Objectives

• Understand how the ‘new’ 2L refrigerant class fits into upcoming code and safety standard changes.

• Discuss how these refrigerants might impact the industry in Canada
### Refrigerant Classifications (Toxicity)

- Refrigerants are classified by flammability and toxicity by the ASHRAE Standard 34 (ISO 817 in Europe and some other countries)

<table>
<thead>
<tr>
<th>Toxicity Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>An OEL of 400ppm or greater</td>
</tr>
<tr>
<td>B</td>
<td>An OEL less than 400ppm</td>
</tr>
</tbody>
</table>

### Refrigerant Classifications (Flammability)

<table>
<thead>
<tr>
<th>Flammability Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No flame propagation when tested at 60°C and 101.3 kPa</td>
</tr>
<tr>
<td>2</td>
<td>Flame propagation and LFL &gt; 0.1 kg/m³ and HOC &lt; 19,000 kJ/kg</td>
</tr>
<tr>
<td>2L</td>
<td>Same as 2 except Burning Velocity &lt; 10 cm/s</td>
</tr>
<tr>
<td>3</td>
<td>Flame propagation and LFL &lt;= 0.1 kg/m³ and HOC &gt;= 19,000 kJ/kg</td>
</tr>
<tr>
<td>Refrigerant Class</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>A1</td>
<td>Majority of HFC refrigerants in commercial and residential use.</td>
</tr>
<tr>
<td>A2</td>
<td>Several blends that are not in widespread use</td>
</tr>
<tr>
<td>A2L</td>
<td>New refrigerants - HFOs, Some HFCs and blends.</td>
</tr>
<tr>
<td>B1</td>
<td>Some obscure refrigerants like sulfur dioxide</td>
</tr>
<tr>
<td>B2L</td>
<td>Ammonia</td>
</tr>
<tr>
<td>B2 &amp; B3</td>
<td>Some obscure refrigerants. There are no B3 refrigerants</td>
</tr>
</tbody>
</table>

Air Conditioning

- A large amount of installed R22(HCFC) equipment remains— HFC replacement refrigerant available (R438A etc)
- New equipment R410A (HFC)
- Some equipment R407C
- Chillers R123 (HCFC) - Alternatives like R514A have a B1 classification
- New chillers R134A (HFC)
Refrigeration

- A very large number of refrigerants in use
- R404A (HFC) and R507A (HFC) make up the largest percentage of commercial refrigerant for new installations
- R134A (HFC) popular in smaller equipment
- Many existing systems are using R22 - HFC replacements are available for applications that don't use flooded chillers.
- CO₂ in limited supermarket and industrial applications
- Ammonia in large industrial applications
Codes and Standards....

• Codes and Standards can be written by anybody.
• They don’t have an impact from a legal standpoint unless they are adopted into legislation somehow.
• They can be adopted by reference (ex. Building and Fire Codes)

• Even if they are not adopted by legislation, designers may choose to use them as a basis for safe design or insurance companies may require compliance.
Recapping the History of the 2L Class

• 2010 - ASHRAE 34 added a 2L subclass to 2. This allowed the development of new rules specific to the risks associated with 2L.

• 2018 - ASHRAE 34 published an addenda that made 2L a class on its own and not a sub class of 2.
Do we know enough about the risks?

- AHRI, ASHRAE and the US DOE contributed a combined $5M to ongoing research.

What are the Risks?

- AHRI 8009 Risk Assessment 2015 Conclusion: Risks are significantly lower than the risks of common hazard events associated with other causes and also well below risks commonly accepted by the general public.

- FIRE
  - Fire Event
  - Products of Combustion = Hydrogen Fluoride

- HF was not considered in the AHRI 8009 Risk Assessment but they implied that it was not likely very relevant.
Research Update (ASHRAE)

- RP-1794 (ASHRAE) Investigation into use of Odorants in Flammable Refrigerants
- RP-1806 Flammable Refrigerants Post-Ignition Simulation and Risk Assessment
- RP-1807 Guidelines for Flammable Refrigerant Handling, Transporting, Storing and Equipment Servicing, Installation and Dismantling
- RP-1808 Servicing and Installing Equipment using Flammable Refrigerants: Assessment of Field-made Mechanical Joints

Research Update (AHRI)

- Codes and Standards
  - 8006 – Low GWP Refrigerants
- Risk Assessment
  - 8016 – Class 2L Refrigerants in Commercial Rooftop Units (2016)
- Performance/Compatibility
  - 8007 – Materials Compatibility and Lubricants (2014)
Research Update (AHRTI)

- 9007 – Whole Room Scale Leaks and Ignition Testing for A2L and A3 refrigerants
- 9013 – A2L Refrigerant Release and Ignition Study for Refrigerated Display Cases
- 9012 – Real-world Leak Assessments of Alternative Flammable Refrigerants

Future Research

- Mitigation and Combustion Product
  - There is some push that these risks have not been adequately understood (perhaps because of what industries are currently planning to use A2L refrigerants).
- Refrigerant Sensors
Training

• NATE (and I think RSES independently?) is developing training and certification in the US for technicians.

• Recent Gap Analysis Identified this as a critical gap

Mitigating the Risks

• Air Movement
• Charge Limits
Refrigerant Concentration Limits

- How much refrigerant can we have in a system that’s in an occupied space - kg/m$^3$
- Available in ASHRAE 34 and CSA B52.
- For most of the refrigerants we are used to, cardiac sensation/toxicity or asphyxiation determine the RCL.
- Flammable A2L refrigerants all have and RCL that is 25% LFL at the moment.

ASHRAE 15 2018 – Addendum D

- This addendum will allow the use of A2L refrigerant in direct systems for comfort cooling (i.e. Split system air conditioners, PTACs, Roof top units, etc.)
- Addendum D has been ongoing for several years. It went for its first public review in 2016 and just completed its 4th public review.
ASHRAE 15 – Addendum D

• Requires equipment to be listed by a recognized listing agency.

• The technical requirements for allowing the flammable refrigerants are centered around rapid leak detection and air movement.
  • Refrigerant detectors are required by 15 when the refrigerant exceeds an amount based on the LFL of the particular refrigerant
  • The listing may require leak detectors as well.
  • The detector will have to turn on the fan and shut off most electrical components.
  • Requires listed VAV boxes that have to be open wide when a leak is detected.
  • Very specific operational requirements for leak detectors (15 seconds to accomplish all actions at 25% LFL)
  • Annual leak detector testing requirements.

ASHRAE 15 2018 – Addendum H

• This addendum will allow the use of A2L refrigerants in machine room applications (i.e. Chillers and Plant rooms)

• Addendum H has been ongoing for several years. It went for its first public review in 2016 and just completed its 3rd public review.
ASHRAE 15 – Addendum H

• Leak detection, visual and automatic alarm requirements
• Gets a similar classified electrical exemption to ammonia
• Leak detection must shut off all electrical over a certain energy level in the room at 25% LFL

• Extensive work was done on machine room ventilation and two levels are required.
ASHRAE 15 2018

• Addendum A removed Ammonia from 15
• The next work is to include changes for 2L refrigerants for other applications (i.e. commercial refrigeration)
• ASHRAE is developing a 15.2 standard for residential applications.

Listed Equipment

• 60355-2-40 currently allows small amounts of flammable refrigerant.
• Work is ongoing for significant increases and the addition of A2L. Mid-winter publication of draft?
• Large multi-national endeavour and CSA is involved
In Canada...

- CSA B52 is the safety code for refrigeration and it relies heavily on ASHRAE 15 for technical content.

- B52 currently allows up to 6.6lb of ANY refrigerant in any occupancy as long as the system is ‘listed’ AND the installation complies with the listing agency’s installation requirements.

- B52 specifically does NOT cover residential air conditioning but yet the standard is called on by CSA product standards for the refrigerant properties.

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Adoption of codes and standards

10(1) Each of the following codes and standards, as amended from time to time, is adopted for the purposes of the Act as a standard governing the design, construction, shop inspection, installation, repair or alteration of boilers, pressure vessels or pressure piping systems:

(a) Canadian Standards Association standard B51-03 Boiler, Pressure Vessel, and Pressure Piping Code;

(b) Canadian Standards Association standard B52-05, Mechanical Refrigeration Code;

(c) American National Standards Institute, Inc. standard ANSI K-61.1-1999/CGA G-2.1 Safety Requirements for the Storage and Handling of Anhydrous Ammonia;


(e) The National Board of Boiler and Pressure Vessel Inspectors (United States) standard ANSI/NB-23 National Board Inspection Code 2004 edition;

(f) Canadian Standards Association standard CAN/CSA-B149.2-00 Propane Handling and Storage Code.
Summary for Canada

• Equipment that uses A2L refrigerant may be available in North America on a much large scale in the near future.
• B52 will most likely cover the safe installation and operation of some of this equipment but there is significant work remaining.
• B52 wouldn’t cover residential AC directly (the primary initial market?)
• The building codes are going to require modification to ensure that some of the safety requirements are captured for new installation
Summary for Canada

- What happens when the listing requires compliance with a US installation code – How does this get handled in Canada?
  - Canada has for the most part been absent in the code discussions.
- If everything under 3 tons is exempt, is there an avenue for enforcement?
- How would enforcement work? What about the requirements for annual leak detector calibration or testing?
- We are going to have to pay more attention to RCL calculations? Think commercial properties!

Potential Pitfall?
Refrigerant Trends

- Environmental regulation is driving the changes.
- Different jurisdictions are acting with different urgency and direction
- A patchwork of codes, standards, legislation and regulation exists allowing some adoption of flammable and slightly flammable refrigerant
- Technology exists in most cases (but not all) to phase down and limit high GWP HFC refrigerants

HFOs and Low GWP refrigerant

- Current systems are available throughout the world using R32
- Increasing use in air conditioning applications
- Some automobile AC
- Possible use in commercial refrigeration
- Extensive use in Canada or US requires code changes which is underway.
- Currently treated as A2 so limited to 22lb in Canada for direct system (commercial)
- Indirect systems would require machine room and only commercial occupancy
Hydrocarbons – Small Systems

- Use in supermarkets with self contained low charge cases
- Retail vending machines
- Small self contained commercial equipment
- Room air conditioners and dehumidifiers (Charge limited by room size up the approximately 1 kg – this amount is likely changing)
- Residential refrigerators

- No code changes required for use in Canada if the equipment is listed.

Ammonia

- Industrial refrigeration
- Commercial refrigeration
- Air conditioning (chillers)
- District heating

- Increasing use in industrial plants
- Focus on low charge systems
- Commercial refrigeration using secondary coolant
- Cascaded with CO\textsubscript{2} in industrial
- Outdoors or machine rooms
Hydrocarbons – Large Systems

- Chillers (Indirect air conditioning)
- Industrial Applications

- Propane use as a refrigerant is common in oil processing
- Prohibited in Canada except in industrial applications
- Code changes required for most uses

CO₂

- Commercial refrigeration
- Auto AC
- Industrial Applications

- Currently in use in supermarkets and arenas and in thermosiphon server room AC.
- More applications possible.
- Not restricted and no code changes required
- Higher pressures
- Complicated controls in transcritical
- Increases safety/food safety in industrial systems
Questions?