# Opteon™ YF (HFO-1234yf) Overview

## SUSTAINABLE TECHNOLOGIES FOR AIR CONDITIONING WORKSHOP

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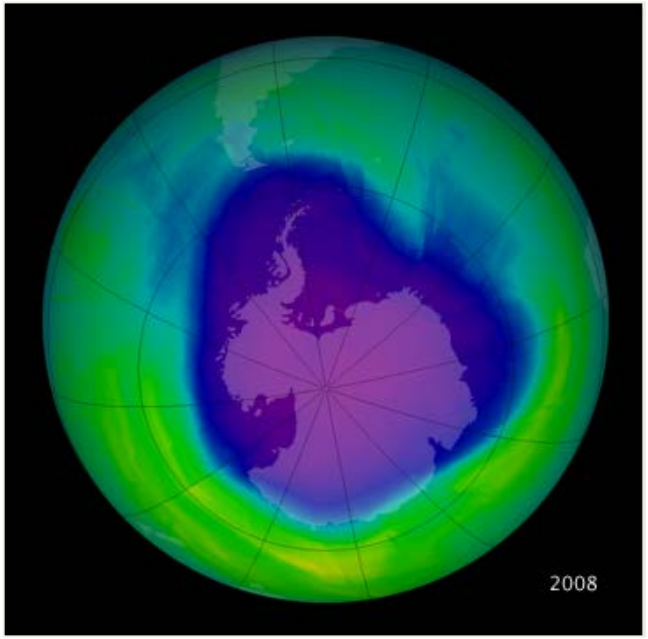
# Agenda

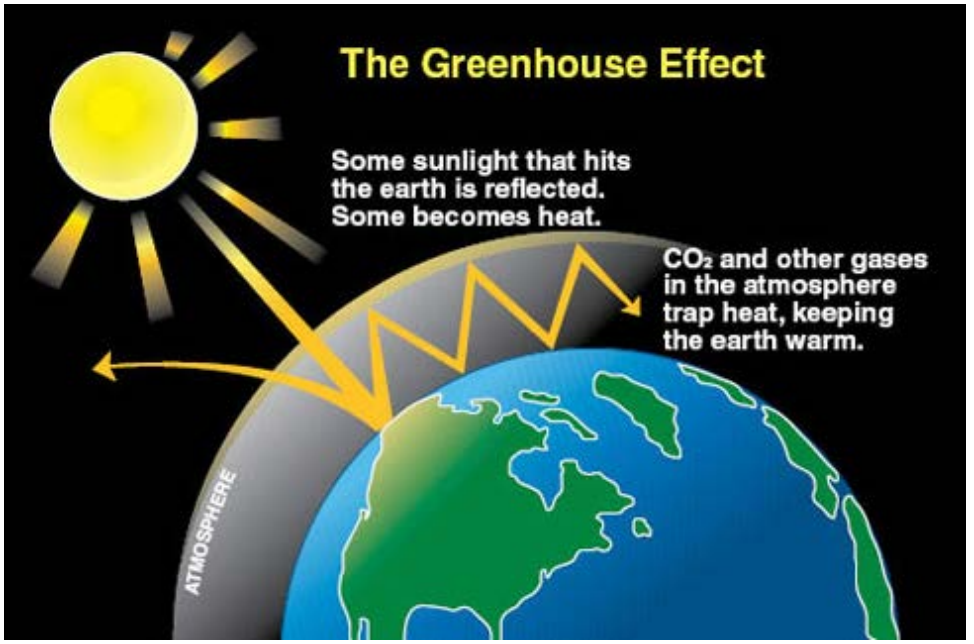
- Climate Change
- Refrigerant Transition
- Industry Drivers
- What is HFO-1234yf ?
- GWP vs Flammability
- General Flammability Information
- ASHRAE/ISO Classification
- Global Fleet
- Product availability

# Climate Change




**Ozone Depletion Potential (ODP)**

Potential for refrigerant *containing chlorine* to reduce the amount of ozone in the stratosphere.




**Climate Change / Global Warming Potential (GWP)**

The potential effect that certain substances have on climate change.

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# Global Warming Potential (GWP) & Refrigerants

Global-warming potential (GWP) –how much a given mass of a chemical contributes to global warming

-GWP expressed overtime period, usually 100 years

-GWP is expressed factor of carbon dioxide (GWP is standardized to 1).


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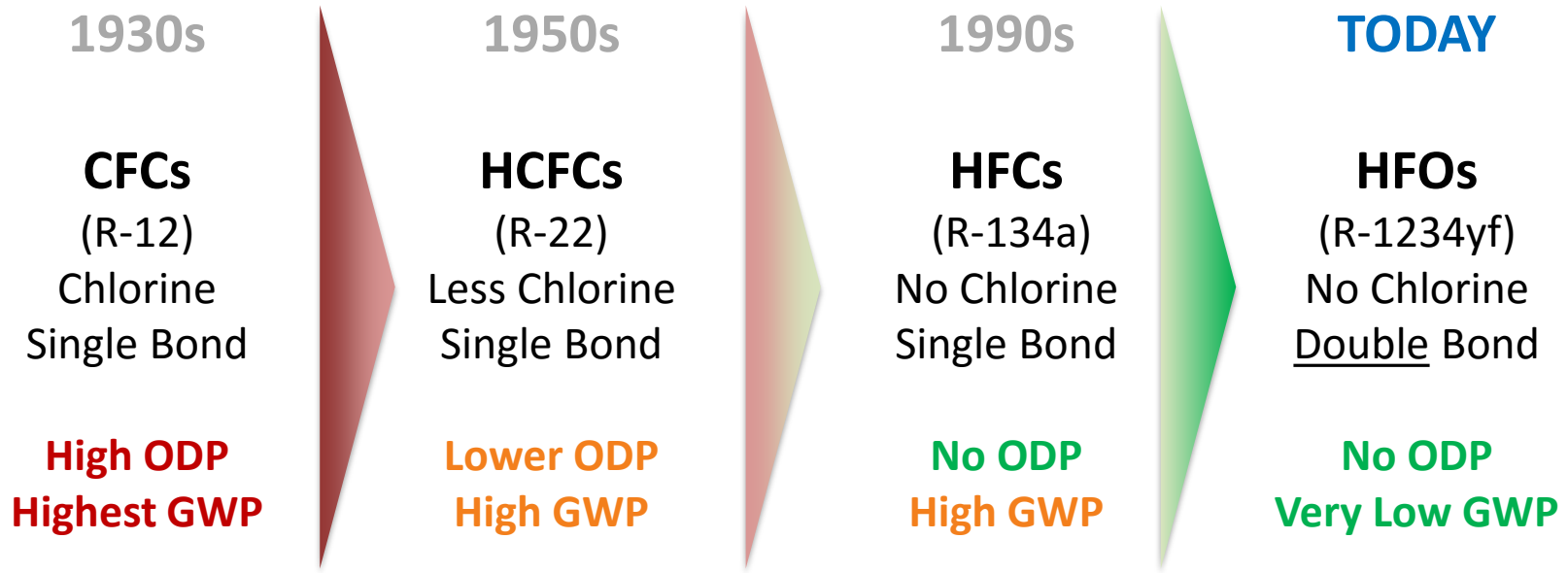
# Refrigerant Industry Transition

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# Drivers to switch to low GWP refrigerants

## United States

- 2016 EPA mandate for corporate fleet average <250 g/mile of CO2
- Low GWP refrigerant, A/C system leak reduction and A/C efficiency improvements provide credits for the manufacturer towards the CO2 requirement
- **US CO2 incentive to meet GHG**

## Europe Union

- Meets EU MAC Directive which requires refrigerant GWP <less than 150
- **EU regulated change**

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# Global Warming Potential (GWP) & Refrigerants

| Refrig | GWP | Comments |
|---|---|---|
| ***R-134a*** | *1300 (AR5)* | ***Base Line.*** |
| ***R-1234yf*** | *<1 (AR5)* | *Mildly Flammable. Safe to use per Stds* |
| ***R-152a*** | *138 (AR5)* | *Due to higher flammability (2), suggested use with secondary loop* |
| ***R-744 ($CO_2$)*** | *1 (AR5)* | *Gas cooler instead of condensor. High operating pressures: up to ~12 MPa (2,000 psi) on the high side, and up to 4 MPa (up to 500 – 600 psi) on the low side.* |

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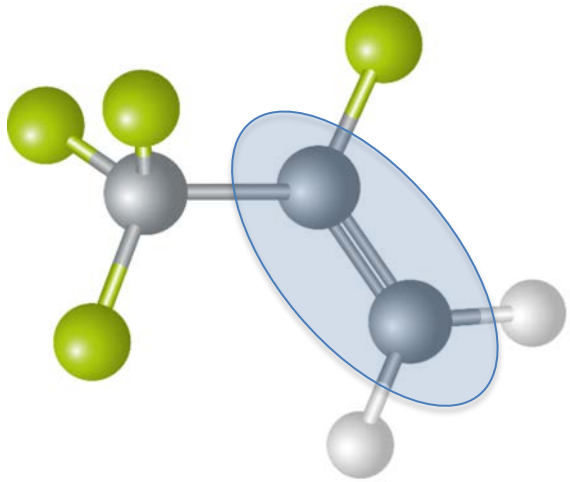
# What is HFO-1234yf ?

**HFC**
**Hydro fluorocarbon**
**1,1,1,2-tetrafluoroethane**



**HFO**
**Hydro fluoro olefin**
**2,3,3,3-tetrafluoropropene**

***Weaker double bond in HFOs allows for quicker breakdown in the atmosphere, but stability in systems***

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# R-1234yf Qs and As

*Q: Why was R-1234yf the refrigerant chosen to replace R-134a versus other low GWP refrigerants?*

*A: Various reasons, but chief among them are its similar-to-R-134a performance and operating characteristics, its overall safety, its low global warming potential and its short atmospheric lifetime.*

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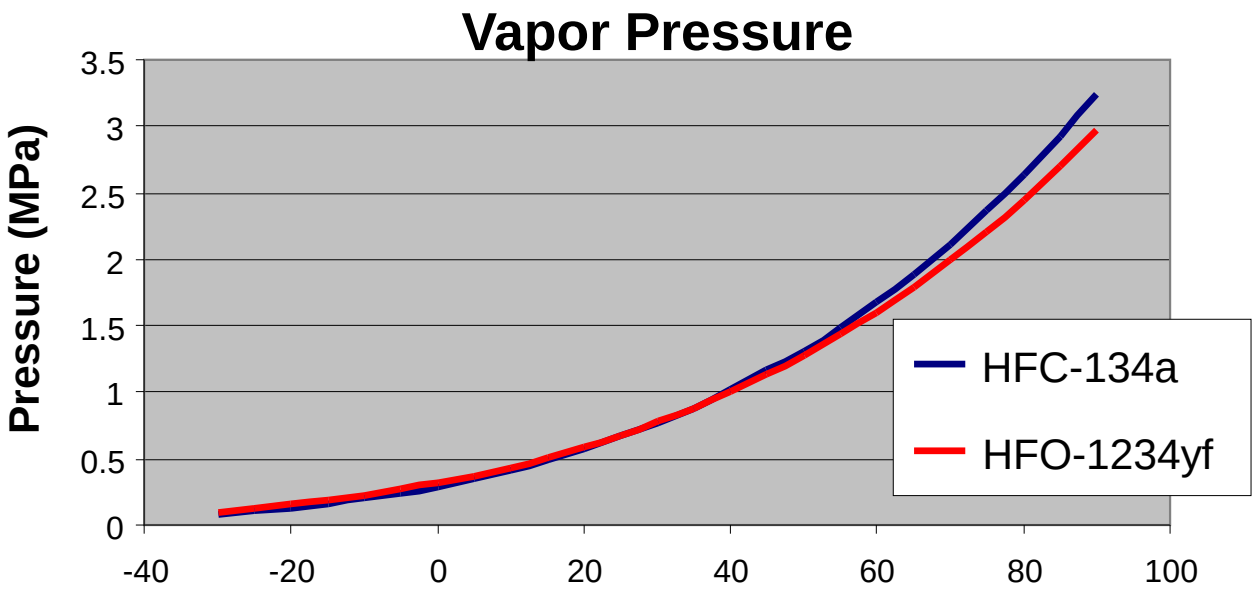
# R-1234yf is very similar to R-134

| Properties | HFO-1234yf | HFC-134a |
|---|---|---|
| Pvap, MPa (25°C) | 0.677 | 0.665 |
| Pvap, MPa (80°C) | 2.44 | 2.63 |
| GWP (100 ITH) | <1 (AR5) | 1300 (AR5) |
| Toxicity | A-Low | A-Low |
| Flammability | Mild | None |




- **Same operating conditions as 134a (similar P/T curve)**
- **Thermally stable under extreme use conditions in a MAC system**
- **Only modest design changes required in MAC**
- **Has mild flammability needed to achieve low GWP, but << flammable than HCs**

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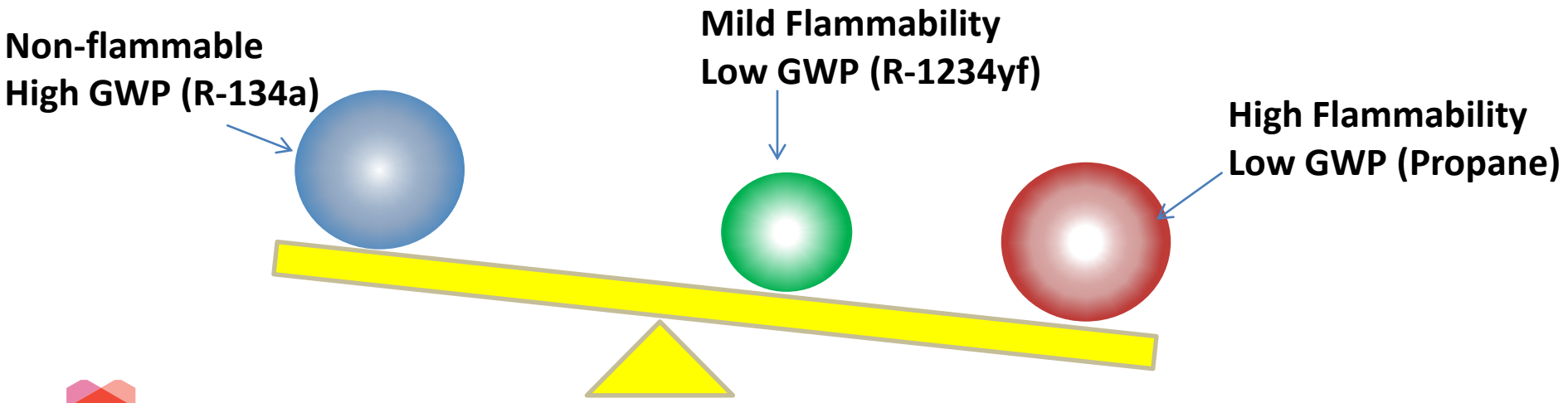
# Low GWP Refrigerant and Flammability

To reduce global warming potential, it was necessary to develop new refrigerants with reduced chemical stability

Low GWP → Fast decomposition → Reduced stability → Increased flammability

These new low GWP fluids represent a compromise of environmental characteristics with mild flammability and acceptable stability.

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# R-1234yf Qs and As

***Q. Why is R-1234yf Flammable and How Flammable is R-1234yf?***

***A. R-1234yf is one of the lowest flammable products under the engine hood.***

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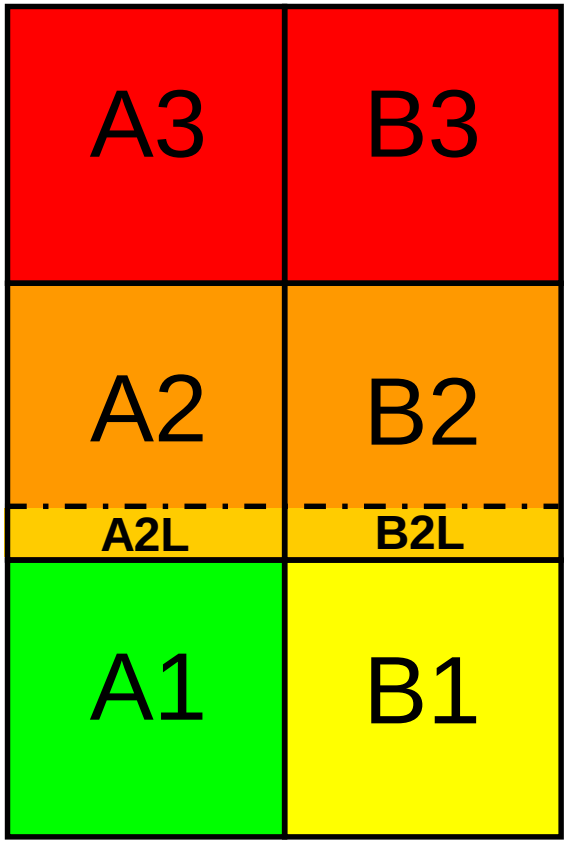
# ASHRAE/ISO 817 Safety Classifications

**ASHRAE Classification**




Highly Flammable (3)

Flammable (2)

Mildly Flammable (2L)

Practically Non-Flammable (1)

Examples:

| | |
|---|---|
| Propane | A3 |
| R-152a | A2 |
| R-1234yf | A2L |
| R-134a | A1 |

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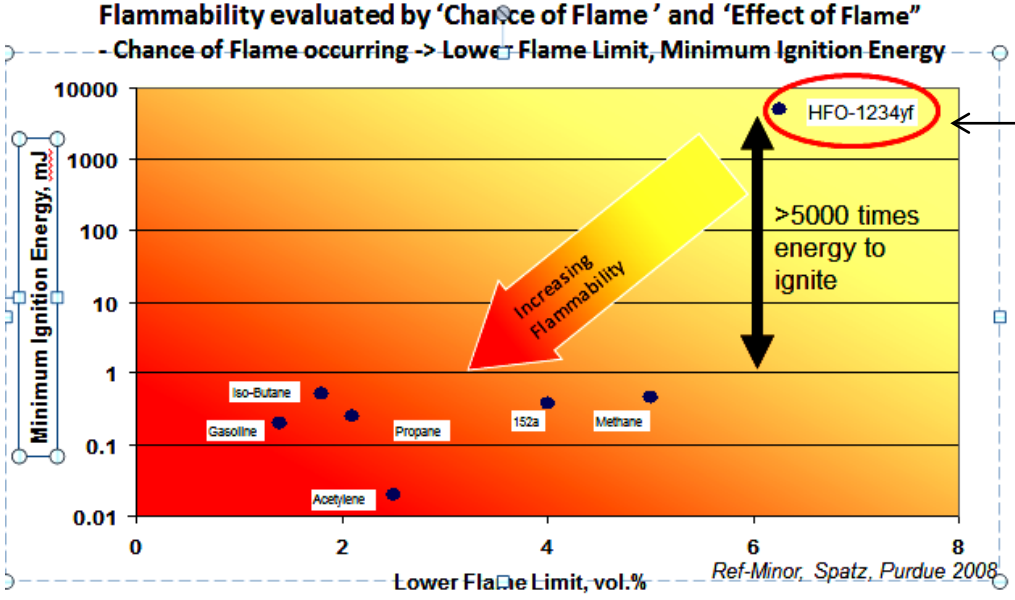
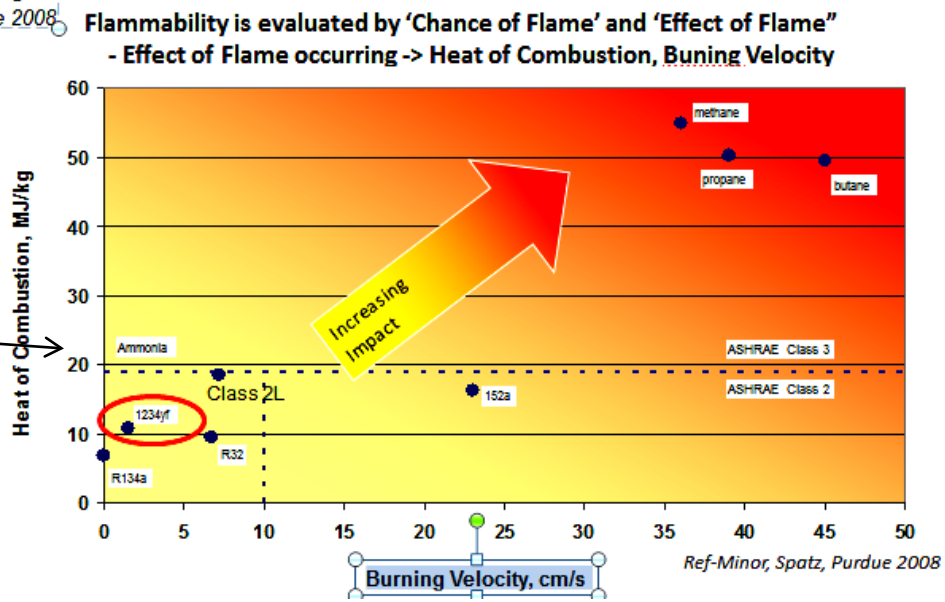
# Flammability Properties




***R-1234yf difficult to ignite***

***R-1234yf has weakly burning, slow flame if ignited***

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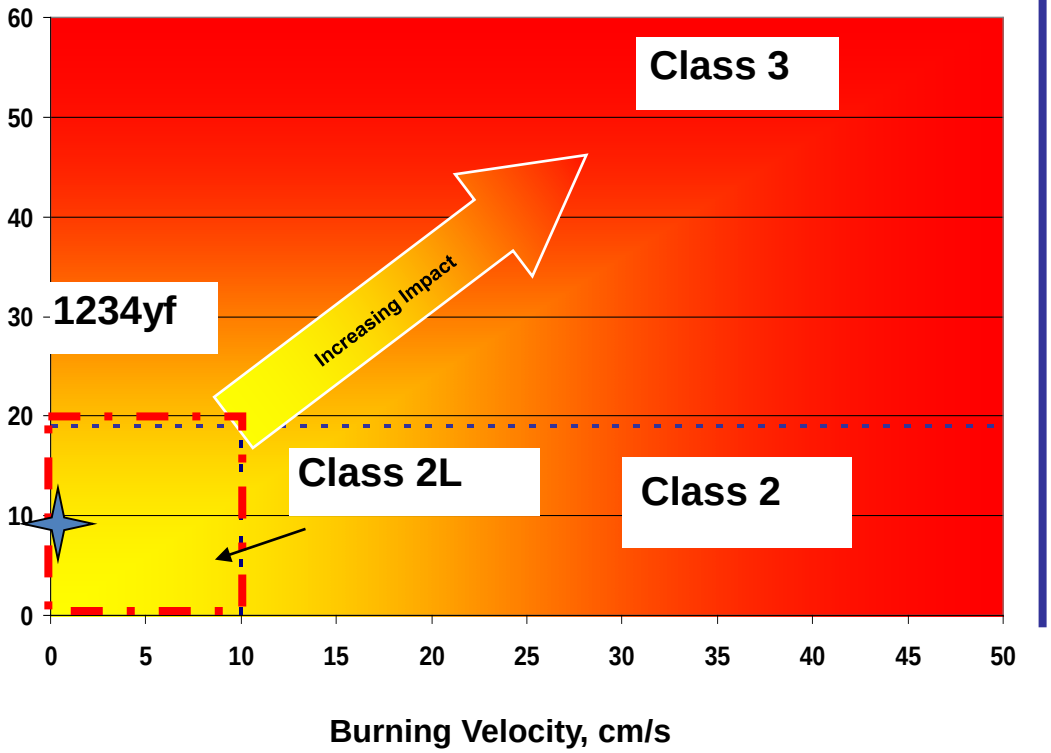
# Refrigerant Comparison-Flammability




## Product Classification

R-134a
***Non-flammable Compressed Gas***

R-1234yf
***2L Flammable Compressed Gas***

***Product users needed to make some changes to handle product***

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# EPA SNAP Requirements

## Vehicles using HFO-1234yf Refrigerants

**HFO-1234yf is EPA SNAP listed and has following requirements:**

- **Requires OEMs conduct FMEA per SAE J1739 and keep on file**
- **Label per SAE J639**

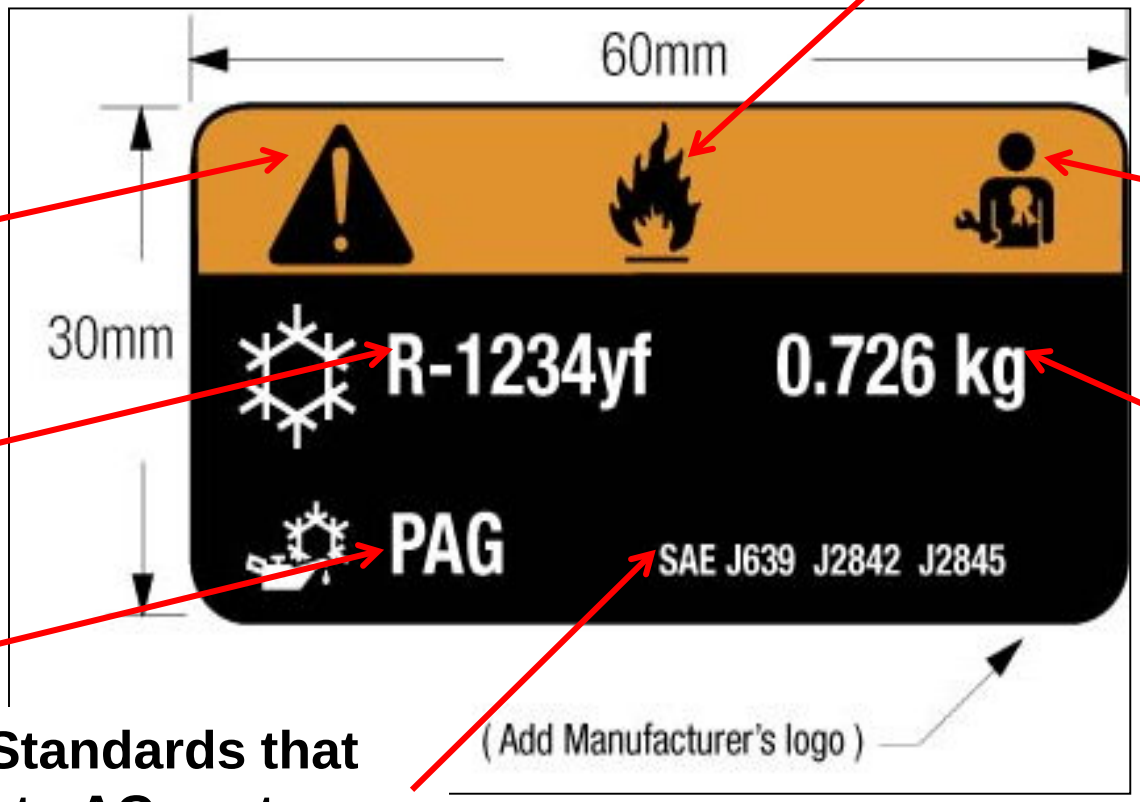
  -Per EPA regulations, need to follow SAE J639 label requirements
- **Fittings per SAE J639**

  **-**Per EPA regulations, need to follow SAE J639 and have unique fittings.
- **Evaporator per SAE J2842**

  -No repaired evaporators can be used. Must use new SAE J2842 compliant evaporator

  -SAE J2842 : “R1234yf and R-744 Criteria and Certification for OEM Mobile A/C Evaporators and Service Requirements”

# SAE J639 A/C Label




**Flammable Symbol**

**Caution Symbol**

**Certified Personnel**

**Refrigerant type**

**Refrigerant amount**

**Lubricant type**

**SAE Standards that apply to AC system**

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# Chemours Estimate-Global Fleet

# Models with R-1234yf

## Chrysler (US)
- Jeep Cherokee
- Chrysler 300
- Dodge Charger
- Dodge Challenger
- Dodge Dart
- Ram 1500
- Chrysler 200

## GM (US)
- Cadillac XTS

## Tesla (US)
- Model S

## BMW (US)
- i3
- i8

## JLR (US)
- Range Rover
- Range Rover Sport

## Honda (US)
- Fit EV

## Hyundai/Kia (EU)
- Hyundai i10
- Hyundai i30
- Hyundai Santa Fe
- Kia Cee'd
- Kia Carens
- Kia Sorento

## Opel (EU)
- Mokka

## Renault (EU)
- Zoe

## Subaru (EU)
- Impreza
- Forester
- BRZ

## Suzuki (EU)
- SX4

## GM (EU)
- Chevrolet Tracker

***More models to come!!***

***-List is not exhaustive, just to show some models using R-1234yf***

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*Information from public domain reports*

# Product Supply-Low GWP Product Available

- New Corpus Christi plant construction is on track for a late 3Q2018 startup
- As plant reaches full operating rates, it will triple Chemours current HFO-1234yf supply capacity

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# *Thank You*