FLAMMABLE REFRIGERANTS

and safety in automotive applications

REFRIGERANT RECLAIM AUSTRALIA

VASA

GHD

Flammable Refrigerants and Safety in Automotive Applications

Preface

This guide is the result of a joint project between Refrigerant Reclaim Australia, VASA and GHD Engineering to study the management of health and safety risks associated with the use of flammable gases, including refrigerants, in an automotive workshop environment.

The purpose of this document is to help people working on or maintaining automotive air-conditioning systems to work safely where it is known or suspected that flammable refrigerants may be present.

Three diverse vehicle air-conditioning service workshops were chosen for the purposes of the study conducted by GHD Engineering that led to the production of this document.

We are grateful to the owners and staff of the following businesses for providing their time, knowledge and experience as well as facilitating access to their workshop facilities:

- Gympie Auto Air, Gympie QLD
- Mr Cool, Milton QLD
- Super Cool, Southport QLD

Introduction

Historically, all automotive air-conditioning systems came charged from the factory with either R12 (a CFC that was phased out in the mid-1990s due to its impact on the ozone layer) or R134a (an HFC that is currently subject to a global phase-down due to its high global warming potential).

Since 2013 a new mainstream HFO refrigerant, R1234yf, has begun to replace R134a. The first vehicles using this product started arriving on the Australian market in 2014 and R1234yf will become increasingly prevalent as the global HFC phase-down gathers momentum.

For various reasons, some repair organisations and private individuals are known to be retrofitting air-conditioning systems with hydrocarbon refrigerants such as R290 (propane), R600a (isobutane) or a blend of both.

Until the publication of this guide, industrial standards and general guidelines for the storage and handling of flammable refrigerants and gases had only been published for stationary air-conditioning and refrigeration systems.

In addition, no dispersion modelling had previously been done to determine the hazardous zones created by the release of flammable gases indoors, as might happen when venting a flammable refrigerant from a vehicle.

Note:
Some manufacturers are adopting carbon dioxide as a refrigerant (R744) but as this is not a flammable substance and has no automotive market penetration in Australia at the time of publication, it is not included in this guide.

Disclaimer

The contents of this document do not constitute legal advice. This document represents a brief overview of applicable legislative requirements in relation to flammable refrigerants and ways of working that help ensure compliance.

In all States and Territories the applicable Work Health and Safety Acts and Regulations apply to the storage and handling of hazardous materials including refrigerants.

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The Law and You

Refrigerant classifications for toxicity and flammability

Understanding different refrigerant classifications helps you determine how Australian Commonwealth, State and Territory work health and safety (WHS) legislation applies when using refrigerants of varying flammability.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) developed a globally recognised refrigerant toxicity and flammability rating system that is reflected in AS/NZS ISO 817:2016.

Refrigerants are grouped as A (non-toxic) and B (toxic), with flammability ranked by number from 1 (non-flammable) to 3 (highly flammable). The toxic category does not apply to any refrigerants used in automotive applications.

Flammability levels are determined by burn velocity, heat of combustion and ease of ignition.

A1: no flammability

Both R12 and R134a are non-flammable.

A2: flammability

No refrigerants currently used in automotive applications are rated A2.

A2L: lower flammability

A2L is a subset of A2 that was created for refrigerants with a burn velocity of less than 10 centimetres per second. R1234yf has a burn velocity of 1.5cm/s.

A3: higher flammability

Hydrocarbon refrigerants such as R290 (propane), R600 (butane), R600a (isobutane) or a blend of these are rated A3. A1, A2 and A2L refrigerants that have been mixed with an A3 product through contamination or topping up are automatically classified A3.

Global Harmonised System (GHS)/Dangerous Goods classification

The United Nations developed the GHS as a single internationally agreed system of chemical classification and hazard communication through labelling and Safety Data Sheets (SDS). Australia fully adopted the GHS from January 1, 2017.

At the time this guide was published, the GHS had no distinction for A2 and A2L refrigerants. This means A2, A2L and A3 gases are all classified 2.1 (flammable) under Australian Dangerous Goods legislation (2.2 is the non-flammable classification).

As a result, when R1234yf is in a cylinder it must be labelled, transported and handled as a highly flammable gas under Australian Dangerous Goods Legislation. R1234yf is also classified as 'extremely flammable' on SDS, as are all A2 and A3 refrigerants.

However, when R1234yf is installed in an air-conditioning system, it falls under the A2L classification and considered 'mildly flammable'.

Refrigerant classification table

The table below provides an at-a-glance guide to the different ways refrigerants are classified when in a vehicle air-conditioning system or in a cylinder.

Refrigerant		In a system	In a cylinder	
CFC-12	R12	A1	2.2	Non-flammable
HFC-134a	R134a	A1	2.2	Non-flammable
HFO-1234yf	R1234yf	A2L	2.1	Flammable
Carbon dioxide	R744	A1	2.2	Non-flammable
Butane	R600	A3	2.1	Flammable
Isobutane	R600a	A3	2.1	Flammable
Propane	R290	A3	2.1	Flammable

Who is responsible for refrigerant health and safety?

Under Australian Commonwealth, State and Territory WHS law, A2L, A2 and A3 refrigerants present a health and safety risk to workers that must be addressed by any person conducting a business or undertaking (PCBU) associated with refrigerants.

Until recently, automotive air-conditioning systems were designed for non-flammable A1 refrigerants such as R12 and R134a, so safety considerations mostly concerned the hazards of liquids under pressure and potential toxicity if exposed to high concentrations.

The use of A3 refrigerants in retrofits and top-ups introduces additional safety considerations due to their high flammability. In a position paper on flammable refrigerant gases, the Heads of Workplace Safety Authorities (HWSA) state that:

"Refrigerant gases must be compatible with the refrigeration system. This determination must be made by a competent person, who has experience in this matter and who may have undertaken relevant formal training.

"A competent person is one who has acquired through training, qualifications or experience the knowledge and skills to conduct the task safely.

"Converting a refrigerant system to use an alternative refrigerant must only be conducted in accordance with advice from the original equipment manufacturer or a competent person. A refrigerant should only be used in equipment that is designed or re-designed for its use.

"Topping up using different refrigerant gas types presents a safety risk for the worker as well as to those people who use that plant after the work has been completed. Systems should only be topped up with the same refrigerant as is in the system."

The HWSA position is that a "*person changing a refrigerant to a more flammable refrigerant takes on a role similar to that of a designer of a refrigeration system*".

> *"Where an alternative refrigerant is being considered, the compatibility of this refrigerant with the system must be assessed and documented by a competent person prior to the substitution. A person changing a refrigerant to a more flammable refrigerant takes on a role similar to that of a designer of a refrigeration system. For example, for a fixed system a refrigeration engineer must assess the suitability of the system for use with the alternative refrigerant, and ensure compliance with relevant standards including AS/NZS 5149, and the AS/NZS 3000 and other electrical standards."*

As such, a PCBU that retrofits or tops up a system designed for A1 refrigerants with A2L, A2 or A3 flammable refrigerants takes on a system designer's responsibilities and liabilities:

> *"Designers of refrigeration systems must eliminate risks associated with the system so far as is reasonably practicable. Where risks cannot be eliminated, they must be minimised as far as is reasonably practicable. This includes risks to people who install, maintain, construct, dispose of or use the system, and those in the vicinity of the system at a workplace."*

> *"Designers of mobile, portable or stationary refrigeration systems that use or are compatible for use with flammable refrigerants must control any flammability hazards and risks and any other hazards or risks associated with the refrigerant. Designers should have relevant experience and training, including accredited courses run by registered training institutes or equivalent where available, for example:*

- *UEENEEJ177A – Design hydrocarbon refrigerated systems.*
- *UEENEEM052A – Classify hazardous area – Gas atmospheres*
- *UEENEJ174A – Apply safety awareness and legal requirements for hydrocarbon refrigerants*
- *UNEENEEJ108A – Recover, pressure test, evacuate, charge and leak test refrigerants"*

The HWSA also make clear the requirement for proper labelling:

> *Refrigeration systems must include labelling or signage specifying the refrigerant used and any hazards associated with that refrigerant. Refer to jurisdictional legislation for specific labelling or signage requirements.*

Now that global car manufacturers have adopted R1234yf as the industry standard successor to R134a, safety considerations must also include the potential for A2L refrigerants to produce a flammable atmosphere when released.

Download the full HWSA position paper here: *http://tinyurl.com/HWSAFRPP*

Queensland situation

The use of A3 refrigerants is legal in most Australian States and Territories, but illegal in Queensland except for in type-approved equipment, or equipment installations that have been individually assessed and approved by the Queensland government.

Queensland also requires people working with A3 refrigerants to obtain a Gas Work Authorisation. This includes working on systems where A3 flammable refrigerants are known to be present.

At the time this guide was published, A2L-rated R1234yf was not considered a flammable refrigerant by the Queensland government, so it is legal to use this refrigerant in Queensland without needing equipment type approval or a Gas Work Authorisation.

Other States and Territories

New South Wales

The Gas Supply (Consumer Safety) Regulation 2012 includes no specific requirements for flammable gases used in vehicle air-conditioning systems and the systems do not have to be certified.

Victoria

Under the Dangerous Goods Act, where flammable refrigerants may be present, users must identify all hazards and use appropriate risk controls. Users must obtain SDS from the refrigerant supplier and users and service providers should ensure staff heed the safety requirements set out in the SDS.

South Australia, Western Australia, Northern Territory, Tasmania

South Australia, Western Australia, Northern Territory and Tasmania have no specific legislative requirements for the licensing or certification of either personnel or equipment for automotive air conditioning. However, local Work Health and Safety legislation and regulations always apply.

Note: The HWSA position paper (as referred to in "Who is responsible for refrigerant health and safety?" on page 4) applies across all States and Territories.

Commonwealth

The Commonwealth Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 does not require a licence for handling hydrocarbon refrigerants or R1234yf. However, anyone handling fluorocarbon refrigerants including R12 and R134a must hold an appropriate refrigerant handling licence.

Any individual (including a repairer or dismantler) who removes R12 or R134a refrigerant from any vehicle air-conditioning system and wants to replace it with hydrocarbon or R1234yf refrigerant must hold, as a minimum, a Restricted Refrigerant Recoverer's Transitional Licence.

Hazardous areas

To comply with hazardous area standards, you must identify and classify areas of your workshop where hazards related to flammable refrigerants may occur, then replace all equipment in these areas with explosion-protected (otherwise known as spark-proof) versions designed to reduce or eliminate ignition sources.

Because this is expensive, complicated and impractical for the automotive workshop environment, the advice in this guide includes techniques and working practices that avoid the need to classify hazardous areas.

Refrigerant flammability in the workshop environment

Under Australian Commonwealth, State and Territory WHS legislation, your duty to ensure the safety of PCBU kicks in when flammable gases may be present at concentrations exceeding 5% of the lower explosive limit (LEL).

Below is a table showing how the *LEL* of R1234yf, R290 and R600a affects the maximum number of vehicles that can safely occupy a small 700m^3 workshop when they have air-conditioning systems charged with 1.5kg of flammable refrigerant.

The *practical limit* is 20 per cent of the lower explosive limit, which is the figure used to calculate maximum flammable refrigerant charge sizes for room sizes in the stationary air-conditioning and refrigeration industries. From this, a vehicle limit was calculated based on the largest per-vehicle charge size being 1.5kg.

Refrigerant		ASHRAE rating	LEL (kg/m^3)	Practical limit (kg/m^3)	Vehicle limit (worst case)
HFO-1234yf	R1234yf	A2L	0.298	0.060	28
Propane	R290	A3	0.038	0.008	3
Isobutane	R600a	A3	0.043	0.008	3

Although the charge sizes and workshop space in the table are arbitrary, it clearly shows that the difference in LEL between the refrigerants allows for more than nine times the number of vehicles charged with R1234yf to safely occupy the same space as those charged with the same amount of R290 or R600a.

You must provide safe systems of work such as adequate ventilation and procedures for the use of personal gas monitors that detect flammable gases and alert people before they reach dangerous concentrations.

Refrigerant dispersion

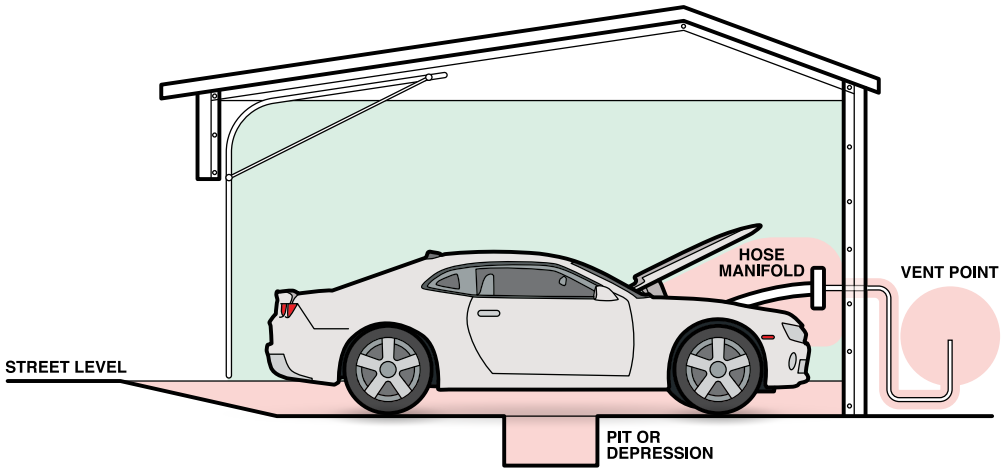
In preparation of this guide, GHD Engineering modelled refrigerant dispersion maps for R1234yf and R290/R600a in an indoor environment. From this they calculated the radius of the hazardous zone (inside which ignition sources can cause the refrigerant to burn) for each refrigerant while venting and vacuum pumping, and in a hose leak scenario.

Scenario	Exclusion Zone	
	R290/R600a	R1234yf
Venting	3.0 metres	1.1 metres
Hose leak	2.0 metres	0.5 metres

In addition, as flammable refrigerants are heavier than air, areas of your workshop that are below street level (such as open pits or drainage channels) become a hazardous zone after the refrigerant has been emitted. Until the refrigerant is removed from these areas, for example, by air movement this hazardous zone remains.

Ultimately, the safest place to emit flammable refrigerant is outside the workshop, but there must still be a three-metre radius exclusion zone for A3 refrigerants such as R290 and R600a. Bear in mind that even outside the workshop, there is still a risk of refrigerant accumulating in nearby pits and drains.

Alternatively, you can install a manifold that pipes the flammable refrigerant outside the building as shown in the diagram below, but the destination must also be three metres away from ignition sources in all directions.



Flammable refrigerant cylinder safety guidelines

The following guidelines apply to cylinders containing any A2, A2L or A3 refrigerant:

DO
Ensure a regulator is fitted before use
Ensure cylinder is firmly secured
Ensure connections are tight and suitable
Ensure cylinders are stored and used away from ignition sources
Store full and empty cylinders separately
Ensure valve guards or caps are fitted when cylinders are not in use
Use mechanical assistance when handling large/heavy cylinders
Ensure adequate ventilation is available for the gas in question
Ensure exposure limits are not exceeded
Read the SDS
Follow appropriate safe work procedures
Have gas detection devices installed if required

DO NOT
Repaint a cylinder
Change the markings on a cylinder
Use oil or lubricants on cylinder valve
Tamper with the gas cylinder test tag
Tamper with or remove the barcode from a gas cylinder
Roll cylinders along the ground
Attempt to fight a fire involving a gas cylinder
Transport gas cylinders in the passenger compartment of a vehicle
Use a cylinder that shows evidence of damage or corrosion
Fill cylinders with any material at all

Working With Flammable Refrigerants

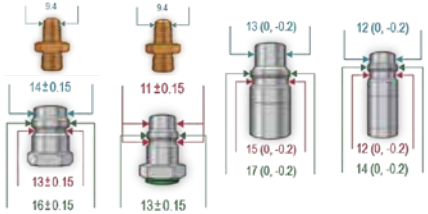
Identify the refrigerant, identify the risks

Correct identification of the refrigerant in an air-conditioning system is the critical first step in ensuring your safety and that of those around you.

The only way to be certain what refrigerant is in a system is to use a refrigerant analyser capable of identifying multiple refrigerant types.

Other methods are unreliable, as explained below:

Fittings



Although automotive air-conditioning systems designed for R12, R134a and R1234yf all have different service fittings, the type of fitting is an unreliable way of determining which refrigerant is in the system because there could be refrigerant contamination during previous servicing, or the system could have been topped up or retrofitted with alternative refrigerants.

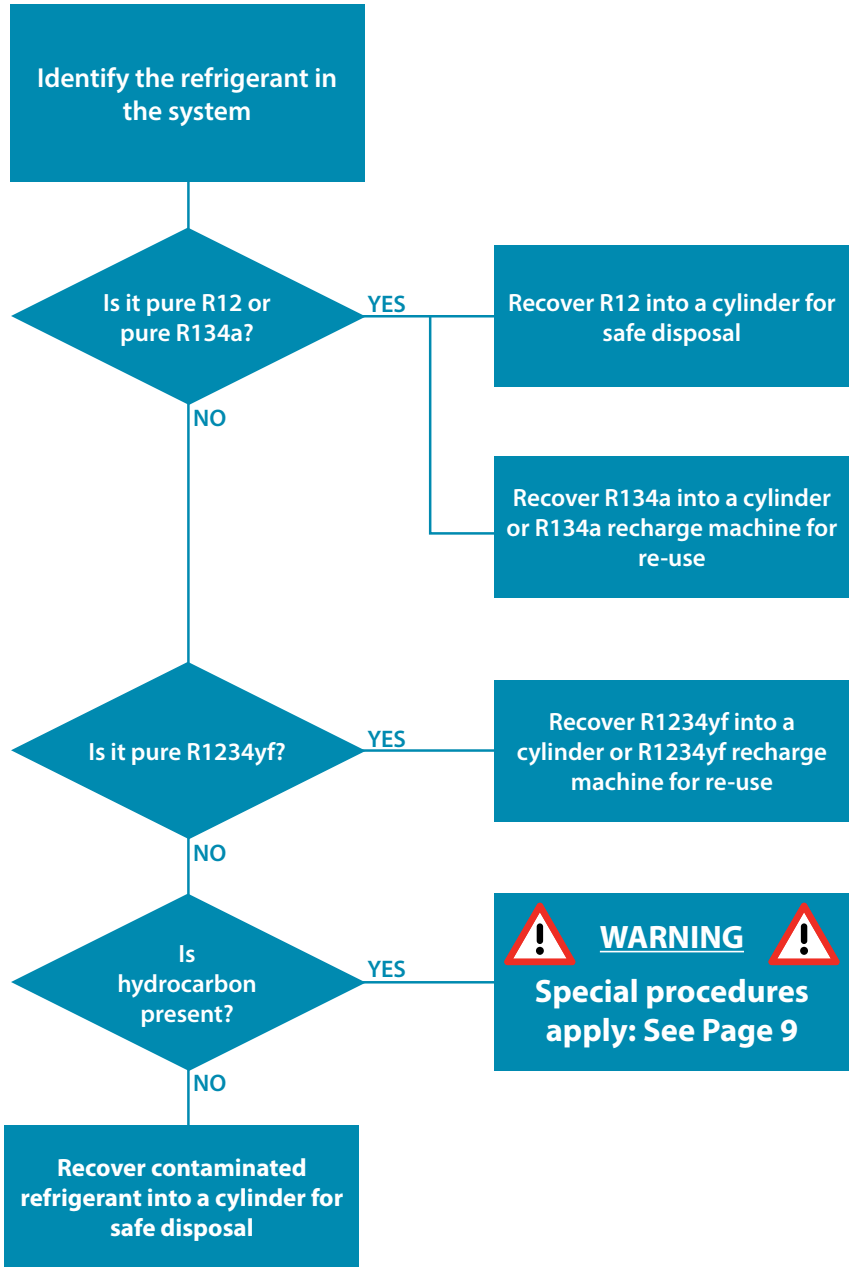
Labels

Labelling is unreliable as even brand-new vehicles do not always come from the factory with any refrigerant labelling under the bonnet and not all systems that have been retrofitted to an alternative refrigerant are properly labelled, if at all.

Pressure/temperature

The pressure/temperature measurement method of identification is unrealistic and unreliable as it requires a stable and uniform environment with consistent ambient temperature and humidity to provide accurate results. Also, it will not work if the system is faulty or the refrigerant is contaminated in some way.

Flowchart: Refrigerant identification and next steps



What to do if a system contains A3 refrigerant

WARNING

In Queensland, if you do not hold a Gas Work Authorisation issued by the Petroleum & Gas Inspectorate of the Department of Natural Resources and Mines, it is illegal to supply, fit or work on refrigeration systems charged with hydrocarbon (A3) refrigerants.

WARNING

Vapour from hydrocarbon (A3) refrigerant is heavier than air. Vapour will tend to flow downwind from leak points and toward the floor, and may accumulate in vehicle floor pans, floor drains, service pits and other depressions.

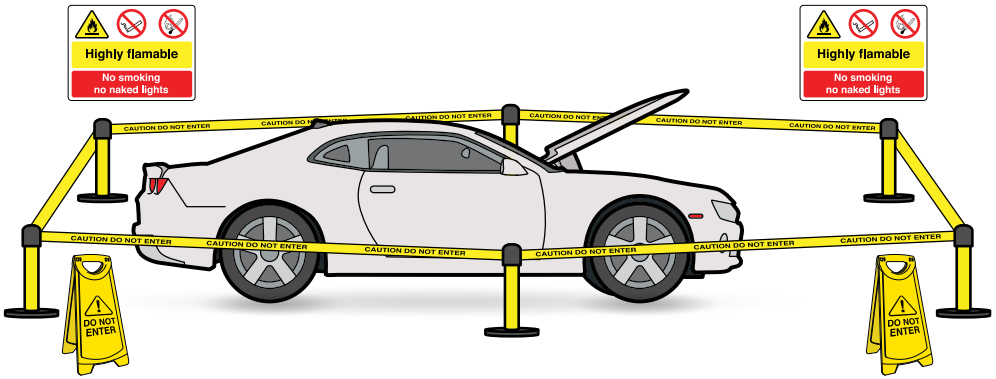
Before you start work

Make sure you have SDS for all flammable refrigerants likely to be encountered in your workshop readily available.

Inspect your diagnostic and recovery equipment including hose manifold, cylinder, regulators, isolation valves and piping for signs of external damage. Replace or repair damaged or worn-out components if required.

Establish an exclusion zone around the affected vehicle before you start work. The zone must be large enough to ensure a separation of at least three metres from any point on the vehicle and people not directly involved with the work.

A physical barrier in the form of 'danger' tape or safety barriers are strongly recommended, as are 'no smoking' and 'do not enter' signs.



Appropriate fire CO2 or dry powder extinguishing equipment must be available.

Ensure workshop staff wear proper personal protective equipment such as gloves and long-sleeved shirts to prevent them being affected by a low-temperature vapour cloud during refrigerant venting.

Workshop staff handling A3 refrigerants are recommended to carry an IECEx certified, explosion-protected personal gas monitor capable of detecting gas concentration, with a gas leak alarm set point no higher than 5% of the refrigerant's LEL.

Working on a system containing A3 refrigerant

Avoid using electrically powered tools and equipment within the exclusion zone.

Take extreme care while diagnosing system faults on a system that is fully or partially charged with A3 refrigerant. Flammable concentrations of refrigerant may have accumulated within the cabin of the vehicle (for example, due to a leaking evaporator).

Shut off the engine and disconnect vehicle batteries (negative terminal first) before the venting or recovery of flammable refrigerants.

Indoor venting of A3 refrigerants is extremely hazardous and must be avoided. It is unlikely that indoor venting can be carried out without creating an explosive atmosphere large enough to make the exclusion zone approach impractical in most workshops.

Venting of A3 refrigerants

WARNING

Venting of flammable refrigerants creates an explosive atmosphere in the immediate vicinity. The extent of the danger area depends on the amount of refrigerant released and the effect of air movement in the area of the release.

- **Venting must only be done outdoors in a well-ventilated location that is at least three metres away from buildings, other vehicles and other obstructions.**
- **Make sure no ignition sources, including vacuum pumps, recovery pumps or other electrical equipment are used during venting operations**
- **Use a hose compatible with the refrigerant and oil to vent the refrigerant at least a metre above ground level to help it disperse and dilute in the air**
- **Beware of hazardous areas near hose connections and make sure all connections are tight before starting work**
- **You need to be certain that the refrigerant will not be blown into any adjacent buildings, and that it has no way of sinking below street level (such as into drains and basements)**
- **Do not vent to an area where people are not aware of what you are doing**

Recovery of A3 refrigerants

When recovering or venting A3 refrigerants from a vehicle air-conditioning system, workshop staff must be present at all times and have the means to safely shut off the refrigerant flow in the event of an emergency. For example, a spring loaded dead-man valve may be used. This is consistent with the LPG decanting procedure set out in AS 1596.

Systems containing a mixture that includes A3 refrigerant

A1 refrigerants mixed with more than 5% of A3 refrigerants are automatically classified A3.

Under environmental law, CFC (such as R12) and HFC (such as R134a) refrigerants must be recovered by a licensed technician and it is a Federal offence to knowingly vent them to atmosphere.

WHS legislation and regulation dictates that you must only use recovery equipment specifically designed and rated for the refrigerant's flammability level when recovering of A2, A2L or A3 refrigerants from vehicle air-conditioning systems. A recovery cylinder suitable for storing flammable gases is also required.

At the time of this guide's publication, genuine A3-rated recovery equipment was scarce in the Australian market.

This makes compliance with both WHS and environmental regulations difficult for people faced with a system containing a mixture of different refrigerant classes.

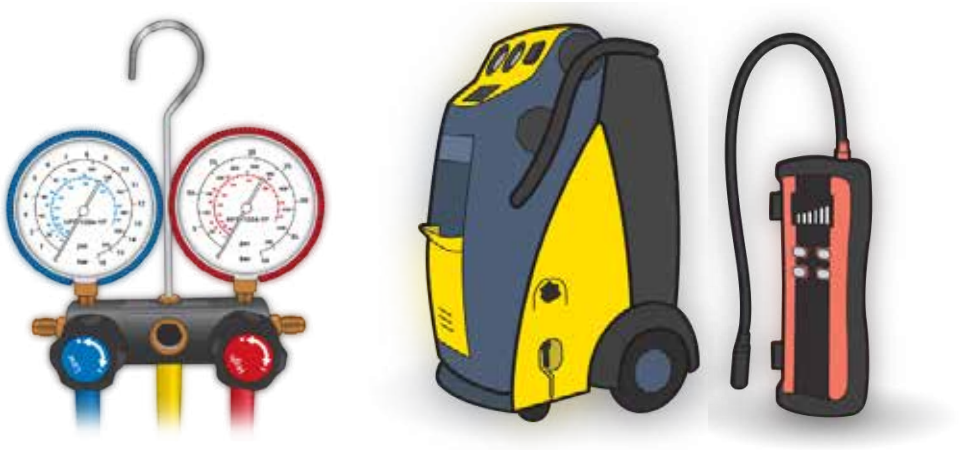
WARNING **If recovery equipment approved for A3 refrigerants is not available, the contaminated mixture must be safely vented as described in "Venting of A3 refrigerants" on page 9.**

What to do if a system contains A2L refrigerant (R1234yf)

WARNING **Vapour from R1234yf (A2L) refrigerant is heavier than air. Vapour will tend to flow downwind from leak points and toward the floor, and may accumulate in vehicle floor pans, floor drains, service pits and other depressions.**

Before you start work

Make sure you have SDS for all flammable refrigerants likely to be encountered in your workshop readily available.



Only use equipment specifically designed for use with R1234yf refrigerant and complies with the relevant standards as shown in the table opposite.

Required equipment for working with A2L refrigerant (R1234yf)

Equipment	Characteristic	Standards
Leak detector	Spark free	SAE J2913
Recovery/recycling unit	Spark free, R1234yf compatible	SAE J2843
Recovery/recycling unit	Spark free, R134a/R1234yf compatible	SAE J3030
Vacuum pump	Spark free	AS/NZS 60079
Gauge sets/hoses	R1234yf specific	SAE J2196
Service couplers	R1234yf specific	SAE J639
Refrigerant analyser	Able to identify R1234yf	SAE J2912/J2927
Refrigerant cylinder	Red manifold guard, LH thread	AS 2030.1
Reclaim cylinder	Yellow & red manifold guard, LH thread	AS 2030.1
Cylinder adaptors	LH thread	AS 2473

Working on a system containing A2L refrigerant (R1234yf)

With the right equipment, R1234yf is readily recoverable. At the time this guide was published, it was legal to vent R1234yf. However, the comparatively high price of this refrigerant is a strong incentive to recover and recycle it.

Indoor venting of A2L refrigerant is not recommended, as it cannot be guaranteed that you can do it without the formation of a large hazardous area in which there are ignition sources.

If venting A2L refrigerant is unavoidable, the safest course of action is to apply the same level of caution as venting A3 refrigerant (please see "Venting of A3 refrigerants" on page 9). At the very least, there must be no ignition sources such as naked flames or exposed electrical wires within a 1.1 metre radius of the point of release.

Workshop safety checklist

WORKSHEET: IS YOUR WORKSHOP GAS SAFE?

Do you USE or STORE any of the following gases at your workshop premises?

☐ **Natural Gas**

☐ Reticulated through work areas	☐ Water heating only	

Highly FLAMMABLE
Safety precautions:

- ☐ Use with approved appliance ONLY
- ☐ Hoses in good condition
- ☐ Ensure adequate ventilation available
- ☐ Fittings and valves in good condition
- ☐ Disconnect portable appliances when not in use

☐ **LPG**

☐ In cylinders < 13 kg	☐ In cylinders > 13 kg	☐ In bulk storage bullet
☐ Reticulated through work areas		

Highly FLAMMABLE – Refer AS/NZS 1596 and AS/NZS 600M9.14
Safety precautions:

- ☐ Use with approved appliance ONLY
- ☐ Hoses in good condition
- ☐ Valves, regulators and fittings in good condition
- ☐ Ensure adequate ventilation available when using appliances
- ☐ Disconnect portable appliances when not in use
- ☐ Consider hazardous areas when reticulated and around bulk storage

☐ **Acetylene**

☐ In cylinders (up to 'G' size)	☐ In manifold packs	☐ Reticulated through work areas

Highly FLAMMABLE
Safety precautions:

- ☐ Hoses in good condition
- ☐ Torches, fittings and valves in good condition
- ☐ Ensure cylinder valves are turned off when not in use
- ☐ Manifold packs may require consideration of hazardous areas if quantity exceeds 30 m3 (6 x G size)
- ☐ No electrical outlets within 2 m of oxy-acetylene outlets
- ☐ Use only approved torches and tools
- ☐ Do not use near refrigerants

☐ **Refrigerant - Hydrocarbons**

☐ R290 (propane)	☐ R600 (butane)	☐ R600a (isobutane)
☐ Branded products		

Highly FLAMMABLE – Refer manufacturer's Safety Data Sheet
Safety precautions:

- ☐ Isolate ignition sources within 3 m of work areas
- ☐ Ensure adequate ventilation available
- ☐ QLD & VIC - Suitable only for appliances certified by Technical Regulator
- ☐ Technician must hold Gas Work Licence issued by Technical Regulator to carry out work on systems containing these gases
- ☐ Use of Personal Gas Monitors while handling recommended to comply with WHS legislation
- ☐ Risk assessment recommended for ALL work activities associated with these gases

☐ **Refrigerant – HFOs (R1234yf)**

FLAMMABLE under certain conditions – refer manufacturer's Safety Data Sheet
Not hazardous when used with approved handling equipment.
Safety precautions:

- ☐ Isolate ignition sources within 1.1 m of work areas
- ☐ Ensure adequate ventilation available
- ☐ Fittings and valves in good condition
- ☐ Trained personnel only to work on systems containing this gas

Workshop risk assessment worksheet

WORKSHEET: WORKSHOP RISK ASSESSMENT

USE BEFORE YOU UNDERTAKE WORK ON A VEHICLE AIR CONDITIONING SYSTEM WITH FLAMMABLE OR UNKNOWN REFRIGERANT	
Conducted by:	Date:

Step 1: Identify the hazards

Refrigerants Note: check carefully for labels, notes in owner's handbook or other markings that may identify refrigerant type		
☐ System does contain refrigerant	☐ Refrigerant type not known or unable able to be determined by inspection alone	
☐ Refrigerant type (if known):		
Leaking refrigerant		
☐ Condenser / evaporator	☐ Compressor	☐ Lines & fill points
☐ Other/details:		
Deliberate release of refrigerant required:		
☐ Unable to recover	☐ Damaged h/l connections	
☐ Other/details:		
Obvious physical damage:		
☐ Condenser / evaporator	☐ Compressor	☐ Lines & fill points
☐ Other/details:		
Energy systems:		
☐ Battery – present & connected	☐ LPG-fuelled vehicle	☐ Mains electricity supply
☐ Other/details:		
Environment:		
☐ Workshop	☐ Service pit	
☐ Doors / windows closed	☐ Floor drains within 3 m of vehicle	☐ Temperature (heat, cold)
☐ Other/details:		
Machinery, plant and equipment		
☐ Recovery/recharge machine	☐ Electric power tools	☐ Hand tools
☐ Electrically powered test equipment		
☐ Other/details:		
Manual tasks / ergonomics		
☐ Manual tasks (repetitive, heavy)	☐ Working at heights	☐ Restricted space
☐ Other/details:		
People		
☐ Technician 1	☐ Technician 2	☐ Workshop supervisor
☐ Office staff	☐ Vehicle owner(s)	☐ General public
☐ Other/details:		
Other hazards / details		

Step 2: Assess the level of risk

Consider the hazards identified in *"Step 1: Identify the hazards" on page 15* and use the risk assessment matrix below as a guide to assess the risk level.

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Critical
Almost certain	Medium	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Low	Medium	High	High	High
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Low	Low	Medium

Consequence	Description of consequence
Insignificant	No treatment required
Minor	Minor injury requiring First Aid treatment (e.g. minor cuts, bruises, bumps)
Moderate	Injury requiring medical treatment or lost time
Major	Serious injury (injuries) requiring specialist medical treatment or hospitalisation
Critical	Loss of life, permanent disability or multiple serious injuries

Likelihood	Description of likelihood
Rare	Will only occur in exceptional circumstances
Unlikely	Not likely to occur as a result of the work being done
Possible	May occur as a result of the work being done
Likely	Likely to occur as a result of the work being done
Almost certain	Almost certain to occur as a result of the work being done

Assessed risk level		Description of risk level	Actions
☐	Low	If an incident were to occur, there would be little likelihood that an injury would result	Do the work with the existing controls in place
☐	Medium	If an incident were to occur, there would be some chance that an injury requiring First Aid would result	Additional controls may be needed
☐	High	If an incident were to occur, it would be likely that an injury requiring medical treatment would result.	Controls will need to be in place before the work is started
☐	Extreme	If an incident were to occur, it would be likely that a permanent, debilitating injury or death would result.	Consider alternatives to doing the work. Significant control measures will need to be implemented to ensure safety

Step 3: Control the risks

Hierarchy of Control	
Most effective (High level) Least effective (Low level)	**Elimination:** remove the hazard completely from the workplace or activity
	Substitution: replace a hazard with a less dangerous one (e.g. a less hazardous chemical)
	Redesign: making a machine or work process safer (e.g. raise a bench to reduce bending)
	Isolation: separate people from the hazard (e.g. safety barrier)
	Administration: putting rules, signage or training in place to make a workplace safer (e.g. induction training, highlighting trip hazards)
	Personal Protective Equipment (PPE): Protective clothing and equipment (e.g. gloves, hats)

Hazards/risks and control measures

In the table opposite:

1. List below the hazards/risks you identified in "Step 1: Identify the hazards" on page 15.
2. Rate their risk level (refer to information contained in "Step 2: Assess the level of risk" on page 16 to assist with this).

Detail the control measures you will implement to eliminate or minimise the risk.

Note: Control measures should be implemented in accordance with the preferred **hierarchy of control**. If lower level controls (such as Administration or PPE) are to be implemented without higher level controls, it is important that the reasons are explained.

Control measures could include such things as: providing barricades to keep bystanders away, removing all ignition sources from area within 3m of vehicle, isolating vehicle battery.

Description of hazards/risks	Risk Level	Control Measures (Note: if only Administration or PPE controls are used, explain why.)

Other details:

Submission

This activity will be conducted in accordance with this risk assessment, implementing the control measures outlined in "Step 3: Control the risks" on page 17. Changes will be made to the activity, if required, to manage any emerging risks to ensure safety.

Person responsible for job:	Date:

Indicate those others involved in the preparation of this risk assessment:

Step 4: Monitor and review controls

Complete this during or after the activity

	Yes	No
1. Are the planned control measures sufficient and effective in minimising the level of risk?	☐	☐
2. Have there been any changes to the planned control measures?	☐	☐
3. Are further control measures required in future?	☐	☐
Details:		

Review completed by:	Designation:
Signature:	Date:

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