

**United  
Technologies**

**Building & Industrial Systems**

Effective and Safe Refrigerant Implementation for HVAC in  
High Ambient Climates

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Bangkok, Thailand

# SUMMARY RECOMMENDATIONS

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## Article 5 – High Ambient

**High ambient solutions still not available**

**Objective and reasonable efficiency standards**

**HFC refrigerant are the current viable solution**

Complete the HCFC phase-out without exceptions or loopholes

Integrate refrigerant migration into higher efficiency standards

**Alternative refrigerants development**

Any HFC phase-down should incorporate a technology review in later years to determine technology state of readiness – including high ambient solutions

Implementation lag in Article 5 countries, similar to Montreal Protocol

**Special consideration for A5 High Ambient countries**

Air Conditioning is a necessity

HCFC phase out on going

Service practices/safety issues

Cost vs. value added to be considered in HFC management initiatives

Total Equivalent Warming Impact (TEWI) to be considered in climate impact validation

# HFCs

Today: R407C, R410A, R134a

| HCFCs<br>1950-2010 | HFCs<br>1990s + |
|--------------------|-----------------|
|--------------------|-----------------|

Lower chlorine

No chlorine

Lower ozone depletion

Zero ozone depletion

Lower global warming

Lower global warming

HCFC-22

R407C, R410A, R134a

HCFC-123

**Viabale Refrigerant  
(High Ambient)**

- Safety
- Energy efficiency
- Commercial availability
- Compliance codes
- Environmental impact
- Application
- Recyclability
- After Market
- Cost

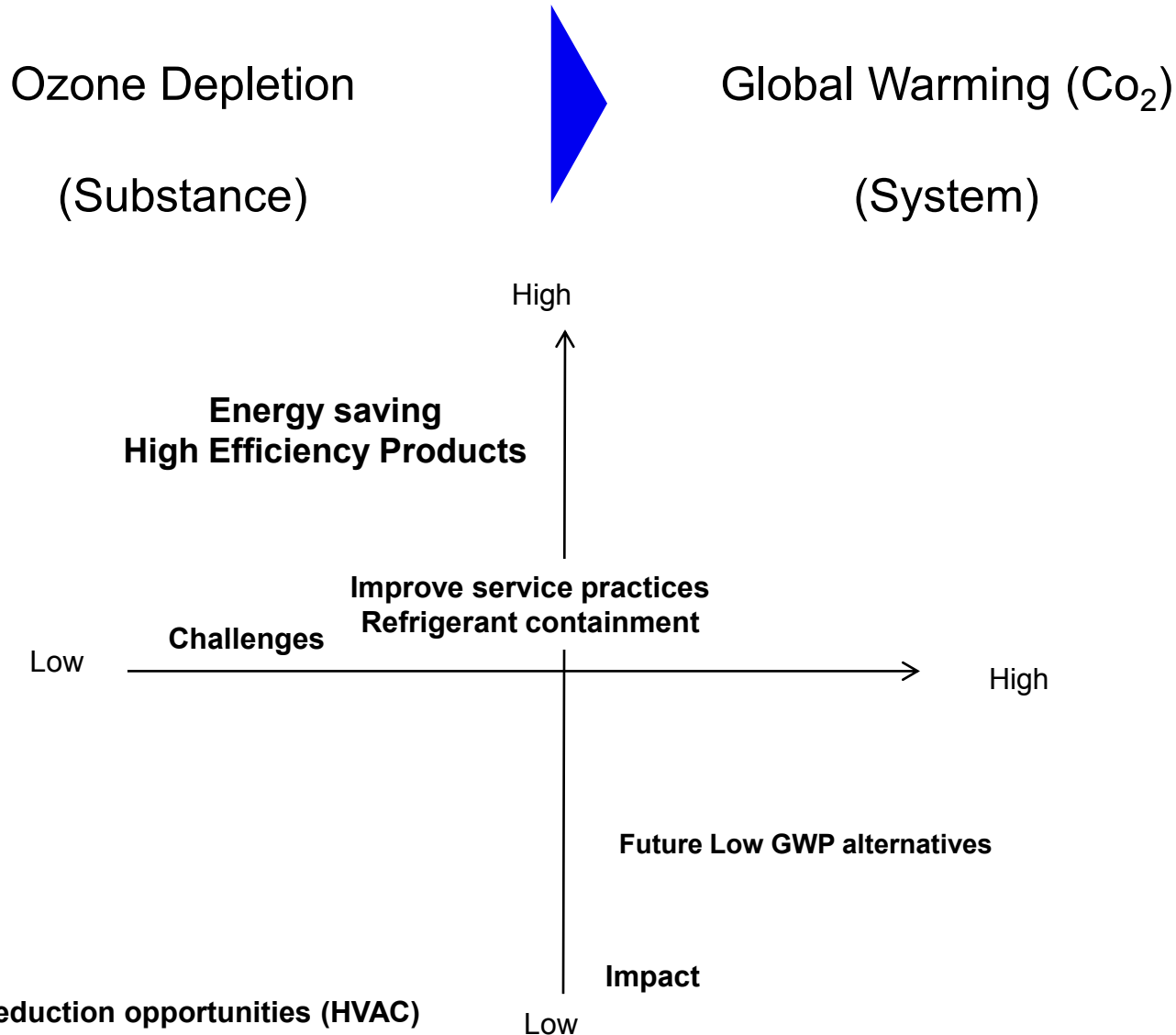
**SAFETY GROUP  
PER ASHRAE 34-2013**

|                                 |                                                                 |                                      |
|---------------------------------|-----------------------------------------------------------------|--------------------------------------|
| <b>High<br/>Flammability</b>    | <b>A3</b><br>R429A, R430A, R431A<br>Propane, Butane,<br>Butene, | <b>B3</b>                            |
| <b>Lower<br/>Flammability</b>   | <b>A2</b><br>R152a, R413A,<br>R439A, R440A                      | <b>B2</b><br>R40, Methyl<br>Chloride |
| <b>Low<br/>Flammability</b>     | <b>A2L</b><br>R1234yf,<br>R1234ze(E), R32                       | <b>B2L</b><br>R717 (Ammonia)         |
| <b>No Flame<br/>Propagation</b> | <b>A1</b><br>R22, R410A,<br>R407C, R134a                        | <b>B1</b><br>R123                    |
|                                 | Lower Toxicity                                                  | Higher Toxicity                      |

→

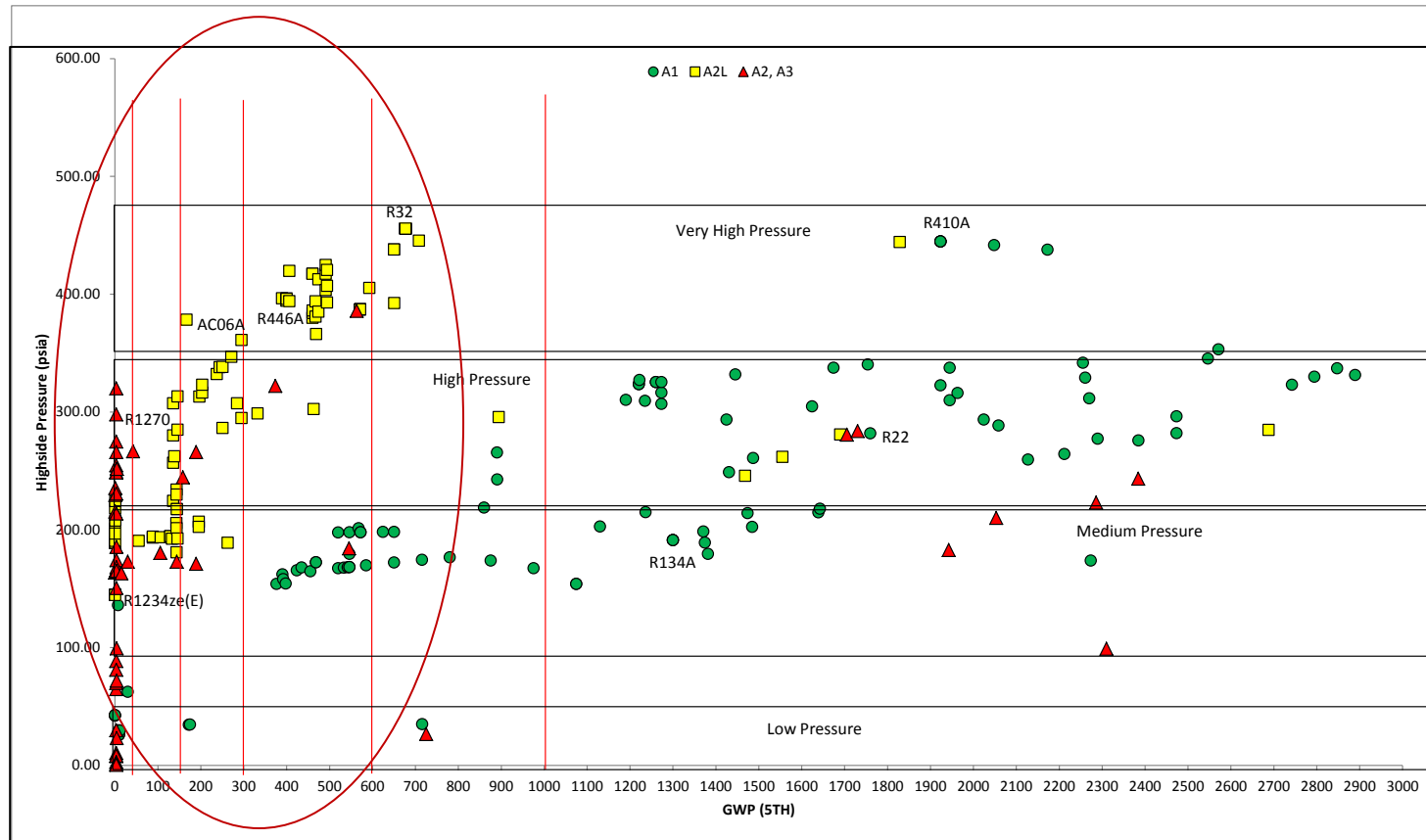
# ENVIRONMENTAL IMPACT REDUCTION

## Opportunities in HVAC



# CHALLENGES

## HFCs Alternatives - HVAC



- Landscape not clear
- Technical issues and challenges
- No ideal GWP refrigerant options
- Flammable and semi flammable refrigerants
- Safety concerns – requires new building standards and codes

# SAFETY CODES

Complete
Under revision
No Activity
Recent changes

| Refrigerant Standards                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Safety Standards                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Model Building Codes & Other                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | State and Local Codes                                                                                                                                                                                                                                                                                                                                                                                 |
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| <div style="border: 1px solid red; border-radius: 10px; background-color: #00b050; color: white; padding: 5px; margin-bottom: 5px;"> <b>ASHRAE 34</b><br/>                     Designation and Safety Classification of Refrigerants                 </div> <div style="border: 1px solid red; border-radius: 10px; background-color: #00b050; color: white; padding: 5px; margin-bottom: 5px;"> <b>SNAP</b><br/>                     Significant New Alternatives Policy Program                 </div> <p style="font-size: small;">Approvals in process</p> <p style="font-weight: bold; font-size: small;">US Specific</p> <p style="font-size: small;">2010-2018</p> | <div style="border: 1px solid red; border-radius: 10px; background-color: #f08080; padding: 5px; margin-bottom: 5px;"> <b>ASHRAE 15</b><br/>                     Safety Standard for Refrigeration Systems<br/>                     2015-2018                 </div> <div style="border: 1px solid red; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;"> <b>UL 1995</b><br/>                     Heating and Cooling Equipment<br/>                     2015-2016                 </div>                                                                                                                                                                                                                                                                                                 | <div style="border: 1px solid red; border-radius: 10px; background-color: #f08080; padding: 5px; margin-bottom: 5px;"> <b>UL 621</b><br/>                     Ice Cream Makers                 </div> <div style="border: 1px solid red; border-radius: 10px; background-color: #f08080; padding: 5px; margin-bottom: 5px;"> <b>UL 471</b><br/>                     Commercial Refrigerators &amp; Freezers                 </div> <div style="border: 1px solid red; border-radius: 10px; background-color: #f08080; padding: 5px; margin-bottom: 5px;"> <b>UL/CSA/ANCE 60335-2-40</b><br/>                     Heating and Cooling Equipment                 </div> <div style="border: 1px solid red; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;"> <b>DOT</b> Transportation Standards                 </div>                          | <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     ICC<br/>                     IBC / IFC / IMC                 </div> <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     IAPMO<br/>                     UMC                 </div> <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     NFPA 1 and NFPA 101                 </div> | <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     State, County &amp; City Building Codes                 </div> <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     Insurance Company Rules                 </div> |
| <p style="font-size: 2em; color: red;">↑</p> <p style="font-size: 2em; color: red;">↓</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <p>11/30/2020</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <div style="background-color: #f08080; height: 20px; width: 100%;"></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p style="font-weight: bold; font-size: small;">International</p> <div style="border: 1px solid red; border-radius: 10px; background-color: #00b050; color: white; padding: 5px; margin-bottom: 5px;"> <b>ISO-817</b><br/>                     Refrigerants - Designation and Safety Classification                 </div> <p style="font-size: small;">Released but Not aligned with 34</p> <p style="font-size: small;">2013-2018</p>                                                                                                                                                                                                                                   | <div style="border: 1px solid red; border-radius: 10px; background-color: #00b050; color: white; padding: 5px; margin-bottom: 5px;"> <b>ISO-5149</b><br/>                     Safety &amp; environmental requirements<br/>                     phase 1 1/2014 phase 2 ?                 </div> <div style="border: 1px solid red; border-radius: 10px; background-color: #f08080; padding: 5px; margin-bottom: 5px;"> <b>IEC 60335-2-40</b><br/>                     Heating and Cooling Equipment<br/>                     2015-2017                 </div> <div style="border: 1px solid red; border-radius: 10px; background-color: #f08080; padding: 5px; margin-bottom: 5px;"> <b>EN - 378</b><br/>                     Refrigerating Systems and Heat Pumps<br/>                     2015-2017                 </div> | <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;"> <b>IEC 60335-2-24</b><br/>                     Refrigerating Appliances, Ice-Cream and Ice Makers                 </div> <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;"> <b>IEC 60335-2-89</b><br/>                     Commercial Refrigerating Appliances                 </div> <div style="border: 1px solid red; border-radius: 10px; background-color: #f08080; padding: 5px; margin-bottom: 5px;">                     Pressure Vessel Standard (PED, JIS, etc)                 </div> <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;"> <b>GHS</b> Transportation Standards                 </div> | <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     Country Specific Building Codes                 </div> <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     Country Specific Transportation Requirements                 </div>                                                                                                                                                                                           | <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     Local Building Codes?                 </div> <div style="border: 1px solid gray; border-radius: 10px; background-color: #cccccc; padding: 5px; margin-bottom: 5px;">                     Insurance Company Rules                 </div>                   |
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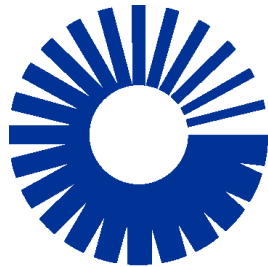
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