

# Use of R1234yf, R744 (CO<sub>2</sub>) and R134a in automotive air conditioning



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AUSTRALIAN  
REFRIGERATION  
COUNCIL

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- Motor Trades Association of Australia (MTAA)
- Institute of Automotive Mechanical Engineers (IAME)
- Cool Drive
- CPS Asia Pacific

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## If your business works with vehicle air conditioning systems, then you need to be aware of new refrigerants that are making their way to Australia in vehicles right now.

The HFC (hydrofluorocarbons) phase-down has been initiated by the Australian Government to reduce the use of gases that harm the environment.

Industry standard automotive refrigerant R134a is an HFC refrigerant and requires a ARC refrigerant handling licence to handle, and a ARC refrigerant trading authorisation to buy, sell and store, as per the requirements set out in the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995. From 2018, imports of this refrigerant will begin to reduce.

This means that the automotive industry will see alternative refrigerants become more common in Australia.

R1234yf and R744 (carbon dioxide) are two refrigerants that have been adopted by some European vehicle manufacturers as alternatives to R134a. These refrigerants are not regulated under the Ozone Protection and Synthetic Greenhouse Gas Management legislation unless they are in a blend containing a HFC. As such an ARCTick handling licence or a trading authorisation is not required for these refrigerants in their pure form.

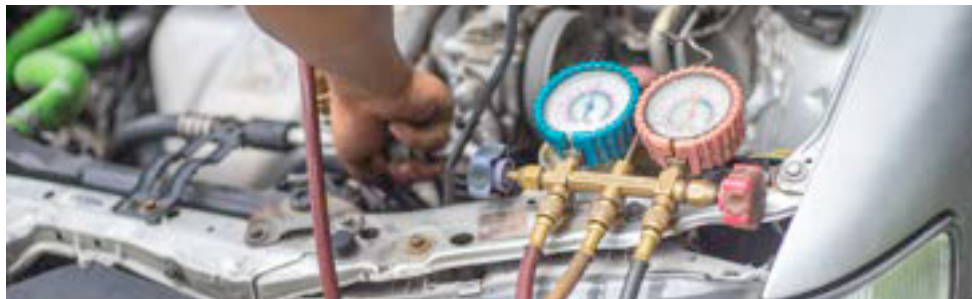
Both refrigerants and the systems designed for them will present significant changes to the tools, working practices, component standards and workplace safety considerations relating to repair, service and refrigerant recovery.

This education booklet has been designed to help ARCTick-licensed technicians and businesses to better understand these refrigerants.

While there is a transition to more environmentally friendly refrigerants, R134a will still be available, and in older systems, for years to come. It is a legal requirement that automotive workshops who provide air conditioning services continue to hold an ARCTick refrigerant handling licence and refrigerant trading authorisation if R134a is being used.

Before working with any refrigerant, please refer to vehicle manufacturers' recommendations, industry standards and the Automotive Codes of Practice.

For further information, visit – [www.tbc.org](http://www.tbc.org)





## R1234yf

R1234yf is a hydrofluoroolefin (HFO) refrigerant. HFO refrigerants are composed of hydrogen, fluorine and carbon atoms, but contain at least one double bond between the carbon atoms. Due to its composition,

R1234yf does not damage the ozone layer or contribute to global warming to the extent that R134a refrigerant does if it is released into the atmosphere. You do not need a refrigerant handling licence or a refrigerant trading authorisation through the ARC to handle, sell or store this refrigerant.

### Main characteristics of R1234yf

Low toxicity

Low GWP;  $GWP = >1$

Zero ozone-depleting potential

A2L Mildly flammable

Low total contribution to climate change

Same operating pressures as R134a system

PROPERTIES	R1234yf	R134a
Boiling Point	-29°C	-26°C
Critical Point	95°C	102°C
Saturation Pressure at 25°C	580 kPa gauge	567 kPa gauge
Saturation Pressure at 80°C	2400 kPa gauge	2490 kPa gauge
Global Warming Potential (100 ITH)	>1	1430

**R1234yf flammability rating = A2L mildly flammable (R134a is non-flammable)**

**ASHRAE classification**

REFRIGERANT SAFETY GROUP CLASSIFICATION		
Higher Flammability	A3	B3
Lower Flammability	A2	B2
	<b>A2L</b>	B2L
No Flame Flammability	A1	B1
	Lower Toxicity	Higher Toxicity

## What equipment do I need to handle R1234yf?

The general requirement for R1234yf tools is summarised in reference to “ignition proof” standards. Ignition proof tooling provides a spark free tool / work environment. This reference is relevant to any tool that has electrical requirements.

## Equipment requirements for R1234yf

(a) A R1234yf calibrated gauge set with dedicated R1234yf couplers. As R1234yf is an A2L flammable substance, SAE standards have been developed for hoses and couplings.

- Red and blue service hoses, the fittings are 12mm O Ring fittings male with a hexagon nut, (R134a is ½” acme female. R12 - commercial industry standard - is ¼” flare female with a knurled nut).
- R1234yf has a unique vehicle quick release fitting, to prevent use of incorrect equipment not fit for this type of refrigerant.
- Yellow service hose ½” LH acme thread (an adaptor is available to fit a universal vacuum pump).
- The manifold gauge set is designed to take the male fittings of the hose set and are calibrated to read R1234yf temperatures.

(b) Refrigerant leak detector (A2L compliant).

(c) Vacuum pump (A2L compliant).

(d) Recovery/reclamation equipment (A2L compliant). Although it is not mandatory to recover R1234yf, it is still good environmental practice and, due to the cost of this refrigerant it would be advisable to do so. Some suppliers can clean recovered refrigerant for re-use if it meets relevant specifications.

- Dedicated cylinders for recovered or new R1234yf have a left-hand valve thread and require a suitable adaptor to connect to the gauge set charge hose. As R1234yf is a flammable gas, cylinder storage and transport practices will differ to R134a cylinders. Check out the relevant dangerous goods handling and storage requirements for your state.

(e) A refrigerant identifier is also recommended to ensure you are handling pure R1234yf, free of contaminants such as air or other refrigerants.

# EQUIPMENT

(EXAMPLES ONLY)



**a** Calibrated gauge set



**b** Refrigerant leak detector



**c** Vacuum pump



**d** Recovery/reclamation unit



**e** Refrigerant identifier



## IMPORTANT

Only use equipment that meets the following Society of Automotive Engineers (SAE) Standards for use with R1234yf:

- Refrigerant Recovery equipment:
  - SAE J 2843:2013, R1234yf recovery/recycling/recharging equipment for flammable refrigerants for mobile air-conditioning systems
  - SAE J 2851:2015, recovery equipment for contaminated R134a or R1234yf refrigerant from mobile automotive air conditioning systems
  - SAE J 3030:2015, automotive refrigerant recovery/recycling/recharging equipment intended for use with both R1234yf and R134a
- Hose sets and gauges: SAE J 2196:1997 service hose for automotive air conditioning
- Leak detectors: SAE J 2913:2016, R1234yf refrigerant electronic leak detectors, minimum performance criteria

## Is R1234yf compatible with existing R134a equipment?

No. The R1234yf system refrigerant circuit is accessed using service couplers that are a different size to those of a R134a system.

The service coupler hose connection also has a left-hand thread that requires a matching hose for connection. Hence the need for an R1234yf gauge set.

R1234yf is classified as an A2L mildly flammable refrigerant, and requires the use of equipment designed for use with such a refrigerant.

The exception is a leak detector. Several manufacturers produce detectors that are suited to both refrigerants. Check with your local refrigerant wholesaler.

## Can I convert an R134a system to R1234yf?

No. R134a systems were not designed to operate using a flammable refrigerant.

A R134a system should not be converted to use R1234yf as these systems are unable to be converted to a level that satisfies the stringent requirements of international standards (SAE J639 and SAE J2842) set for systems that use R1234yf. Businesses dealing with flammable refrigerants have work health and safety and consumer protection obligations to consider.

The standards lay down specific requirements for system design. For example, the R1234yf evaporator is significantly stronger than the one you would commonly find in an R134a system.

Aside from the safety aspects, although the two refrigerants have similar thermodynamic properties, they are not the same. Therefore, compressor damage or system performance limitations may be experienced by attempting to convert an R134a system to R1234yf.

## Where can I buy R1234yf from?

R1234yf is available from refrigerant wholesalers and automotive air conditioning component suppliers. Ask your supplier for availability and pricing.

## Do I need an ARCTick licence to buy and handle R1234yf?

No. An ARCTick licence is not required to purchase, store, sell or handle R1234yf as it is a low global warming potential refrigerant and is not controlled under the Ozone Protection and Synthetic Greenhouse Gas legislation.

We recommend finding out if there are state-based licence requirements are for your state.



## R744 (CO<sub>2</sub> carbon dioxide)

R744 is pure carbon dioxide. You do not need a refrigerant handling licence or a refrigerant trading authorisation through the ARC to handle, sell or store this refrigerant.

### Main characteristics

R744 has a global warming potential (GWP) of >1 and is non-flammable.

However, the high operating pressures of R744 and hazards associated with potentially high concentrations of CO<sub>2</sub> in vehicle cabins or working environments means this refrigerant must be used with care.

R744 can exist in all three states, vapour, liquid and solid (dry ice) and, as such, the skills of the technician are critical.

**Dry ice changes from a solid to a vapour (sublimates) at -78° and the boiling point of liquid CO<sub>2</sub> at atmospheric pressure is also -78°C.**

PROPERTIES	R744	R134a
Boiling Point, tb	-78°C	-26°C
Critical Point, Tc	31°C	102°C
Saturation Pressure at 25°C	6370 kPa gauge	567 kPa gauge
Saturation Pressure at 80°C	Not Applicable	2490 kPa gauge
Global Warming Potential (100 ITH)	>1	1430



**R744 flammability rating = A1 non-flammable (R134a is non-flammable)  
ASHRAE classification**

REFRIGERANT SAFETY GROUP CLASSIFICATION		
Higher Flammability	A3	B3
Lower Flammability	A2	B2
	A2L	B2L
No Flame Flammability	<b>A1</b>	B1
	Lower Toxicity	Higher Toxicity

### What equipment do I need to handle R744?

R744 requires systems and service equipment that are more durable than those used for R1234yf and R134a due to the high operating pressures.

R744 service equipment, which vents used refrigerant to atmosphere, has integrated fans to disperse the refrigerant. If R744 concentrations in the air increase to an unsafe level, built-in sensors shutdown the process and alert the technician. Vehicles using R744 have cabin air quality sensors that detect refrigerant leaks and let in fresh air if R744 concentrations exceed 800 parts per million (average atmospheric levels are below 400ppm).

Handling equipment for R744 is not commonly available in Australia. Contact your refrigerant wholesaler or the vehicle manufacturer if you have questions about equipment for R744.

### Is R744 compatible with R134a equipment?

No. R744 operates on pressures up to ten times higher than R134a. Although it has been used for some time in stationary equipment, developing R744 systems for automotive applications has been a significant engineering challenge, with unique components and system layouts required for this refrigerant.

Working with R744 will require new service equipment meeting the relevant SAE standards, as well as technical training about the major differences. Contact your local TAFE or relevant registered training organisation to see if they incorporate R744 into their automotive air conditioning training.

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## Can I convert a R134a system to R744?

No. R134a systems were not designed to operate using a high pressure refrigerant.

## Where can I buy R744 from?

R744 is available from refrigerant wholesalers and automotive air conditioning component suppliers. Ask your supplier for availability and pricing.

## Do I need an ARCTick licence to buy and handle R744?

No. An ARCTick licence is not required to purchase, store, sell or handle R744 as it is a low global warming potential refrigerant and is not controlled under the Ozone Protection and Synthetic Greenhouse Gas legislation.

We recommend finding out what the state-based licence requirements are for your state.

## Are there safety issues to be aware of when handling R744?

R744 systems operate at extremely high and dynamic pressures. Even when the system is turned off, the static pressure of R744 is still very high.

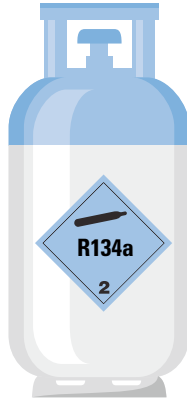
R744 can displace oxygen if released in excessive amounts, and therefore precautions must be taken to prevent its release and breathing in of high levels of CO<sub>2</sub>. Symptoms from overexposure to CO<sub>2</sub> range from drowsiness to, in extreme cases, death. But the right training, equipment and attitude will allow safe use of R744.

CO<sub>2</sub> systems must also be charged and degassed in a specific manner to avoid the formation of dry ice. Frost burns can occur if contact is made with liquid or solid CO<sub>2</sub>. Appropriate personal protective equipment must be used, and system specific safety procedures should be followed.

For example, R744 systems can operate at up to 170 bar (2466 psi) and trapped liquid CO<sub>2</sub> in hoses can cause pressure explosions if exposure to higher temperatures causes a phase change.

If dry ice is allowed to form, it can cause severe skin burns and block parts of the system for long periods of time until it has evaporated.

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## R134a

While the automotive industry is transitioning to more environmentally friendly refrigerants, the industry standard R134a will still be available and in older systems for years to come. It is a legal requirement that automotive workshops who provide air conditioning services continue to hold an ARCTick refrigerant handling licence and refrigerant trading authorisation if R134a is being used.

## Tips for your permit condition check

**If your business holds a Refrigerant Trading Authorisation (RTA), then you need to have in your possession specific equipment and records.**

All companies (or individuals) that hold a RTA may have a permit condition check conducted by a Field Officer from the ARC. The permit condition check is a means to ensure RTA holders are meeting their obligations under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 as well as being a great opportunity to make sure you are managing your paperwork and equipment in the most efficient and accurate way, which will go a long way to reducing your refrigerant use and costs.

*Images used as examples only.*

**Equipment maintenance records**

Quarter ending	Page No.				
Date to	Equipment	Make	Model	Serial No.	Action Taken
Quarter	Type				

**Cylinder leak test records**

Quarter ending	Page No.				
Working	Cylinder	Full	Date	Tested	Pressure
Type	Number	Serial	Leak	By	at
		Number	Tested	Tested	at

**Risk management plan around emissions of refrigerant**

Activity	Control Measures	Responsible Person and Job Role	Frequency of Review	Date of Implementation	Responsible Person
Refrigerant	Refrigerant	ARC	ARC	ARC	ARC

**Cylinder leak test records**

# RTA PERMIT CONDITION CHECKLIST

There are a number of basic actions and conditions an authorisation holder must take to ensure they are complying with the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995.

Below is an illustrated checklist to assist RTA holders with equipment and requirements relevant to HFC, HCFC and CFC refrigerants.

## Equipment List

Make sure you keep quarterly records of inspection and/or maintenance of the equipment, and ensure it is working correctly.



Electronic leak detector



Vacuum pump



Refrigerant recovery unit

## Refrigerant Gas Cylinders

A list of all refrigerant containers (cylinders) in your possession during each quarter and their test dates. In addition, quarterly records that show you have checked your cylinders for leaks, at least once during the quarter.



Cylinder test date

(generally stamped into the handle/collar of the cylinder)

## Risk Management Plan

A good RMP can outline sensible business steps to reduce your refrigerant costs, specific to the handling and storage of refrigerant at your business. Visit the ARC website for guidelines on creating a RMP.

## Refrigerant Records

Records for refrigerant bought, sold and recovered.

## Licensed staff lists

A list of all staff at your organisation who hold a current Refrigerant Handling Licence including name and licence number.

## RTA number

You must display your RTA number on any advertising that promotes refrigeration and air conditioning services, and on any invoices, receipts or quotes for work carried out under the RTA.



Refrigerant handling licence

*Images used as examples only*