



AIRAH – Tasmania

**R22 phase out, replacements and
new refrigerants**

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Agenda

➤ R22 Phase out

- ❖ HCFC phase down legislation
- ❖ Interim replacement products
- ❖ Retrofit considerations

❖ Legislation, Market Trends and new HFO refrigerants

- ❖ Market trend towards low GWP
- ❖ Carbon levy repeal and what could replace it
- ❖ New HFO refrigerants, properties and blends
- ❖ HFO flammability

R22 Phase Out

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R22 – Legislation and Options

- R22 is subject to phase down (Ozone Protection and Synthetic Greenhouse Gas Management Act 1989).
- The HCFC phase down schedule is as follows:

| Year | Annual import limit (ODP tonnes) | R22 max import (tonnes) |
|-------------|----------------------------------|-------------------------|
| 2012, 2013 | 40 | 720 |
| 2014, 2015 | 10 | 180 |
| 2016 – 2029 | 2.5 | 45 |
| 2030 | 0 | 0 |
| | | |

*1 ODP tonne equates to 9 metric tonnes of HCFC-141b or 18 tonnes of HCFC-22

- With potential shortfall in supply a real possibility, businesses need an action plan:
 1. Retrofit to an interim replacement product
 2. Decommission and replace systems
 3. Retrofit some systems but look to hold on for new HFO solutions
- R22 recycling schemes will mean that R22 availability will be better than forecast above

R22 – Interim Replacement Products

- Many products have been marketed to replace R22
- Two main Manufactures:
 - ❖ DuPont – Isceon ‘9 series’
 - ❖ Refrigerant Solutions – RS range
- Drop-in replacements
- Mainstream HFCs
- From global experience, A-Gas would recommend:
 - ❖ R438A or R407C for air conditioning application
 - ❖ R407F for medium and low temperature application



R22 – Replacement Considerations

Seals

- R22 absorbed into elastomeric seals causing swelling.
- R22 leaches out on retrofit causing seals to shrink, dehydrate and crack.
- Replacement of all elastomeric seals recommended

Oil

- Isceon and RS products compatible with mineral and AB oil.
- Oil performance not as good.
- POE recommended for long pipework runs
- R407C, R407F and R427A require an oil change to POE

Capacity

- Isceon, RS products and R427A have lower capacity than R22
- R407F and R407C offer similar capacity to R22

R22 – Replacement Considerations

Mass Flow

- R407F, R407C, R427A, R438A have similar mass flow to R22
- R434A and R428A require significant mass flow increase

Glide

- R407F, R407C, R427A and R438A = High Glide
- R434A and R428A = Low Glide
- Important for flooded systems

Pressure

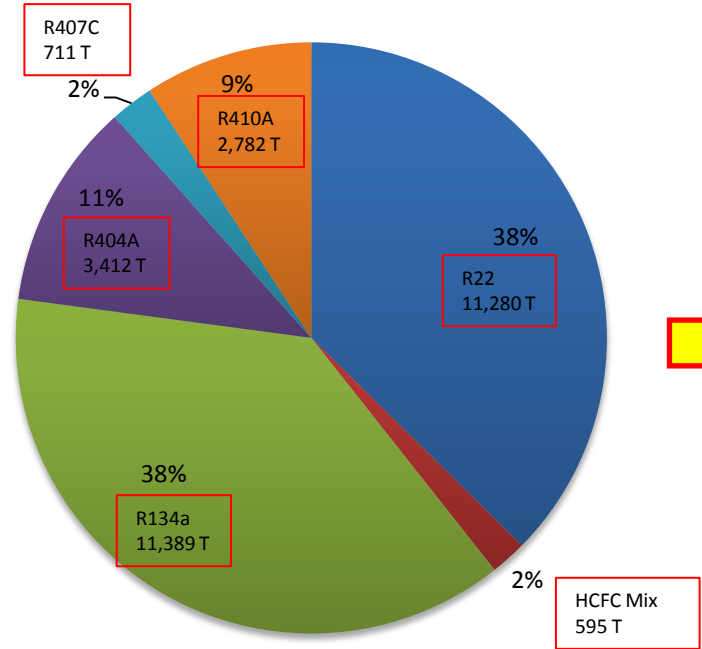
- R438A is the best pressure match to R22
- All others have higher pressures
- PRDs and pressure switches should be considered during retrofit

Legislation, Market Trends and new HFO refrigerants

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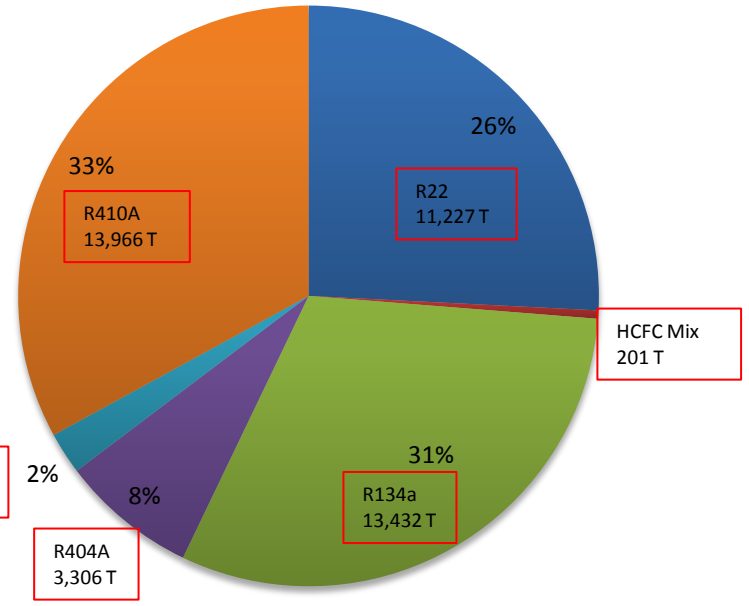
Market trend 2006 - 2012

The Refrigerant bank 2006



Total Bank = 30,169 Tonnes

The Refrigerant bank 2012



Total Bank = 43,523 Tonnes

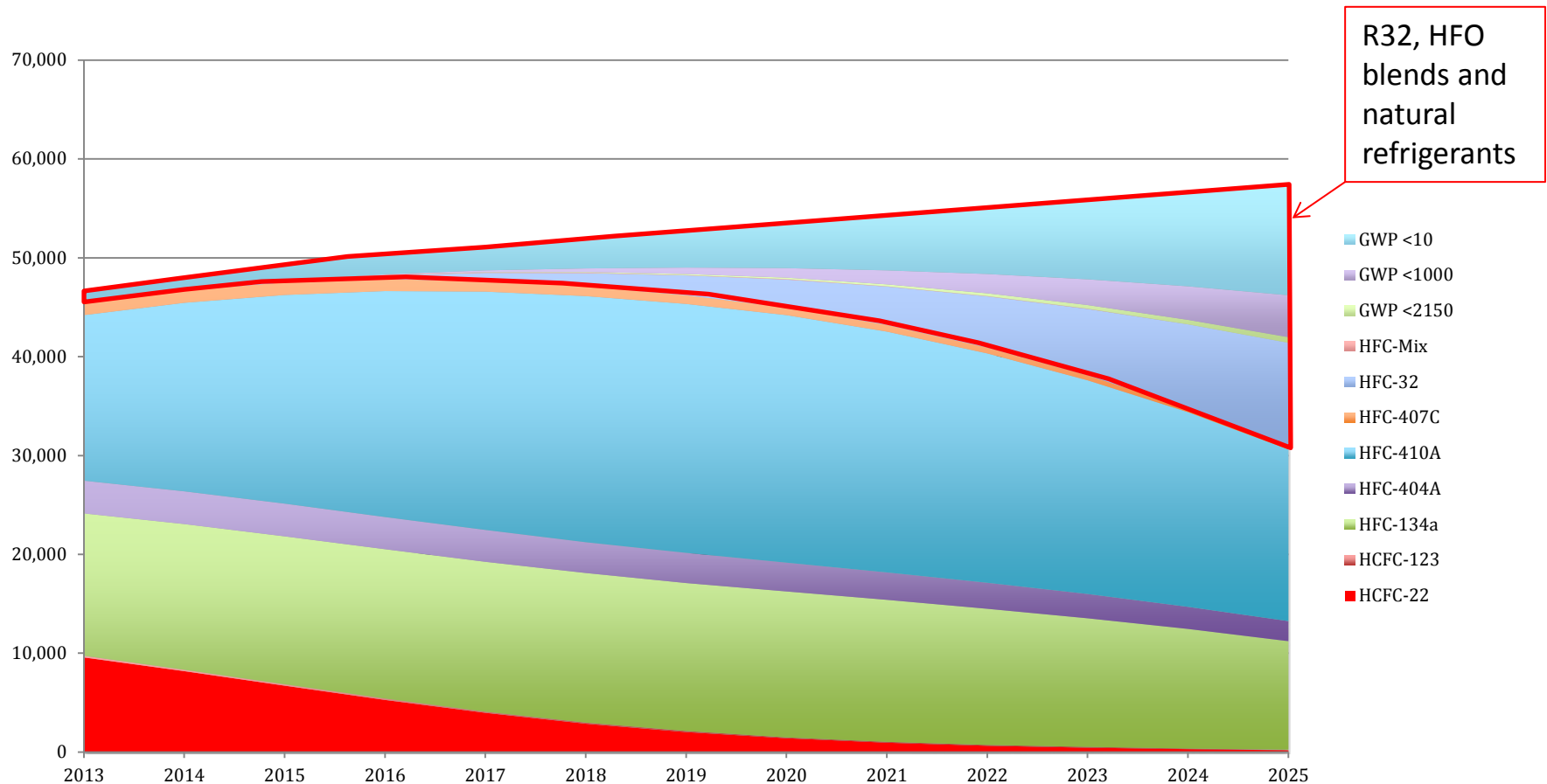
+ 4,800 Tonnes of natural refrigerants

- Total bank of HFCs has increased by 44%
- R22 Bank has remained stable due to phase down
- Huge growth in R410A as new AC units move away from R22
- Australian bank dominated by Aircon – 84% (stationary and Mobile)
- Strong Growth in natural refrigerant use

Source = Cold Hard Facts 2 – Expert Group



Market forecast 2013 – 2025 – Based on introduction of North American Amendment



- Total bank is forecast to grow steadily
- Bank of higher GWP HFCs to fall as replacements take over
- Low GWP HFO blends, R32 and natural refrigerants to constitute 40 % of the bank by 2025

This Model requires a legislative driver to occur!

Source = HFC Consumption in 2013 and an assessment of the capacity of industry to transition to nil and lower GWP alternatives – Expert Group

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Current Australian Market Position

- Moves towards use of low GWP fluids and better energy efficiency has been driven predominantly by legislation.
- The Carbon equivalent price mechanism affecting SGG's was repealed on Thursday 17th July 2014
 - HFC pricing has subsequently reduced and it may be some time before pricing stabilises in the market
- Europe and the USA are moving towards a fast phase down of HFCs
- OEMs can also drive change by adopting new low GWP fluids



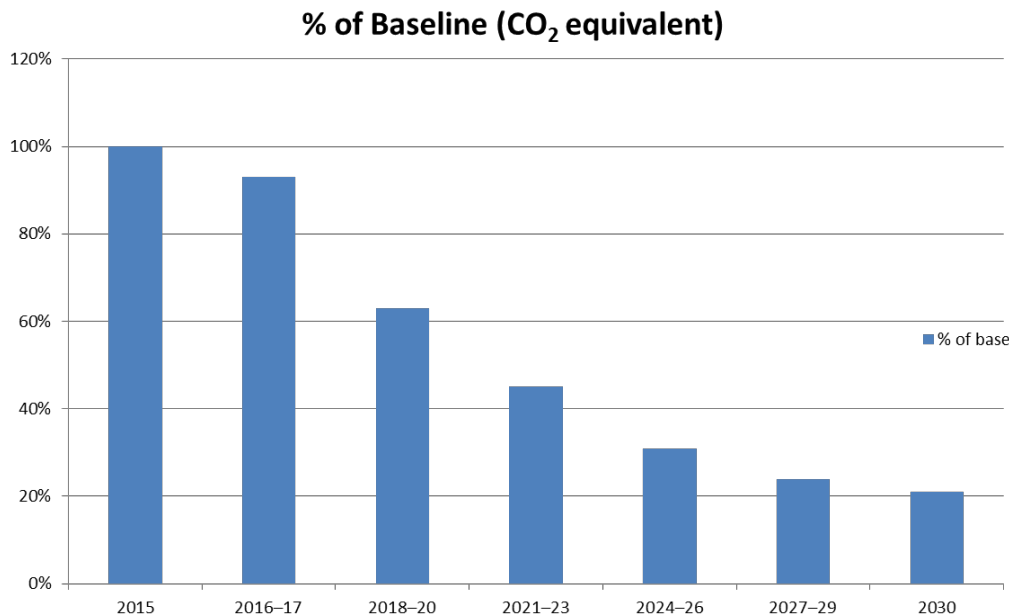
- With the demise of the Carbon Levy there is a legislative vacuum in Australia with nothing pushing the industry towards low GWP fluids
- This is not likely to last long!

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European legislation - The F-Gas Directive

- Changes to the F-Gas Directive to make it more stringent have been overwhelmingly voted through the European parliament
- Key elements:
 - Cap and phase down on the sale of HFC's starting in 2015
 - Bans on new equipment containing high GWP refrigerants
 - Bans on servicing high GWP kit from 2020

HFC Phase Down based on CO₂ equivalent



The F-Gas Directive Provides a possible route the Australian Government may take to Phase down high GWP HFC use...

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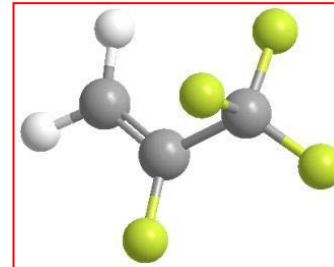
European legislation - The F-Gas Directive

| Products & equipment | Year ban starts | Refrigerants affected |
|---|-----------------|----------------------------------|
| Domestic fridges and freezers with GWP>150 | 2015 | All HFCs |
| Commercial fridges/freezers (hermetic) GWP>2500 | 2020 | R404A, R507 |
| Stationary refrigeration with GWP>2500 | 2020 | R404A, R507 |
| Movable A/C (hermetic) with GWP>150 | 2020 | R134a, R407C, R410A |
| Commercial fridges/freezers (hermetic) GWP>150 | 2022 | R134a, R404A, R407A, R407F, R507 |
| Multipack centralised refrigeration systems (commercial) >40kw with GWP>150. Exception applies to cascade systems where GWP limit is 1500 | 2022 | R404A, R407A, R407F, R507 |
| Split A/C with <3kg HFCs GWP>750 | 2025 | R134a, R407C, R410A |

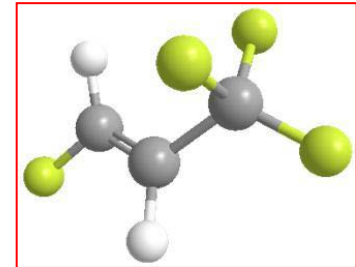
Long Term Replacement Products – HFO Properties

- HFO stands from Hydrofluoroolefin – carbon to carbon double bond.
- HFOs are stable in a system but not in the atmosphere.
 - ❖ Atmospheric residency = 11 - 26 days
 - ❖ R134a = 20 – 100 years!
- yf and ze - ASHRAE A2L class
- yf and ze used to replace R134a in automotive and chiller application
- HFO 1233zd and 1336mzz are polyurethane foam blowing agents but are being trialled as R123 replacements
- zd and mzz – non flammable / not ASHRAE classified yet
- 1233zd is being used by Trane in new chillers

HFO Refrigerants

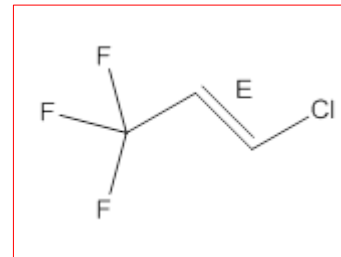


R1234yf – GWP = 4

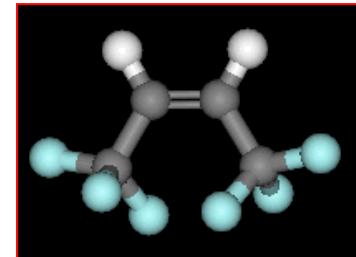


R1234ze – GWP = 6

HFO Blowing Agents – likely R123 replacements



HFO 1233zd – GWP = 6
ODP = 0.00024 – 0.00034

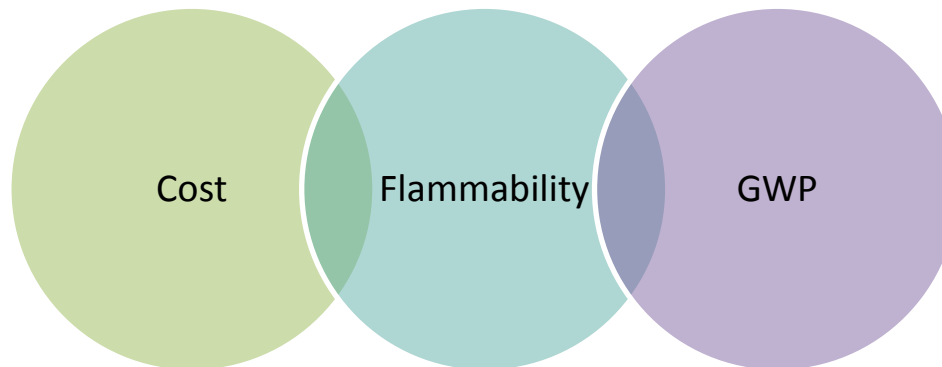


HFO1336mzz – GWP = 9.4

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Long Term Replacement Products – HFO blends

- HFO 1234yf and HFO1234ze have similar capacity to R134a
- Blending with other products is required to replicate lower temperature application products
- Blending with low GWP HFC's such as R32 and R152a keep GWP low but are flammable
- R134a or R125 are used to reduce flammability (but increase GWP)
- Blends with higher HFO content will cost more
- Not all blends will be released....
- Once products are released most businesses will conduct trials before choosing their replacement



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Long Term Replacement Products – HFO blends

A selection of new blends being trialed for R22 replacement:

| Product | Composition | % Composition (mass) | GWP | ASHRAE Class | Performance - Capacity | Performance - Efficiency |
|--------------|--------------------------------|-----------------------------|------|--------------|------------------------|--------------------------|
| ARM-32a | R32/R125/R134a/R1234yf | 25%/30%/25%/20% | 1577 | A1 | No data | No data |
| DR-7 | R32/R1234yf | 36%/64% | 246 | A2L | No data | No data |
| L-20 (R444B) | R32/R152a/R1234ze | 41.5%/10%/48.5% | <350 | A2L | No data | No data |
| N-20 | R32/R125/R134a/R1234yf/R1234ze | 12.5%/12.5%/31.5%/13.5%/30% | 975 | A1 | -17% | 0% |
| LTR4X | R32/R125/R134a/R1234ze | 28%/25%/16%/31% | 1295 | A1 | 8% | -2% |
| LTR6A | R32/R744/R1234ze | 30%/7%/63% | 206 | A2L | 16% | -2% |
| D52Y | R32/R125/R1234yf | 15%/25%/60% | 979 | A2L | -5% | -1% |

Source: AHRI – Alternative Refrigerant Evaluation Program

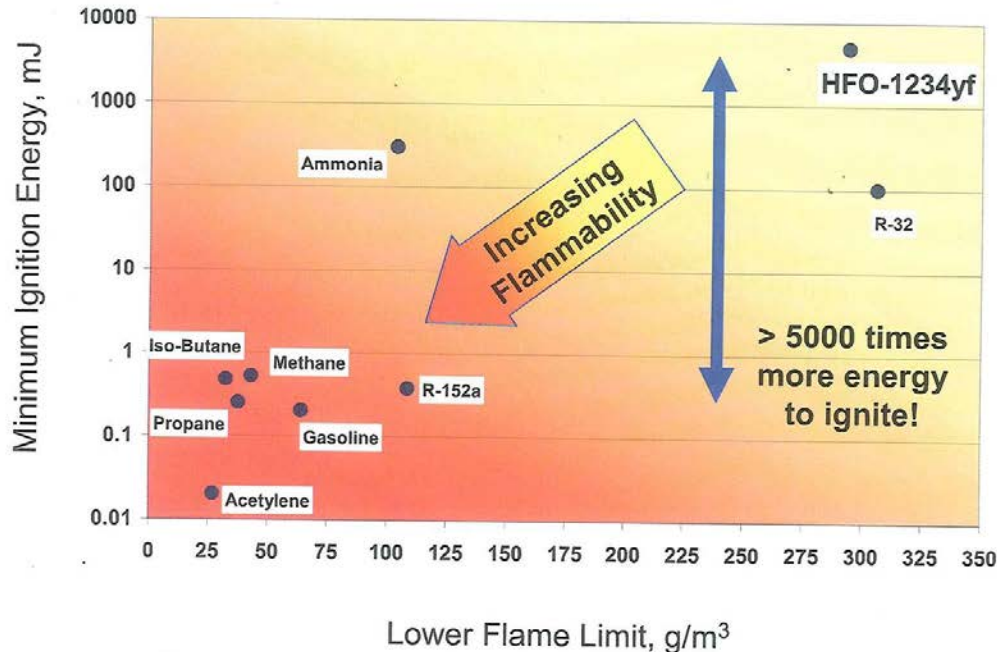
Performance data is relative to R22 based on 4°C Evaporating and 38°C Condensing temperatures



HFO Refrigerants - Flammability

Flammability is evaluated by 'Chance of Flame occurring' and 'Effect of Flame occurring'

- Chance of Flame occurring -> Lower Flame Limit, Minimum Ignition Energy

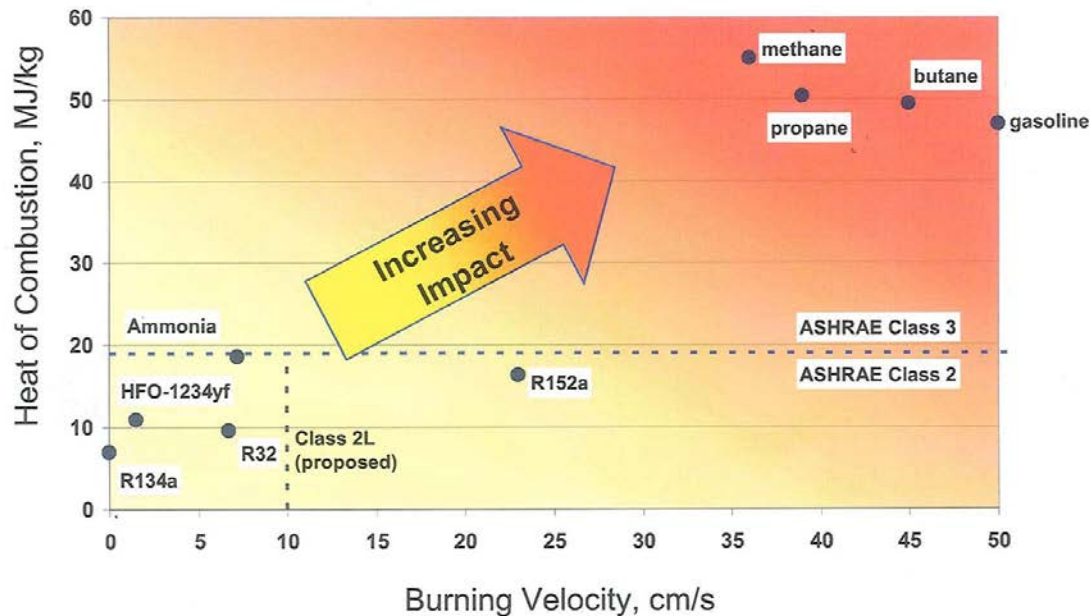


Difficult to ignite HFO-1234yf due to high Minimum Ignition Energy

- R1234ze does not exhibit an LFL until it reaches a temperature of approx 29°C. It is therefore recognised as being non-flammable

HFO Refrigerants - Flammability

Flammability is evaluated by 'Chance of Flame occurring' and 'Effect of Flame occurring'
•Effect of Flame occurring -> Burning Velocity, Heat of Combustion



HFO-1234yf will be classified in Class 2L (Low Burning Velocity)

The low heat of combustion means burning velocity is very slow for R1234yf, as a result the flame struggles to propagate and tends to self extinguish.

A thick, bright pink curved shape starts from the top left corner and curves downwards and to the right, ending near the bottom left corner of the frame.

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**THANK YOU
FOR LISTENING**