocol-sets-global-hfc-phasedown>



Montreal Protocol Sees Global HFC Phasedown
BY RON RAJECKI
THE NEWS STAFF

The end is near for hydrofluorocarbons (HFCs). The 197 Parties to the Montreal Protocol agreed to begin work on an amendment that will reduce the global production and consumption of HFCs at the 27th Meeting of the Parties (MOP), held Nov. 1-5 in Dubai, United Arab Emirates. The amendment, deemed the "Dubai Pathway," is expected to be completed in 2016 and puts to rest an... HFC usage

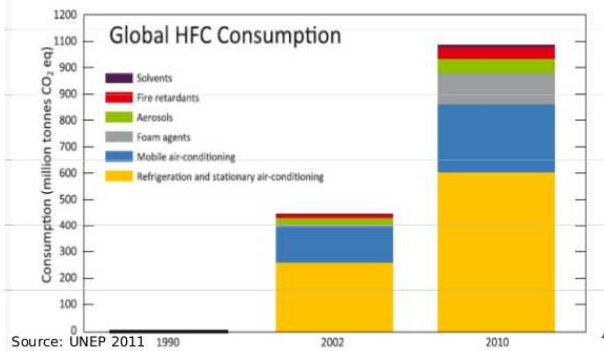
Primer on Hydrofluorocarbons
Fast action under the Montreal Protocol can limit growth of HFCs, prevent impact that are more severe, and 10 years of action required to reduce climate pollutants. This Primer describes how the Montreal Protocol can be used to quickly reduce one climate pollutant, hydrofluorocarbons (HFCs), with further support from national and regional laws and institutions. HFCs are the fastest growing greenhouse gases in much of the world, increasing at a rate of 10-15% per year. They are factory-made gases used in air conditioning, refrigeration, foam insulation, and other specialized sectors. World leaders recognized the threat posed by the growth of HFCs in the outcome document of the Rio +20 Summit in 2012 and called for the gradual phase-down of their production and consumption. Six countries, with the support of more than 100 others, have submitted proposals to undertake such a phase-down under the Montreal Protocol. Support for this approach is growing rapidly, including most recently from the... IGSD

Global agreement to include HFCs in global phase-down expected
Montreal Protocol: October 2016 at Rwanda, Africa

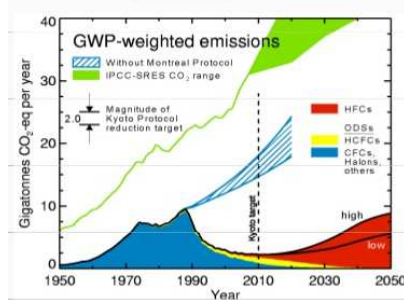
What is Driving Action in the USA?

Dramatic global growth of high-GWP HFCs

Recent HFC Growth Dramatic and Increasing



HFCs: Potential Growth If Unmitigated



- HFC growth directly linked to Montreal Protocol's ODS phaseout and expanding availability of refrigeration & air conditioning
- HFC emissions could reach 19% of projected global CO₂ emissions by 2050 if left unchecked

Alignment with expected Montreal Protocol Amendment in 2016

World Motivation Taking Action

Montreal Protocol Targets New Global Agreement on Greenhouse Gases

November 6, 2015

"Pleased with the progress made, Stephen Yurek, president and CEO of the US Air Conditioning, Heating, and Refrigeration Institute (AHRI), said "AHRI's member companies – including refrigerant producers and original equipment manufacturers – have proactively been researching potential alternative refrigerants to ensure that the world's air conditioning and refrigeration equipment manufacturers will have access to appropriate refrigerants."

<http://www.coolingpost.com/world-news/world-could-agree-hfc-phase-down-in-2016/>

World could agree HFC phase-down in 2016

Posted on Friday, November 6, 2015 · Leave a Comment

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DUBAI: With HFCs now to be included within the Montreal Protocol, this week's meeting in Dubai ended with real prospects of a global HFC phase-down agreement next year.

In the face of four amendments on the table from the Island Nations, India, the EU and North America, objections to forming an HFC contact group to begin negotiating an amendment were finally dropped.



Global agreement to include HFCs in Montreal Protocol

Global Pressure on Refrigerants Continues...

JULY 26, 2004

HFCs Are On Shaky Ground In Europe

By Peter Powell
Of The NEWS

Equipment used in many locations in Europe. In a statement issued at the time of the conference, environmental group Greenpeace stated, "Under [said it] will purchase only HFC-free ice cream cabinets. Already 14,000 units have been replaced. Coca-Cola..."
Continued on page 5

the NEWS
THE HVACR CONTRACTOR'S WEEKLY NEWSMAGAZINE SINCE 1926
July 29, 2013 | \$5.00 | Visit us online at www.achrnews.com, Twitter, Facebook + LinkedIn

Complex Equipment: The Choice of a New Generation

By James Taylor
Of The NEWS

100 countries back HFC phase down
USA: More than 100 countries yesterday backed an "early freeze date" on an amendment to the Montreal Protocol to phase down HFC refrigerants.
29th September, 2016

AUGUST 11, 2008 ■ \$5.00 ■ VISIT US ONLINE AT WWW.ACHRNEWS.COM ■ A BPP PUBLICATION

Refrigerant Talk Turns to HFOs

By Peter Powell
Of The NEWS

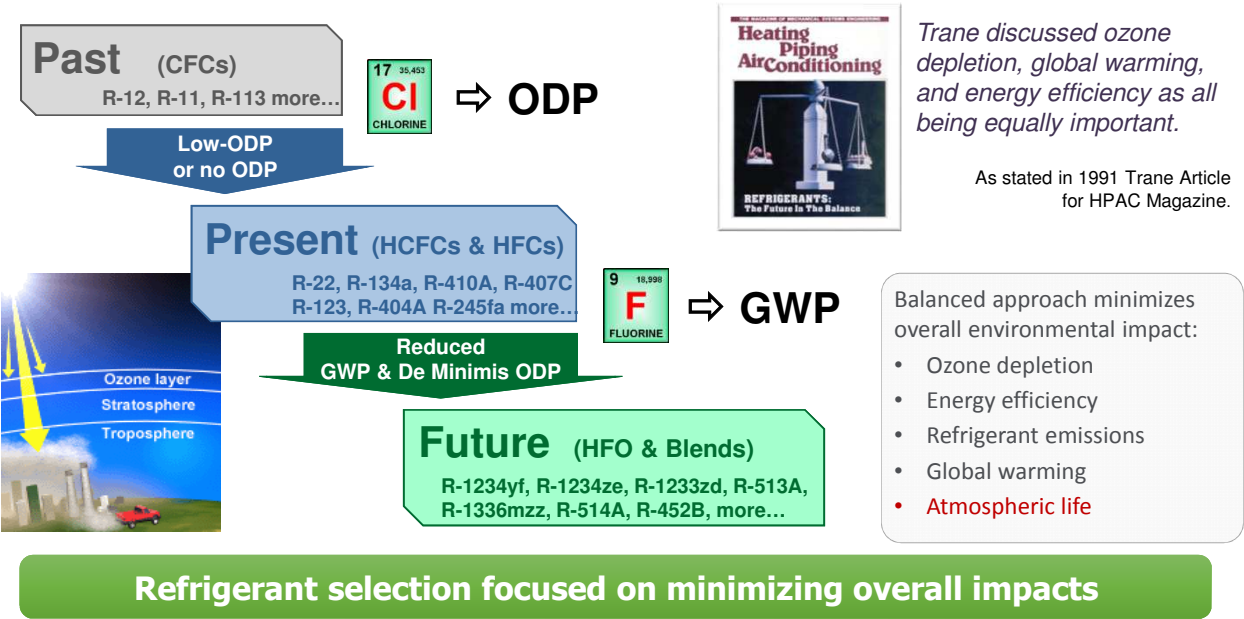
many address before you engineers from 30 countries at the combined International Compressor Engineering and International Refrigeration/Air Conditioning conferences hosted by Purdue University. He specifically cited research cur...

COOLING POST
US EPA considers future ban on R134a chillers
Posted on Wednesday, September 23, 2015

USA: The US Environmental Protection Agency (EPA) is considering declaring refrigerant R134a as being unsuitable for use in chillers.
This potential future prohibition was one of a...

The industry's commitment to new solutions remains steadfast

Where were we and where are we going?



What Actions Have Been Taken Already

European Environment Agency

European Union F-Gas Regulations

1-1-2013 de facto ban on R-134a in new model vehicles per Directive 2006/40/EC for Mobile AC



SAE finds R1234yf is "safe and effective"



AHRI's Yurek says global momentum building to phase down HFCs

OnPoint: Wednesday, June 8, 2016



<http://www.eenews.net/videos/2138?platform=hootsuite>

During this Interview, Stephen Yurek, president of AHRI, discusses new research collaboration with the USA DOE and the international momentum for aggressive timelines to phase-down HFCs along with how will industry work to comply in phasing-out of HFCs.



Corporate Average Fuel Economy (CAFE)

The 2012-2016 Standards offered credits for using low-GWP refrigerants instead of R-134a, with ban in 2021:

- ~ 3-4 MPG for changing refrigerant
- ~ 5 MPG for overall system changes

Vehicles using R-1234yf refrigerant (United States)

- ✓ BMW i3, i8
- ✓ Cadillac XTS
- ✓ Chevrolet Spark EV, Malibu, Trax
- ✓ Chrysler 200, 300
- ✓ Dodge Challenger, Charger, Dart
- ✓ Ford Transit
- ✓ Honda Fit EV
- ✓ Hyundai Santa Fe, i30
- ✓ Infinity Q50
- ✓ Jeep Cherokee
- ✓ Kia Sorento, Optima, Carenz
- ✓ Mazda CX-5
- ✓ Mitsubishi Mirage
- ✓ Range Rover Sport
- ✓ Subaru BRZ, Forrester, Impreza
- ✓ Tesla Model S



Auto industry began transition in 2006; HVAC industry is next

US Government Partnership with Industry

Executive action to reduce GHG emissions & spur a global phasing-out of HFCs



White House statement: "These industry associations and companies are making significant commitments to phase out or phase down their use of HFCs and transition to climate-friendly alternatives, good for the environment and good for business."

AHRI president and CEO Stephen Yurek stated: "Close to \$2bn has been spent by the industry since 2009 researching energy-efficient equipment and the utilization of low-GWP refrigerants," Yurek stated, "and over the next 10 years, the HVACR industry will invest an additional \$5bn for r&d and capital expenditures to develop and commercialize low-GWP technologies."

In 2014 **22 companies** committed to cutting GHG emissions by 2020

	Carrier, announced that its commitment to pursue the commercialization of HFC-free refrigerants in road transportation refrigeration by 2020.
	Danfoss, announced that it's championing a stakeholder task force to accelerate adoption of standards and building codes for next generation, low-GWP refrigerants.
	Johnson Controls, announced that it commits to using the lowest GWP option for each application that best fits the needs of its customers. It also committed to spend an additional \$50 million over the next three years to develop new products and improve and expand its existing portfolio.
	Goodman Manufacturing Company, commitment to help slash greenhouse gas emissions by developing low-global warming potential (GWP) air conditioners and/or heat pumps. Daikin aims to reduce its greenhouse gas emissions in 2020 to one-quarter of its 2005 emissions.
	Ingersoll Rand, commitment to slashing greenhouse gas emissions at their operations by 35%, reduce refrigerant-related GHG associated with our products by 50% (increased unit efficiency and the transition to lower GWP refrigerants) and will invest \$500M in research and development... all by 2020

Industry Consensus & Agreement with NRDC

AHRI support of the phase-out of HFCs

February 1, 2016



AHRI and NRDC have engaged in discussions on the importance of responsibly moving beyond high-GWP refrigerants used in chillers. Considerations have included the safety of alternatives, the continued improvement of system energy efficiency, reasonable product development timelines, and the avoidance of market migration. With these factors in mind, AHRI and NRDC support EPA finalizing the following changes of status:

- Remove R-134a, R-410A, and R-407C from the list of acceptable substitutes in all new air-cooled and water-cooled chillers using centrifugal, screw, scroll, and all other compressor types effective January 1, 2025

This proposal allows eight years from the publication of the final rule for industry to finish designing and manufacturing new chillers using alternative refrigerants.

"US Environmental group the Natural Resources Defense Council (NRDC) and the Air Conditioning, Heating, and Refrigeration Institute (AHRI) are said to have agreed on a schedule for eliminating the use of the refrigerants in new chillers of all types and sizes."

<http://www.coolingpost.com/world-news/r134a-faces-chiller-ban-from-2025/>

COOLING POST

R134a faces chiller ban from 2025

Posted on Wednesday, February 3, 2016 · Leave a Comment

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USA: HFC refrigerants R134a, R410A, and R407C could be banned from use in US chillers from 2025 under new industry proposals.

US Environmental group the Natural Resources Defense Council (NRDC) and the Air Conditioning, Heating, and Refrigeration Institute (AHRI) are said to have agreed on a schedule for eliminating the use of the refrigerants in new chillers of all types and sizes.



Industry support of phase-out by January 1, 2025

Proposed Changes to HFC Acceptability



Environment and Climate Change Canada

March 23, 2016

"...prohibit the manufacture and import of certain refrigeration and air conditioning products that contain HFCs with a global warming potential (GWP) greater than a specified value..."

- Stand-alone Med Temp Commercial Refrigeration** (Jan 1, 2020 – GWP > 650)
- Stand-alone Low Temp Commercial Refrigeration** (Jan 1, 2020 – GWP > 1500)
- Centralized Refrigeration** (Jan 1, 2020 – GWP > 1500)
- Chillers - Centrifugal & Positive Displacement** (Jan 1, 2025 – GWP > 700)
- Domestic Refrigeration** (Jan 1, 2025 – GWP > 150)
- Mobile Refrigeration** (Jan 1, 2025 – GWP > 2200)

<https://www.ec.gc.ca/ozone/default.asp?lang=En&n=77A94123-1>



March 29, 2016

"...this action proposes to list a number of substances as acceptable, subject to use conditions; to list several substances as unacceptable..." changes status to "unacceptable" for certain HFC refrigerants:

- Centrifugal Chillers** (Jan 1, 2024)
R-134a, R-410A, R-407C, R-245fa...
- Positive Displacement Chillers** (Jan 1, 2024)
R-134a, R-410A, R-407C, R-245fa...
- Cold Storage Warehouses** (Jan 1, 2023)
- Retail Food Refrigeration** (Jan 1, 2021)
- Household Refrigerators/Freezers** (Jan 1, 2021)

<https://www.epa.gov/snap/snap-regulations>



California EPA

- All HVAC Refrigerants >750 GWP** (Jan 1, 2021)
- Effectively phasing out R-134a, R-410A

<http://www.arb.ca.gov/cc/shortlived/shortlived.htm>

3. Proposed change of listing status by end-use:
1) For new centrifugal chillers, we are proposing to list as unacceptable, except as otherwise allowed under a narrow use limit, as of January 1, 2024:
• FOR12A, FOR12B, HFC-134a, HFC-227ea, HFC-125/134a/600a (28.1/70.1/9), R-125/280/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-421A, R-421B, R-421C, R-421D, R-423A, R-424A, R-507A, RS-44 (2003 composition), and THR-03.
2) For new positive displacement chillers, we are proposing to list as unacceptable, except as otherwise allowed under a narrow use limit, as of January 1, 2024:

US Final Rule pending; Canada & California still out for public review

Final Ruling on HFC Acceptability in Chillers



September 26th 2016 <https://www.epa.gov/snap/snap-regulations>

“These two rules demonstrate the United States’ continued leadership in protecting public health and the environment,” said EPA Administrator Gina McCarthy. “We are reducing emissions of HFCs that are harmful to the climate system and showing the world that we can do this responsibly and thoughtfully by working with businesses and environmental groups. I’m especially excited that we have taken these actions ahead of next month’s Montreal Protocol negotiations.”

- **Centrifugal Chillers** (Jan 1, 2024)
R-134a, R-410A, R-407C, R-245fa...
- **Positive Displacement Chillers** (Jan 1, 2024)
R-134a, R-410A, R-407C, R-245fa...
- **Cold Storage Warehouses** (Jan 1, 2023)
- **Retail Food Refrigeration** (Jan 1, 2021)
- **Household Refrigerators/Freezers** (Jan 1, 2021)



US places bans on R404A and R134a

Posted on Tuesday, September 27, 2016 · Leave a Comment

USA: The US EPA is to ban a host of high GWP refrigerants including R404A, R134a, R407C and R410A in certain new products from as early as January 1, 2021.

The bans are part of wide ranging new rules finalised by the US Environmental Protection Agency yesterday, that will see bans on a number of existing refrigerants and a tightening of leak rate rules to reduce HFC emissions.

Commonly-used high GWP refrigerants R404A and R507A are among a number of refrigerants to be banned in new retail food refrigeration from as early as January 1, 2021, with both also being banned in new cold storage warehouses from January 1, 2023. Also included in the bans are many of the so-called retrofit blends including R407A and R407B.

R134a is one of a number of common refrigerants that will be banned from use in new centrifugal and positive displacement chillers as of January 1, 2024. Others include R407C and R410A, as well as a number of interim “drop-in” blends.

The new rules will also see R134a being banned in new domestic fridges and freezers from January 1, 2021.



<http://www.coolingpost.com/world-news/us-places-bans-on-r404a-and-r134a/>

US phase-out of HFCs in chillers 1/1/2024

Final Rule 21: Protection of Stratospheric Ozone: SNAP: Significant New Alternatives Policy



EPA Proposed Rule



Proposed Rule

What is EPA proposing?

- List as acceptable subject to use conditions, list as unacceptable, and change the status of several substances
- Exempt propane from the CAA’s section 608 venting prohibition
- Clarify status of acceptable fire suppression alternative

Which industrial sectors are included?

- Refrigeration & Air Conditioning
- Fire Suppression & Explosion Protection
- Foam Blowing

Who is affected?

- Chemical producers, some manufacturers, and some end-users of equipment and products using refrigerants, fire suppressants, and foam blowing agents

When?

- Starting 30 days after publication of a final rule; see table for dates

FOR IMMEDIATE RELEASE: March 29, 2016 www.epa.gov/snap

FACT SHEET PROPOSED CHANGE OF LISTING STATUS

End-Uses	Substitutes	Proposed Effective Date
Air Conditioning		
Centrifugal chillers (new)	FOR12A, FOR12B, HFC-134a , HFC-227ea, HFC-236fa, HFC-245fa, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C , R-410A , R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-423A, R-424A, R-434A, R-438A, R-507A, RS-44 (2003 composition), and THR-03	Unacceptable, except as otherwise allowed under a narrowed use limit, as of January 1, 2024
Positive displacement chillers (new)	FOR12A, FOR12B, HFC-134a , HFC-227ea, KDD6, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C , R-410A , R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-424A, R-434A, R-437A, R-438A, R-507A, RS-44 (2003 composition), SP34E, and THR-03	Unacceptable, except as otherwise allowed under a narrowed use limit, as of January 1, 2024

EPA mechanism for managing regulations

Where can I learn more?

Proposed USA EPA changes documented in the Federal Register

<https://www.federalregister.gov/agencies/environmental-protection-agency>

22842 Federal Register / Vol. 81, No. 74 / Monday, April 18, 2016 / Proposed Rules



FEDERAL REGISTER

Vol. 81 Monday,
No. 74 April 18, 2016

Part III

Environmental Protection Agency

40 CFR Part 82
Protection of Stratospheric Ozone: Proposed New Listings of Substitutes;
Changes of Listing Status, and Reinterpretation of Inapplicability for
Classed Cell Foam Products Under the Significant New Alternatives Policy
Program, and Revision of Clean Air Act Section 608 Venting Prohibition
for Pumps, Proposed Rule



(1) For new centrifugal chillers, we are proposing to list as unacceptable, except as otherwise allowed under a narrowed use limit, as of January 1, 2024

- FOR12A, FOR12B, HFC-134a, HFC-227ea, HFC-236fa, HFC-245f

<https://www.gpo.gov/fdsys/pkg/FR-2016-04-18/pdf/2016-08163.pdf>

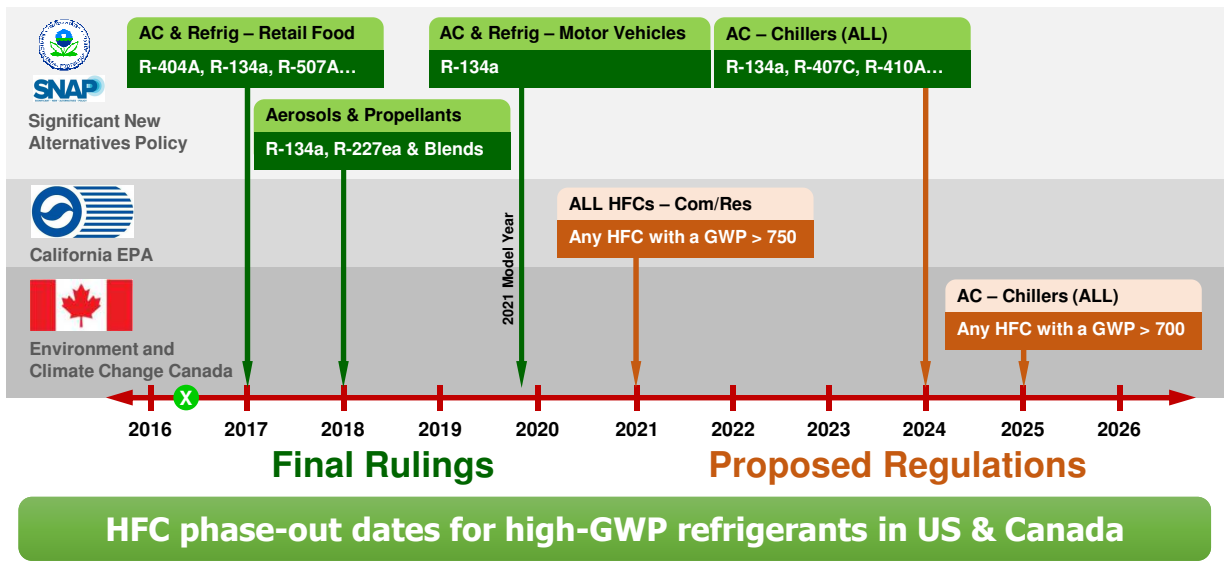
(2) For new positive displacement chillers, we are proposing to list as unacceptable, except as otherwise allowed under a narrowed use limit, as of January 1, 2024

- FOR12A, FOR12B, HFC-134a, HFC-227ea, KDD6, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-424A, R-434A, R-437A, R-44 (2003 composition), and

Federal mechanism for documenting rulings & proposals for the public

Review of Current and Pending Regulations

Ban on shipment of new equipment with HFCs



US EPA to Tighten HFC Regulations

Changes to Section 608 of the Clean Air Act

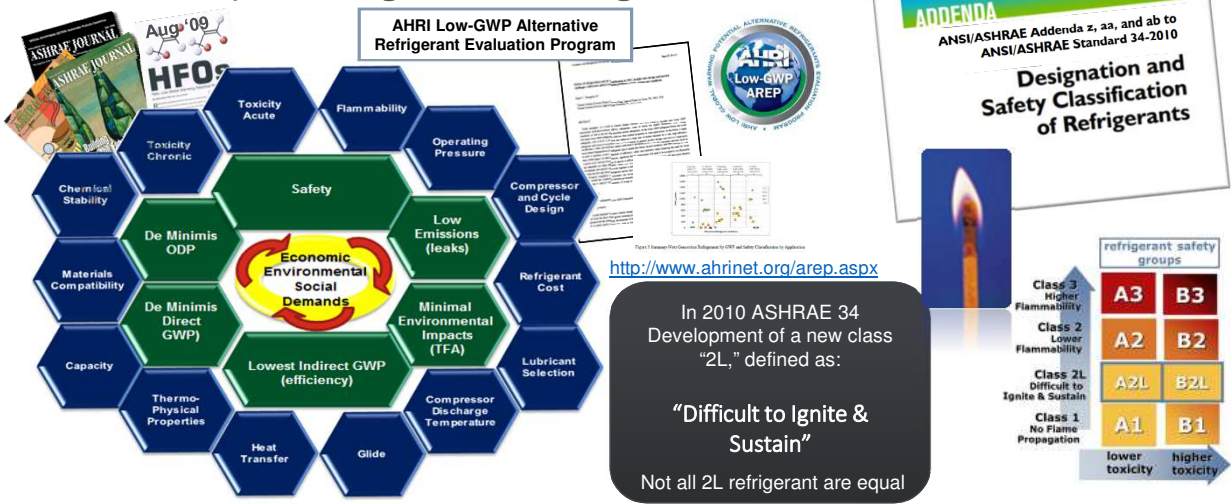
Overview of Changes	Current Requirement	New Requirement
Refrigerants Covered	CFCs and HCFCs	CFCs, HCFCs, HFCs and all other replacement refrigerants (HFOs, HFO blends, etc.)
Leak Rate Threshold (<i>50+ lbs. of refrigerant</i>)		
Industrial Process Refrigeration	35%	30%
Commercial refrigeration	35%	20%
Comfort cooling equipment	15%	10%
Required Leak Inspections	None	50+ lbs.: annual inspections 500+ lbs.: quarterly inspections
Recordkeeping Requirement	> 50 lbs.	5-50 lbs.
Prohibits System Operation	None	50+ lbs. charged Units: if leaks ≥ 125% in calendar year, detailed repair efforts must be submitted to EPA of their charge for 2 consecutive years

<https://www.epa.gov/sites/production/files/2015-11/documents/608factsheet.pdf>

Leak-tight machines gaining advantage – enhancing hermetic appeal

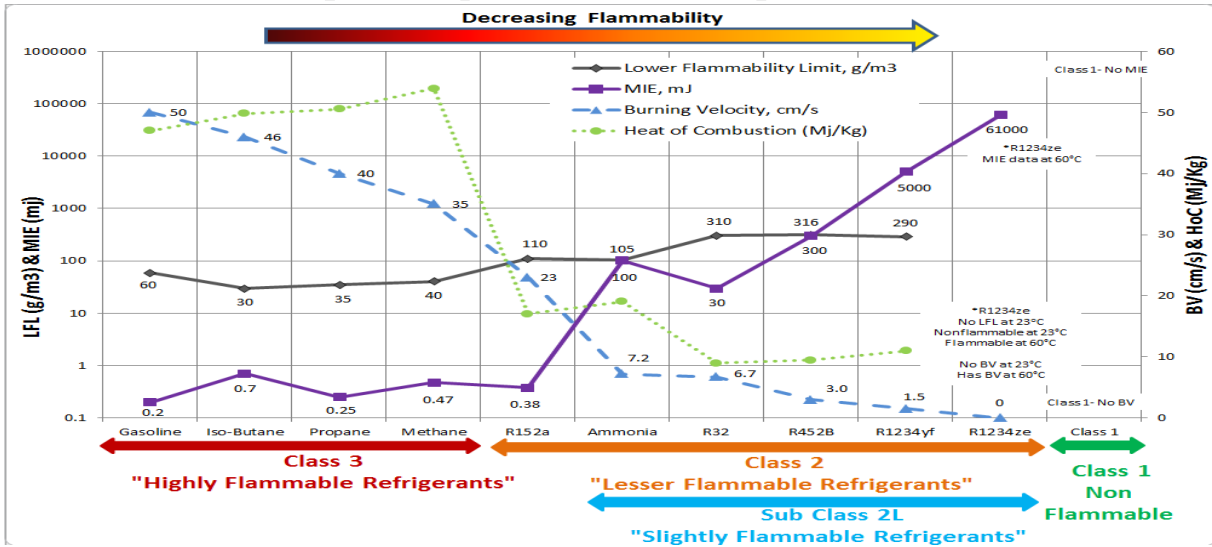
Next-Generation Refrigerants

More variables; balancing offers challenges



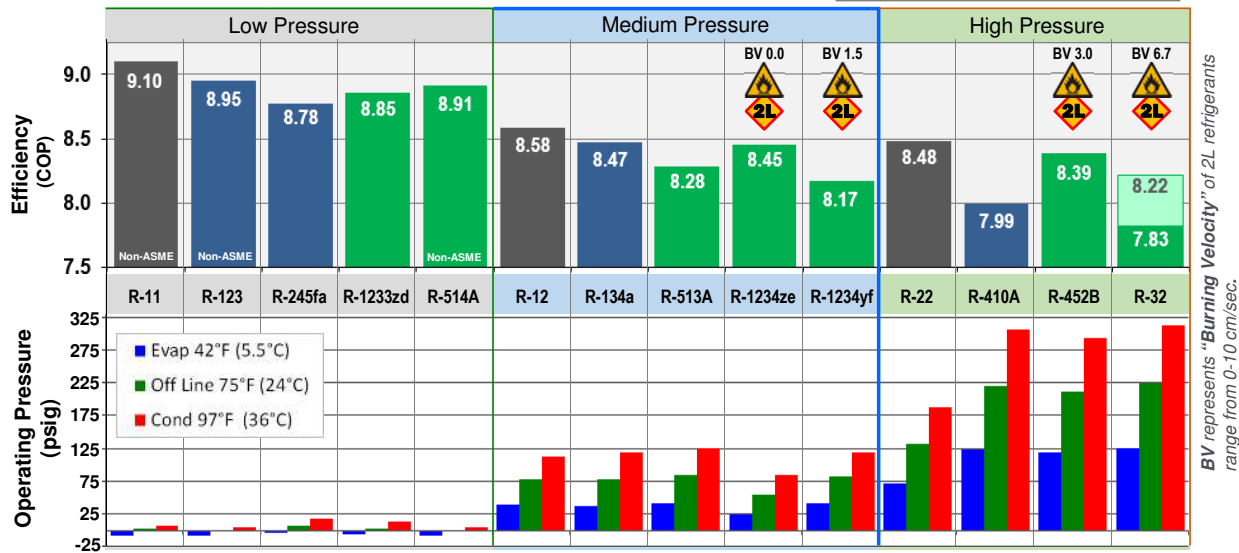
Some next-generation refrigerants offer new challenges

Flammability Properties Vary



HVAC Industry Next Transition Begins

Next-Generation Refrigerants now available...



HFO Options for Chillers Grow

R-514A and R-513A now SNAP-approved and ASHRAE-listed

May 22, 2016

“...Developed by Chemours... HFO1336mzz(Z) is also to be found in another new... blend deemed acceptable under the SNAP regulations...proposed for ASHRAE designation as R514A, blends R-1336mzz(Z) with R-1130 (trans-1,2-dichloroethene), a gas not previously used in refrigerants...R514A is deemed acceptable as a retrofit gas as well as in new equipment.

The EPA has also extended the acceptability of R513A as a substitute for R134a in both new and retrofit retail food refrigeration, refrigerated food processing and dispensing equipment...”

<http://www.coolingpost.com/world-news/epa-snap-lists-r123-alternatives/>

COOLING POST EPA SNAP-lists R123 alternatives

Posted on Sunday, May 22, 2016 · [Leave a Comment](#)

USA: The EPA has SNAP-listed two new R123 alternatives and expanded the acceptable uses of R513A and CO2 in air conditioning and refrigeration.

A determination of acceptability, listed in tomorrow's Federal Register, expands the list of acceptable substitutes under the US Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) programme.

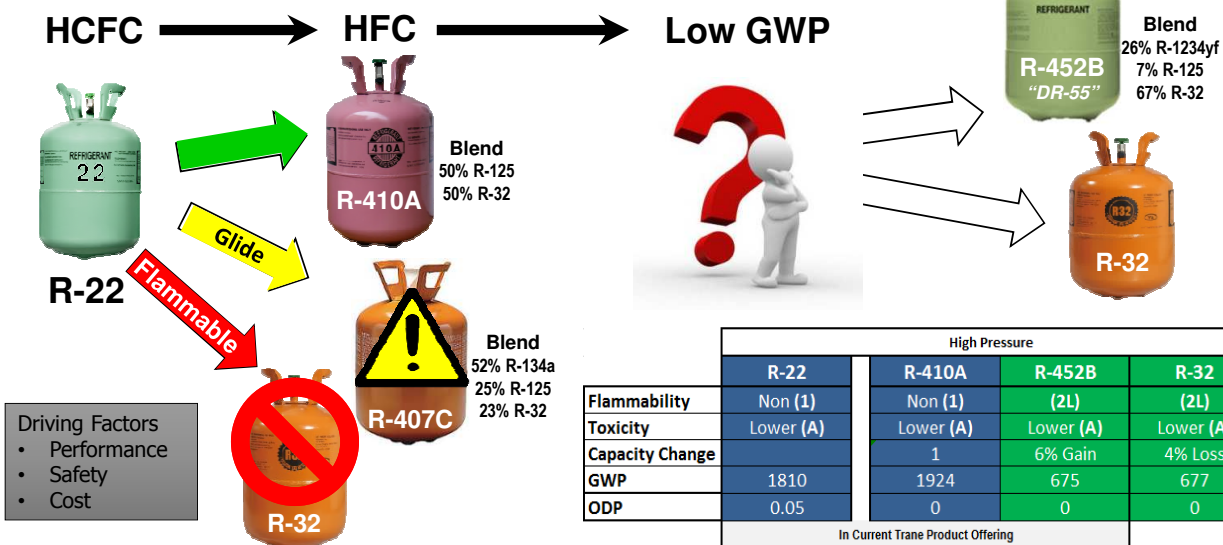
Already listed as acceptable as a foam blowing agent, the HFO 1336mzz(Z) is determined to be acceptable in centrifugal chillers, positive displacement chillers and industrial process air conditioning. This is in new equipment specifically designed for use of 1336mzz(Z) and not as a retrofit. It is, however, deemed acceptable for use in new and as a retrofit gas in non-mechanical heat transfer applications.

Developed by Chemours, HFO 1336mzz(Z) has been seen as a potential replacement for R134a in new and retrofit retail food refrigeration, refrigerated food processing and dispensing equipment.



US EPA's SNAP program increases next-gen refrigerant options

High Pressure Replacements

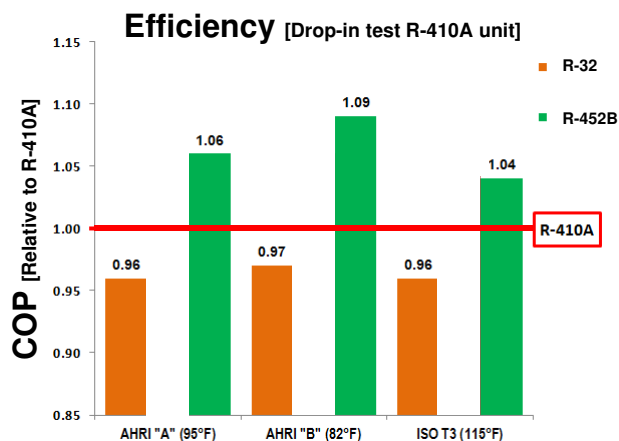


Next transition with high pressure refrigerants

High Pressure Refrigerant Replacements

Drop-in test results

- Drop-in of R-452B into York residential heat pump designed for R-410A
- Chemours made no system or lubricant changes to the unit
- R-452B delivered:
 - ✓ nearly 5% improvement in energy efficiency
 - ✓ equivalent cooling capacity
 - ✓ discharge temperatures similar to R-410A.



<http://www.coolingpost.com/world-news/is-dr-55-best-option-to-replace-r410a/>

R-452B: Better performance than R-410A at all 3 global conditions

High Pressure Refrigerant Replacements

Safety review

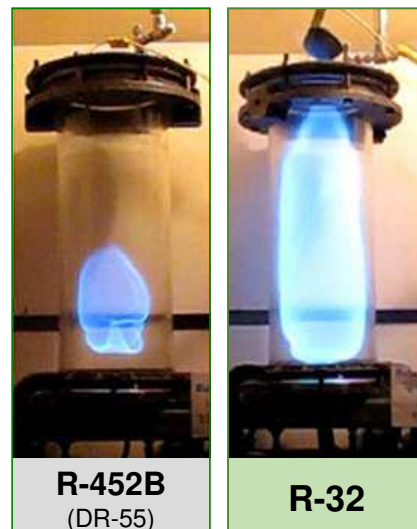
Tests have shown that R-452B exhibits:

- ✓ a slower burning velocity (BV) and
- ✓ higher minimum ignition energy (MIE) requirement when compared to R-32

➤ **R-452B is 5X less flammable than R-32**

Although R-452B has the same A2L “mildly flammable” classification as R-32, Chemours maintains that some global OEMs have indicated that the lower flammability properties are compelling and are likely to be an important consideration in product selection, especially for larger charge size equipment.

➤ **AND... Almost 70% reduction in GWP compared to R-410A**



Not all 2L refrigerants are the same...

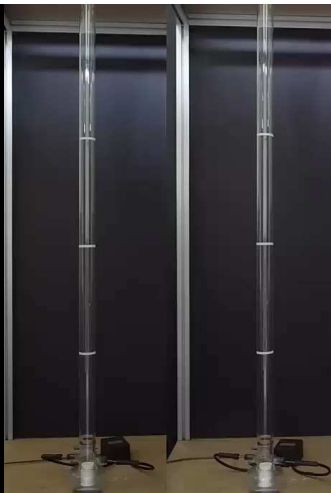
Visual Examples of Burning Velocity

Differences with 2L Flammable Refrigerants

R-32

Burning Velocity
6.7 cm/sec

Minimum Ignition Energy
>30 mj



R-1234yf

Burning Velocity
1.5 cm/sec

Minimum Ignition Energy
>5000 mj

Not all 2L refrigerants have the same flammability characteristics

Refrigerant Support

R-452B Gaining Momentum

July 26, 2016

<http://www.coolingpost.com/world-news/ingersoll-rand-backs-r410a-alternative-dr-55/>

Efficiency gains compared to R410A were reported following tests this year by the US Department of Energy's Oak Ridge National Laboratory using the new refrigerant on Trane rooftop units. The Trane/ORNL tests showed DR-55 providing a 5% boost in RTU efficiency compared to R410A. Similar improvements were reported by fellow US manufacturer Lennox when testing the new refrigerant in a 17.6kW rooftop unit last year.

R452B is a blend of R32, R125 and R1234yf, DR-55 but, like R32, another refrigerant being adopted to replace R410A, it is categorised by ASHRAE as a "mildly flammable" A2L refrigerant.

°COOLING POST

Posted on Tuesday, July 26, 2016 • 1 Comment

USA: Ingersoll Rand, manufacturers of Trane air conditioners, has endorsed the use of alternative refrigerant R452B (DR-55) as a lower GWP replacement for R410A.

The US manufacturer has also announced that it will provide royalty-free access to the patent rights it holds for the use of the new



er flammability than its

researchers, national
sfrigerant alternative to

efficient alternative to

R-452B (DR-55) growing as lead for R-410A replacement

Refrigerant Choices & Comparison

Screw & Centrifugal Technology Options

	Low Pressure			Medium Pressure			
	R-123	R-1233zd	R-514A	R-134a	R-513A	R-1234yf	R-1234ze
Flammability	Non (1)	Non (1)	Non (1)	Non (1)	Non (1)	Slight (2L)	Slight (2L)
Toxicity	Higher (B)	Lower (A)	Higher (B)	Lower (A)	Lower (A)	Lower (A)	Lower (A)
Fluid Efficiency	9.4 COP	9.3 COP	9.4 COP	8.5 COP	8.3 COP	8.2 COP	8.5 COP
Capacity Change	1	35% Gain	Similar	1	Similar	5% Loss	25% Loss
GWP	79	1	< 2	1300	573	1	1



Chiller efficiency impacted by refrigerant choice

What refrigerant do I buy?

- There are **no** perfect refrigerants
- Take a balanced approach:
Safety, Environmental Impact, Efficiency
- R-123, R-134a, R-410A, R-404A, R-407C are all responsible HVAC refrigerant choices... *today*
- Leak tightness is key!
Means lower emissions, higher efficiencies, lower cost, safer
- Next-generation alternatives are available; only A1/B1 refrigerants offer clear and immediate solutions... *it's time to evaluate your options*



Understand the facts today; plan for tomorrow

How Can I Protect My Investment?

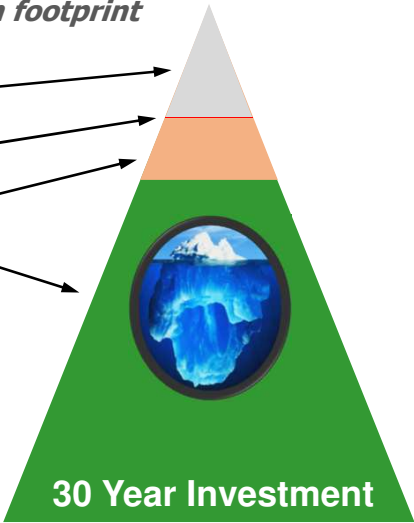
Total cost of ownership encompasses total carbon footprint

“First Cost” (chiller + refrigerant)	4.92%
Lifetime Refrigerant Supply*	0.04%
Lifetime Service Costs*	6.53%
Lifetime Electrical Costs	88.51%

All refrigerants used today are and will be – available for the life of the equipment.

Focus on reliable, efficient designs!

And let the manufacturer worry about the refrigerant!



A balanced approach, with a focus on efficiency

* Based on low-pressure, hermetic design

Support Documentation & Sources

AHRI Discusses HFC Phasedown with E&ETV



Following AHRI's agreement with ASHRAE and the Department of Energy to help fund flammable refrigerant research, AHRI President and CEO Stephen Yurek spoke with E&ETV's OnPoint to discuss the growing global momentum to phase down HFCs, specifically focusing on how the HVACR industry will work to comply with proposed amendments to the Montreal Protocol. Yurek highlighted AHRI's extensive and proactive research effort to identify suitable alternatives for many

different applications in an effort to reduce the use of high-global warming potential refrigerants. [Watch the full interview here.](#) Contact: [Francis Dietz](#).

AHRI's Yurek says global momentum building to phase down HFCs

OnPoint: Wednesday, June 8, 2016

<http://www.eenews.net/videos/2138?platform=hootsuite>



Data sources & additional information

How do I Find Out More?

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEplete THE OZONE LAYER

November 2015 meetings:

<http://www.coolingpost.com/world-news/world-could-agree-hfc-phase-down-in-2016/>
<http://www.achrnews.com/articles/131056-montreal-protocol-sets-global-hfc-phasedown>

...and industry support:

<http://www.racplus.com/newsletter/news/usa-focus/ahri-applauds-hfc-phase-down-decision/8691735.article>
<http://www.achrnews.com/articles/131199-industry-reacts-to-groundbreaking-hfc-phase-down-discussions>



<http://www.epa.gov/climatechange/ghgemissions/gases/fgases.html>

<http://www.coolingpost.com/world-news/us-epa-considers-future-ban-on-r134a-chillers/>

Rule 20 (July 2015) – Prohibition on the use of certain high-GWP HFCs as alternatives

Final Rule: <https://www.gpo.gov/fdsys/pkg/FR-2015-07-20/pdf/2015-17066.pdf>

Fact Sheet: <http://www.epa.gov/snap/final-rule-protection-stratospheric-ozone-change-listing-status-certain-substitutes-under>

AHRI/NRDC petition (February 1, 2016):

http://www.ahrinet.org/App_Content/ahri/files/News%20Room/Press%20Releases/2016/AHRI_NRDC_Letter_to_EPA_Regarding_Chiller_Action_Under_SNAP_02_01_16.pdf

<http://www.coolingpost.com/world-news/r134a-faces-chiller-ban-from-2025/>

<http://www.achrnews.com/articles/131955-ahri-nrdc-align-on-refrigerant-phaseout>

the **NEWS**

AHRI, NRDC Align on Refrigerant Phaseout

March 7, 2016

EPA expected to decide soon whether to accede to the consensus recommendation

Additional references to learn more about impending transitions

How do I Find Out More? (cont.)

R-452B (formerly "DR-55"):

<http://www.coolingpost.com/world-news/is-dr-55-best-option-to-replace-r410a/>
<http://www.coolingpost.com/world-news/trane-debuts-r410a-replacement/>
<http://www.acr-news.com/chemours-refrigerant-gains-preliminary-ashrae-classification-1>



AHRI's Low-GWP Alternative Refrigerants Evaluation Program

<http://www.ahrinet.org/site/514/Resources/Research/AHRI-Low-GWP-Alternative-Refrigerants-Evaluation>

Kujak S., Thompson, M. "Future of refrigeration and air conditioning in 2032; insights into design and market challenges with lower global warming potential (GWP) refrigerant candidates." Cryogenics and Refrigeration-Proceedings of ICCR2013. Paper ID: B-4-10.

Trane / Ingersoll Rand:

<http://company.ingersollrand.com/ircorp/en/discover-us/sustainability/our-climate-commitment.html>

Considerations for Next-Generation HVAC Refrigerants (February 2015)

http://www.trane.com/content/dam/Trane/Commercial/global/products-systems/education-training/industry-articles/ENV-APN001A-EN_2015_refrigerants.pdf

HVAC Refrigerants: A Balanced Approach (June 2011)

http://www.trane.com/content/dam/Trane/Commercial/global/products-systems/education-training/engineers-newsletters/energy-environment/adm-apn041-en_0711.pdf

CenTraVac™ Chiller Environmental Product Declaration (EPD) – UL Environment Sustainable Products Guide

<http://productguide.ulenvironment.com/ProductDetail.aspx?productID=66583&CertificationID=15&CategoryID=67>

Additional references to learn more about impending transitions

Other References:

http://www.epa.gov/ozone/downloads/HFC_Amendment_2013-Summary.pdf
(Nice summary of North American proposal to Montreal Protocol)

<http://www.achrnews.com/articles/122923-the-future-of-hfcs-in-montreal-protocol>
(April 2013, quotes from other HVAC companies)

<http://www.epa.gov/ozone/intpol/mpagreement.html>
(Sept 2013, fact sheets on the right side of page – focuses on refrigeration, but shows next refrigerants)

<http://www.arqusmedia.com/pages/NewsBody.aspx?id=863805&menu=yes>
(Sep 2013, G20 nations sign agreement to curtail HFCs)

http://articles.economictimes.indiatimes.com/2013-10-02/news/42617384_1_hfcs-montreal-protocol-climate-change
(Oct 2013, U.S. and India joint agreement on HFC phasedown)

http://www.hydrocarbons21.com/articles/european_parliament_formally_backs_eu_f-gas_regulation_deal
(Mar 2014, New EU F-gas regulation passed)

<http://www.alliancepolicy.org/index.php>
(Learn more about The Alliance for Responsible Atmospheric Policy)

<http://www.bna.com/epa-proposes-prohibit-n17179892134/>
(Jul 2014, Article on proposed EPA bans/reductions on HFC refrigerants through SNAP)

Global Pressure on ALL Refrigerants:

- Powell, Peter. "HFCs Are On Shaky Ground." ACHR News. July 26, 2004.
- Powell, Peter. "Refrigerant Talk Turns to HFOs." ACHR News. August 11, 2008.
- Turner, Fred. "Commentary: Midgley's Legacy." ASHRAE Journal. July 2010.
- Wilkins, Robert. "The Global Debate On The Phasedown of HFC Refrigerants." Engineered Systems. December 2011.

Additional references to learn more about impending transitions

SNAP Ruling Documentation

(Unacceptable Refrigerants & Those Subject to Restrictions)

U.S. Government Publishing Office/Electronic Code of Federal Regulations

Title 40 > Chapter I > Subchapter C > Part 82 > Subpart G

<http://www.ecfr.gov/cgi-bin/text-idx?SID=1336e126c41c481006b799e3ad21d554&mc=true&node=sp40.18.82.g&rgn=div6>

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Title 40 → Chapter I → Subchapter C → Part 82 → Subpart G

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Title 40: Protection of Environment
PART 82—PROTECTION OF STRATOSPHERIC OZONE

Subpart G—Significant New Alternatives Policy Program

Contents

§82.170 Purpose and scope.
§82.172 Definitions.
§82.174 Prohibitions.
§82.176 Applicability.
§82.178 Information required to be submitted.
§82.180 Agency review of SNAP submissions.
§82.182 Confidentiality of data.
§82.184 Petitions.
Appendix A to Subpart G of Part 82—Substitutes Subject to Use Restrictions and Unacceptable Substitutes
Appendix B to Subpart G of Part 82—Substitutes Subject to Use Restrictions and Unacceptable Substitutes
Appendix C to Subpart G of Part 82—Substitutes Subject to Use Restrictions and Unacceptable Substitutes Listed in the May 22, 1996 Final Rule
"Revised June 1, 2009"

Find the Appendix with the ruling of interest:

Appendix U to Subpart G of Part 82—Unacceptable Substitutes and Substitutes Subject to Use Restrictions Listed in the July 20, 2015 Final Rule, Effective August 19, 2015

Appendix U -- http://www.ecfr.gov/cgi-bin/text-idx?SID=1336e126c41c481006b799e3ad21d554&mc=true&node=sp40.18.82.g&rgn=div6#ap40.18.82_1184_u

Title 40 → Chapter I → Subchapter C → Part 82 → Subpart G → Appendix

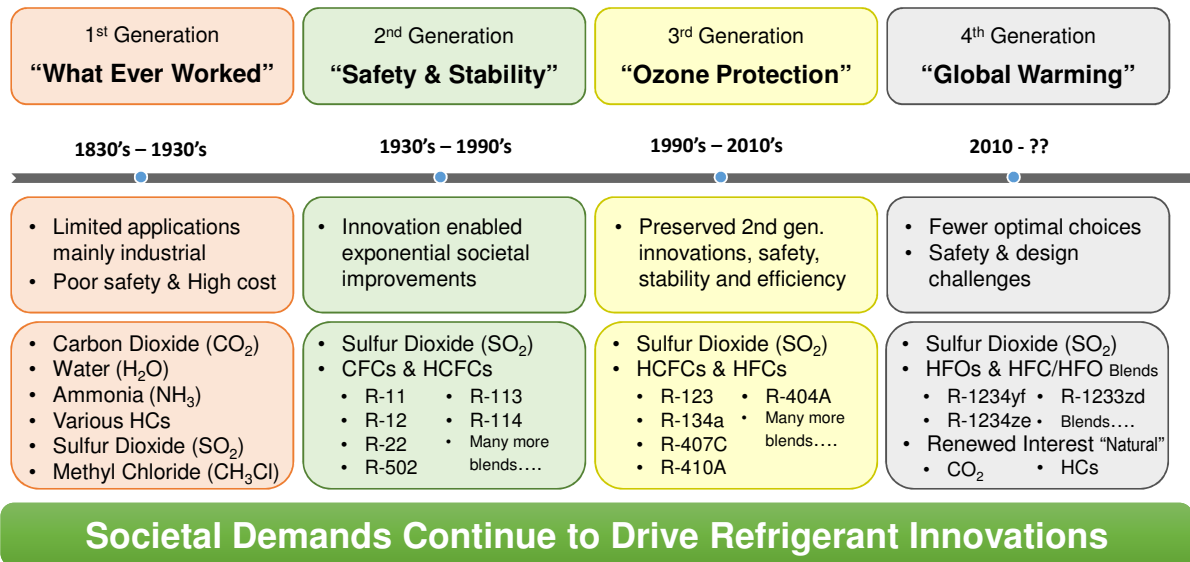
Title 40: Protection of Environment
PART 82—PROTECTION OF STRATOSPHERIC OZONE
Subpart G—Significant New Alternatives Policy Program

APPENDIX U TO SUBPART G OF PART 82—UNACCEPTABLE SUBSTITUTES AND SUBSTITUTES SUBJECT TO USE RESTRICTIONS LISTED IN THE JULY 20, 2015 FINAL RULE, EFFECTIVE AUGUST 19, 2015

REFRIGERATION AND AIR CONDITIONING—UNACCEPTABLE SUBSTITUTES

End-use	Substitute	Decision	Further information
Retail food refrigeration (supermarket systems) (new)	HFC-227ea, R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Unacceptable as of January 1, 2017	These refrigerants have GWPs ranging from 2,729 to 3,985. Other substitutes will be available for this end-use with lower overall risk to human health and the environment by the status change date.
Retail food refrigeration (supermarket systems) (retrofit)	R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Unacceptable as of July 20, 2016	These refrigerants have GWPs ranging from 2,729 to 3,985. Other substitutes will be available for this end-use with lower overall risk to human health and the environment by the status change date.
Retail food refrigeration (remote)	HFC-227ea, R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Unacceptable as of January 1, 2017	These refrigerants have GWPs ranging from 2,729 to 3,985. Other substitutes will be available for this end-use with lower overall risk to human health and the environment by the status change date.

History of HVAC/R Refrigerants



Questions?

W. Ryan Geister
Systems Leader, Trane

Thank you for your time and attention!