

Use of R1234yf, R744 (CO²) and R134a in automotive air conditioning



This initiative was developed by:



Content and guidance kindly provided by the following organisations:

- Cool Drive
- CPS Asia Pacific
- Institute of Automotive Mechanical Engineers (IAME)
- Motor Trades Association of Australia (MTAA)
- Vehicle Air Conditioning Specialists of Australia (VASA)
- Victorian Automobile Chamber of Commerce (VACC)

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 Australia's greenhouse gas emissions. Australia will start a phase-down of HFC imports on 1 January 2018 and reach an 85% reduction from 2036.

Industry standard automotive refrigerant R134a is a HFC refrigerant and requires an ARCTick refrigerant handling licence to handle, and an ARCTick 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 be reduced.

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 global 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 where there is certainty that these refrigerants occur in their pure form. Where there is a risk of a blend containing a HFC, for example when degassing vehicles that are not clearly labelled as only containing a pure refrigerant, an ARCTick handling licence or trading authorisation is required.

While there is a transition to more environmentally friendly refrigerants, R134a will still be available for maintenance and servicing of older equipment 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 or present in systems being serviced.

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

For further information visit – arctick.org/information/autogas





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 and has minimal global warming impact. You do not need an ARCTick refrigerant handling licence or a refrigerant trading authorisation to handle, sell or store this refrigerant

Main characteristics of R1234yf

Low toxicity

Low GWP; GWP = <1

Zero ozone-depleting potential

Class A2L refrigerant - 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 |
| Flammability Rating | A2L Mildly Flammable | A1 Non Flammable |

What equipment do I need to handle R1234yf?

As R1234yf is an A2L mildly flammable refrigerant, the general requirement for R1234yf tools is that they are "ignition proof". 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) Electronic 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.
- 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 mildly 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/Territory.
- (e) A refrigerant identifier is also recommended to ensure you are handling pure R1234yf, free of contaminants such as air or other refrigerants.

Safety issues to be aware of when handling R1234yf

R1234yf is classified as A2L mildly flammable. Technicians need to take the relevant safety measures for the correct transport, storage and handling of a flammable gas. This would include, but is not limited to, ensuring no open flames (including smoking) near the system. It is also worth noting that highly toxic substances are created when this gas is burnt. Asphyxiation and freeze burns are also a risk.

It is advised to check with your state-based Worksafe agency, and refer to the relevant material safety data sheets available from your refrigerant wholesalers for specific safeguards when handling this refrigerant. Suitable Personal Protective Equipment (PPE) is to be worn when handling this refrigerant. Suitable trade training in flammable refrigerants is recommended prior to working on systems containing flammable refrigerants.

EQUIPMENT

(EXAMPLES ONLY)



a Calibrated gauge set



b Electronic 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 a 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 an electronic leak detector. Several manufacturers produce detectors that are suited to both refrigerants. Check with your refrigerant wholesaler.

Can I convert R134a systems to R1234yf?

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

R134a systems should not be converted to use R1234yf as these systems are unable to be converted to a level that satisfies the requirements of international standards (SAE J639 and SAE J2842) set for systems that use R1234yf.

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 a 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 R134a systems to R1234yf.

Where can I buy R1234yf?

R1234yf is available from most refrigerant wholesalers and automotive air conditioning component suppliers.

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

No. R1234yf is not controlled under Australia's Ozone Protection and Synthetic Greenhouse Gas legislation. However, a licence is required if it is part of a blend containing a controlled HFC refrigerant. R134a will also still be used in systems for years to come. It is a legal requirement that automotive workshops who provide air conditioning services (including recovery) continue to hold a refrigerant handling licence and refrigerant trading authorisation if R134a is being used.

For additional licensing requirements, check with your relevant state-based licensing authorities.



R744 (CO² carbon dioxide)

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

Main characteristics

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

However, the extremely high operating pressures of R744 and hazards associated with potentially high concentrations of carbon dioxide 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°C and the boiling point of liquid carbon dioxide at atmospheric pressure is also -78°C.

| PROPERTIES | R744 | R134a |
|--------------------------------|-------------------|--------------------|
| Boiling Point | -78°C | -26°C |
| Critical Point | 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) | 1 | 1430 |
| Flammability Rating | A1- Non Flammable | A1 - Non Flammable |

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 yet commonly available in Australia. Contact your refrigerant wholesaler or the vehicle manufacturer for guidelines on handling the refrigerant and servicing the system.

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.

Can I convert R134a systems 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 most refrigerant wholesalers and automotive air conditioning component suppliers.

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

No. R744 is not controlled under Australia's Ozone Protection and Synthetic Greenhouse Gas legislation. However, a licence is required if it is part of a blend containing a controlled HFC refrigerant. R134a will also still be used in systems for years to come. It is a legal requirement that automotive workshops who provide air conditioning services (including recovery) continue to hold a refrigerant handling licence and refrigerant trading authorisation if R134a is being used.

For additional licensing requirements, check with your relevant state-based licensing authorities.

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.

Do not handle this refrigerant in a confined space and take all precautions to prevent its release.

Oxygen will be displaced with carbon dioxide if R744 is released in excessive amounts (it is heavier than air and can congregate). Symptoms from overexposure to carbon dioxide range from drowsiness to asphyxiation, and in extreme cases, death. But the right training, equipment and attitude will allow safe use of R744.

R744 systems must also be charged and degassed in a specific manner to avoid the formation of dry ice inside the refrigerant pipework. Frost burns can occur if contact is made with liquid or solid carbon dioxide. Appropriate Personal Protective Equipment (PPE) must be used. Refer to the relevant material safety data sheets and ensure system-specific safety procedures are followed.

For example, R744 systems can operate at up to 170 bar (2466 psi) and trapped liquid carbon dioxide 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.



R134a

While the automotive industry is transitioning to more environmentally friendly refrigerants, the industry standard R134a will still be used in 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.

Equipment Maintenance Records Authorisation No.: AU/.....

Quarter ending: _____ Page No: _____

| Date in Quarter | Equipment Type | Make | Model | Serial No. | Action Taken |
|-----------------|----------------|------|-------|------------|--------------|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Images used as examples only.

Equipment maintenance records

Cylinder Leak Test & In-Test Date Records Authorisation No.: AU/.....

Quarter ending: _____ Page No: _____

| Refrig. Type | Cylinder Owner | Cyl. Serial Number | Date Leak Tested | In-Test Exp. Date | Name of person who checked |
|--------------|----------------|--------------------|------------------|-------------------|----------------------------|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Cylinder leak test records

Risk Management Plan Guide

*The Australian and New Zealand Refrigerant Handling Code of Practice 2007
**The Australian Automotive code of Practice 2008

| Activity | Potential Hazards/Risks | Australian Standards and Code of Practice References | Risk Control Measures | Name of responsible person | Last when review date (at least annually) |
|------------------------|--------------------------------|--|--|----------------------------|---|
| Purchasing Refrigerant | Leak or damaged Cylinder caps. | AS 2000.1 AS 4502 "ODP" Code **"ODP" Rule | On receipt check cylinders are tightly secured with sealing tags. Fluor-hall detector around the valve area WHEN the wrapping to check for leaks. Record weight. | John Smith | 08/2016 |

Risk management plan around emissions of refrigerant

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**



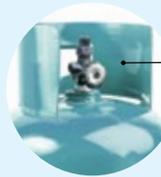
Vacuum pump



**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 refrigerant risk management plan will identify potential risks which could result in the emission of refrigerant to the atmosphere and outlines measures to minimise the possibility of those risks occurring. It's your safeguard against accidents that could be potentially damaging to the environment and costly for your business.

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