2017 Climate & Refrigerants Outlook

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President & CEO
Much Has Occurred...

There is Much to Come
Kigali is Merely the Beginning

- Many, many products and equipment use HFCs
- Research must be completed on alternatives...and quickly
- When we transition, we must have trained, qualified technicians
- This is good for the industry, but road could be a little bumpy
AHRI is a Trade Association

315: Member Companies: Over 95% of all HVACR products manufactured and installed in North America

102: AHRI standards and guidelines in use across the globe

44: AHRI Certification Programs: Nearly 900 participants representing over 70% of all HVACR products manufactured globally
AHRI Members Manufacture:

- Residential and commercial central air conditioners and heat pumps and components
- Residential and commercial furnaces and boilers and components
- Residential and commercial water heaters and components
- Commercial refrigeration equipment and components
Big Changes are Coming

- High GWP Refrigerants will be phased down on a global scale

- Drivers:
  - Montreal Protocol – Kigali Amendment
  - U.S. EPA SNAP Program / Climate Action Plan
  - Canadian regulations
  - F-gas regulations in Europe
Montreal Protocol Developments

- Agreement on HFC phase down reached in Kigali, Rwanda
  - Reduces greenhouse gas emissions by 70 Gigatons CO2e by 2050
  - Separate baselines and reduction schedules for A2 and A5 countries
  - Will be guided by a technology and economic review process every 5 years
  - Provides financial assistance to developing countries
  - First step down is in 2019 for A2 countries
## Phase Down Schedule

<table>
<thead>
<tr>
<th></th>
<th>A5 Group 1</th>
<th>A5 Group 2</th>
<th>A2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formula</strong></td>
<td>Average HFC</td>
<td>Average HFC</td>
<td>Average HFC</td>
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<tr>
<td></td>
<td>consumption</td>
<td>consumption</td>
<td>consumption</td>
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<tr>
<td><strong>HCFC</strong></td>
<td>65% baseline</td>
<td>65% baseline</td>
<td>15% baseline*</td>
</tr>
<tr>
<td><strong>Freeze</strong></td>
<td>2024</td>
<td>2028</td>
<td>–</td>
</tr>
<tr>
<td><strong>1st step</strong></td>
<td>2029 – 10%</td>
<td>2032 – 10%</td>
<td>2019 – 10%</td>
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<tr>
<td><strong>2nd step</strong></td>
<td>2035 – 30%</td>
<td>2037 – 20%</td>
<td>2024 – 40%</td>
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<tr>
<td><strong>3rd step</strong></td>
<td>2040 – 50%</td>
<td>2042 – 30%</td>
<td>2029 – 70%</td>
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<tr>
<td><strong>4th step</strong></td>
<td>2045 – 80%</td>
<td></td>
<td>2034 – 80%</td>
</tr>
<tr>
<td><strong>Plateau</strong></td>
<td>2045 – 80%</td>
<td>2047 – 85%</td>
<td>2036 – 85%</td>
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</tbody>
</table>

* For Belarus, Russian Federation, Kazakhstan, Tajikistan, Uzbekistan 25% HCFC component of baseline and different initial two steps (1) 5% reduction in 2020 and (2) 35% reduction in 2025

Notes:
1. Group 1: Article 5 parties not part of Group 2
2. Group 2: GCC, India, Iran, Iraq, Pakistan
3. Technology review in 2022 and every 5 years
4. Technology review 4-5 years before 2028 to consider the compliance deferral of 2 years from the freeze of 2028 of Article 5 Group 2 to address growth in relevant sectors above certain threshold.
How does this impact HVAC&R equipment manufacturers?
Equipment Manufacturers:

▪ Must assess available alternatives for products and applications
▪ Conduct research and development, both individually and collectively
▪ As an industry, adapt regulatory and safety barriers to allow the safe use of equipment using A2L and A3 refrigerants
▪ Retool and optimize manufacturing processes
▪ Train technicians and building managers
What’s Next?

▪ Montreal Protocol Amendment, while good, is just the beginning
▪ We must identify suitable alternative refrigerants...and quickly
▪ Low-GWP Alternative Refrigerants Evaluation Program (AREP) laid the groundwork, identifying most promising alternatives
▪ Now the final work begins
## HFC-Using Equipment Around the World

<table>
<thead>
<tr>
<th>Region</th>
<th>Equipment Types</th>
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</table>
| North America| Ducted equipment – AC/HP (mature)  
               | Commercial AC (mature)  
               | Mini/multi-split, VRF (mature) |
| Asia         | Mini/multi-split, VRF (mature)  
               | Commercial AC (mature)         |
| Europe       | Ducted equipment – AC/HP (mature)  
               | Commercial AC (mature)         
               | Mini/multi-split, VRF (mature) |
| Middle East  | Mini/multi-split, VRF (mature)  
               | Commercial AC (mature)         |
Industry is Moving Forward

- OEMs starting to select alternatives
  - Commercial refrigeration: HCs, CO2, HFC/HFO blends, and cascade systems
  - Chillers: HFO 1233zd(E), HFO-1234ze(E)
  - Unitary: R32, R452B
- Manufacturers are developing components and equipment
- However,
  - Regulatory and safety barriers must be adapted to allow the safe use of equipment using A2L and A3 refrigerants
  - Difference between available alternative refrigerants and equipment and Commercially Available Equipment
AHRTI Flammable Refrigerant Research

Objective is to produce publicly available technical results to support codes and standards activities related to the use of flammable refrigerants

• Ensure timely completion of relevant standards such as ASHRAE 15 & IEC 60335-2-40

Joint effort by AHRI, ASHRAE, DOE, and California

Joint Research to support ASHRAE 15 revisions

Summer 2017: draft ASHRAE 15 completed for PPR

End of 2017: publication of the updated ASHRAE 15 including 2L refrigerants

Jan 2018: 2021 IMC: change proposals are due
# State of Safety Standards – Global View

<table>
<thead>
<tr>
<th>Refrigerant Classification</th>
<th>Usage Restriction</th>
<th>Application</th>
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<tbody>
<tr>
<td><strong>United States</strong></td>
<td></td>
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<tr>
<td>UL2182</td>
<td></td>
<td>UL471 Commercial Refrigerators and Freezers 2015-2019</td>
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<tr>
<td></td>
<td></td>
<td>UL621 Ice Cream Makers 2015-2019</td>
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<tr>
<td></td>
<td></td>
<td>UL60335-2-40 Heating and Cooling Equipment -2017</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UL60335-2-89 Commercial Refrigeration -2018</td>
</tr>
<tr>
<td><strong>International</strong></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>IEC60335-2-89 Commercial Refrigeration 2015-2019</td>
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<tr>
<td></td>
<td></td>
<td>IEC60335-2-24 Refrigerating appliances Ice and Ice Cream Makers 2015-2019</td>
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</tbody>
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Source: Rajan Rajendran - Emerson
Commercial Availability

Components (refrigerants, compressors, controls, values, etc.)
- Design and testing of prototypes
- Regulatory approvals
- Retool and optimize manufacturing processes
- Production

Equipment
- Design and testing of prototypes
- Regulatory approvals
- Retool and optimize manufacturing processes
- Production

Distribution, Installation, Operation, and Maintenance
- Training (technicians, operators, building owners)
- Regulatory requirements for transportation, installation, and operation
Buckle up...

It’s going to be a bumpy ride!