

Refrigerant Update Affiliates Forum April 16, 2019

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HVAC Environmentally Driven Regulations

Regulations are being developed globally for the direct emissions (refrigerant venting to atmosphere) and for indirect (CO2 emissions from power plants)



Environmental Regulations

As mentioned these regulations are link will have a significant impact on the HVAC&R industry and redesign and qualification for the next 10 years



Sustainable building regulations (new)

Why The Concern?

GLOBAL LAND-OCEAN TEMPERATURE INDEX

Data source: NASA's Goddard Institute for Space Studies (GISS). Credit: NASA/GISS



Global Regional Temperature Increase







The time series below shows the fiveyear average variation of global surface temperatures. Dark blue indicates areas cooler than average. Dark red indicates areas warmer than average.

Data source: NASA/GISS Credit: NASA Scientific Visualization Studio

Phasedown Requirements – with Average GWP



Chart shows the various GWP regulations and also the average industry GWP levels that will be required but the required values likely will be different and need to factor in;

- Industry Growth
- Available options (i.e. some products have better options)
- Reclaim, recovery and recycle
- Efficiency (tends to increase charge)

Baseline Model Volume Assumptions

• The following shows the breakdown of CO2e by major end uses as assumed in the Alliance Model

Alliance for Responsible Atmospheric Policy A2 Developed Country Base Year (2011-2013) CO₂e Distribution



Historical Data

Consumption (MMT CO ₂ e	2010	2011	2012	2013	2014	Kigali Base
Reported Consumption (GHGRP)	235	241	227	278	254	249

Source EPA 2016a

US State Initiatives

8.

22 states have committed to reducing emissions of short-lived climate pollutants (SLCPs) by joining the U.S. Climate Alliance.

7 of these states have proposed or enacted **13** different laws, regulations, and plans for HFCs since 2018



Future Refrigerant Selection

There are many factors that influence the selection of a refrigerant



HVAC Product Refrigerant Selection

- It is likely that different refrigerants will be selected for different product type similar to what is done today and these decisions are being
 evaluated to determine the best efficiency and applied cost, plus they are complicated by a very slow process for modified standards and
 codes
- The following are some details
 - R-410A Comfort Air Conditioning Products For products that use R-410A (A1, GWP=2088), Carrier has announced the selection of R-454B (A2L, GWP=465) because it has a lower GWP and could be a long term solution. Others are consider R-452B (A2L, GWP=697), R32 (A2L, GWP=675). There is also a possible A1 option which is R-466A (A1, GWP=733) but there are technical issues and qualification work is still being conducted. Note that R-410A is one of the more difficult refrigerant to find a good replacement for and likely will include the use of the new mildly flammable A2L refrigerants if similar operating pressures and compressor sizes are used
 - R-134A Air and Water Cooled Screw and Centrifugal Chillers Carrier as well as several manufactures have announced R-513A (A1, GWP=629) as a medium term solution for R-134A (A1, GWP=1300) chillers Longer term solutions include R-1233zd(E) (A1, GWP=1.34) for large water cooled centrifugals and R-1234ze(E) (A2L, GWP=0.97) for screw chillers. Several other options are also being evaluated.
 - Large Refrigeration Systems Carrier is in production in Europe with CO2 based systems with enhancements using ejectors and has now produced over 10,000 systems. Short term solutions are also being used include R-452A (A1, GWP=2139), R-448A (A1, GWP= 1386) and R-449A (A1, GWP = 1400) and other longer term solutions
 - Mobile Refrigeration Carrier has also produced some CO2 based systems for containers and has announced the use of R-452A (A1, GWP=1400) to replace R-407C and R-513A (A1, GWP-629) for R134a products. Other options are also being evaluated









Standards and Codes

- It is likely that that A2L mildly flammable and A3 highly flammable refrigerants will be needed for some products to support the phasedown requirements defined the Kigali agreement and the various prescriptive requirements
- US has not approved Kigali but 7 states have indicated they may adopt local phasedown requirements
- To support this will require new standards and codes and adoption by the provinces and cities in their building codes
- This requires significant changes and updates to the standards and especially the building codes



2- Refrigerant Classifications (ASHRAE 34)

To support consideration of new refrigerant options the industry updated the classification categories for new refrigerants to create the A2L category for low flammability refrigerants



Refrigerants ASHRAE 34 and EN 378

2 - Refrigerant Classifications

This is another way to look at the flammability classification and degree of flammability

Category 3 Refrigerants are highly flammable/explosive

The following is a comparison to stick of dynamite for Propane

114g = 5.2 Sticks 150g = 6.9 Sticks 300g = 13.9 Sticks 500g = 23.2 Sticks 1kg = 46.4 Sticks



Refrigerants Flammability



2 - Refrigerant Options - Classification

- The primary standards used for classification of refrigerants is ASHRAE 34 and the European ISO-817
- The two standards are essentially harmonized and aligned but for new refrigerants they may be out of phase
- These standards defined the safety classification, number systems and key properties for the use of refrigerants
- Also for the US refrigerants also currently must be SNAP approved
- With the desire for new lower GWP refrigerants many new options are being consider
 - HFO new refrigerants
 - HFO/HFC Blends and Mixtures (R-500 series act like single fluid refrigerants, R-400 series have glide)
 - Hydrocarbons
 - Inorganic Compounds
- It is import to consider both the direct GWP impact (leakage) and the indirect impact (efficiency and power generation emissions)

3 - Standards and Codes Details



3 - Equipment Safety Standards Codes

- In the US and Canada the industry is in the process of switching from UL 1995 (US) and CSA 22.2 No 236 (CA) to the new by-national UL/CSA 60335-2-40 with a likely effective date of 1/1/2024
- The basic standard is derived from the IEC60335-2-40 6th edition but with modifications for the US and Canada local requirements
- The standard is already released as the 2nd version but work is underway to develop the 3rd release to include revisions for the new A2L and A3 refrigerants
- The draft 2rd edition standard just went thru a ballot process and did receive enough votes to approve, but there were 160 comments that the working group is now in process of addressing and making updates
- Target is to complete the standard by Sept 24, 2019 to support 2021 building codes
- There are many new requirements in the standard for flammable refrigerants including some of the following;
 - Refrigerant charge limits m1, m2, m3
 - Minimum occupied areas for direct systems (Amin)
 - Refrigerant Sensor requirements for charge levels above m1
 - New qualification requirements
 - Hot surface and ignition source control
 - Service requirements



4 - Application Safety Standards

US Standards (ASHRAE 15, 15.2)

- In the past the primary standard has been the ASHRAE 15 standard
- This standard has been partially updated for use of A2L refrigerants with the release of 2 addenda
 - Addendum d Direct System Requirements for use of A2L refrigerants modifications to ASHRAE 15-2016
 - Addendum h Requirements for use of A2L refrigerants in machine rooms modifications to ASHRAE 15-2016
- The standard may have some additional modifications and effort to harmonize with UL60335-2-40 and to address commercial refrigeration



- ASHRAE 15 Commercial Application
- ASHRAE 15.2 Residential Applications
- ASHRAE 15.2 draft has been created and the working group is working to have a final standard by Sept 2019

Canada Standards (B52)

- 2018 version of the standard has been released and it added the classification for A2L
- But the changes in UL60335-2-40 and ASHRAE 15, 15.2 have not yet been addressed, but are planned to be included in an update





4 - Refrigerant System Categories



4 - Standard Changes: Direct System

Likely Product Impact (UL60335-2-40, ASHRAE 15.2, ASHRAE 15 & B52)



Standard Changes: Outdoor Indirect Systems

Likely Product Impacts (UL60335-2-40 and ASHRAE 15 & B52)



Standard Changes: Indoor Indirect Systems

Likely Product Impacts (ASHRAE 15, B52)







ASHRAE 15 addendum h Modified UTC proposal, to simplify but over ventilates in some cases

New Cylinder colors Coming - AHRI Guideline N and AHRI Guideline G for fittings left hand threads



ASHRAE 15, addendum h

control interface Inspection?

Safety / ventilation

Refrigerant sensor (already required for A1)



Hot surface limit of <700 C





Flame arrestors or control box



qualification for units and machine room



Routine inspection & Leak checking. CARB Section 608



Laboratory Upgrades





Machine Room **Electrical Protection** Not yet defined in standards?



Relief valves vented outdoors And refrigerant relief on waterside



Production Processes







4,5,6 Building, Shipping and Local Adoption

- The final steps in the modifications for the use of new refrigerants is the National Building codes, modifications in states/provinces, shipping standards and adoption
- These are some of the oldest codes and have very rigid schedules for national code modification with the US being every 3 years (2019, 2021, 2024, etc.) and Canada every 5 years but the last Canada update was in 2010 and nothing has happened since then.
- US has a large number national building codes developed by ICC and IAPMO and several states that adopt modified building codes
- The ICC based 2021 codes where not updated for A2L although proposals were submitted so the next updates will 2024, but states adopting phasedown may implement local modification. UMC hearings are on May 2-3
- Canada has the NBC National code developed by the NRC but there are local modifications by Alberta, British Columbia and Vancouver has it owns code. Other provinces adoption the NBC, but timing may be different

US Building Codes

UMC – Uniform Mechanical Code 2018 (ICC) * IRC – International Residential Code 2018 (ICC) * IBC – International Building Code 2018 (ICC) * IFC – International Fire Code 2018 (ICC) * IMC – International Mechanical Code -2018 (IAPMO) ** NFPA 1 – Fire Code 2018 (NFPA)* NFPA 101 – Life Safety Code 2018 (NFPA)* Canada Building Codes

NBC – National Building Code of Canada -2010*

* Should have been updated in 2015 and 2020 but was not. On February 28, 2019, the Government of Canada confirmed funding that will support ongoing and future building code development work.

* 2021 revision was not approved for A2L modifications ** Hearing Schedule for May2, 3

 In addition to the Building Codes changes also need to be made to the US and Canada DOT shipping codes which are typically harmonized. They start with the international GHS standard which was updated in 2018 to the 7th revision

Summary

- Significant refrigerant and efficiency work has been underway both in the US and Canada as well as Internationally in Europe
- Over the next year or two the short/medium term refrigerant selections will likely be finalized, but may but depending on GWP may not be the final solution with a GWP less than 500
- European safety standards are completed and being adopted and used to support the accelerated F-Gas requirements but are taking higher risks with flammable options than US versions
- Work is supported by AHRI and ASHRAE research of validation testing as well as validation testing by many equipment manufactures
- The first Kigali phasedown of 10% started in 2019 and likely will be supported by auto, foam and other industries
- It is likely some A2L refrigerants will be required for products as well as some A3 for smaller appliances but in US
 likely will be limited to 114 g, but codes and standards need to be updated and adopted as well as service training
- Reclaim is an import part of the phasedown compliance
- CO2 as a refrigerant is being used for refrigeration, but is not an efficient option for HVAC
- Hydrocarbon A3 refrigerants will be limited to small charge systems (likely 114 g in US)
- HVAC&R will have to implement equipment changes to support the 2024 40% phasedown and will require standards and building codes in place and approved locally by 2024 but due to the code process timing changes need to be finalized in 2019-2020
- Very important to align efficiency and refrigerant change implementation dates
- Some states and provinces implementing regulations for accelerated phase down will likely have to also consider local code modifications

Questions and Discussion