Learning Resource Manual

VU22583

Handle Class A2/A2L Flammable Refrigerants

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- Australian Institute of Refrigeration, Air conditioning and Heating (AIRAH)
- EE-Oz Training Standards
- Refrigeration and Air Conditioning Contractors Association (RACCA)
- Superior Training Centre

Feedback:
We value your opinion and welcome suggestions on how we could improve this resource manual. Keep in mind that the manual is intended to help students learn and is not a text book.

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1. Introduction

This resource manual is part of a series of learning resources and assessment instruments. It is designed to assist students achieve the outcomes and purpose described in the nationally accredited Unit Descriptor. It is an example of the depth and breadth of the learning expected.

The topics listed in the content are arranged in the preferred learning sequence. It is recognised that this is not the only sequence in which the material could be learnt. Assessment arrangements and sample assessment instruments are based on the sequence of topics listed.

A teacher may decide that for a particular student or group of students it is more effective to present the topics in a different sequence. In this case the students must be informed in writing of the resulting changes in the assessment events before starting the unit.

Learning plan

The following topic weighting will help you plan and allocate the effort needed to achieve the purpose and outcomes of the unit.

Topic	***Weighting***
2. Environmental Issues	5%
3. Class A2/A2L Refrigerants	15%
4. Relevant Acts, Regulations, Standards and Codes	5%
5. Relevant A2/A2L Acts, Regulations, Standards and Codes	10%
6. Emergency Procedures and Incident Management	5%
7. First Aid	5%
8. SDS and Hazchem Codes	5%
9. Special Equipment and Tools	10%
10. Installation Requirements	20%
11. Service Requirements	20%

2. The Environmental Issues

Purpose

In this section you will revise the environmental concerns associated with the refrigeration and air conditioning industries, the range of synthetic and natural refrigerants available, and the environmental aspects of each.

Objectives

At the end of this topic you should be able to:

- Describe the basic effects of ultraviolet light on various life forms
- Describe the ozone layer and its function in relation to ultraviolet light
- Identify a range of natural and un-natural greenhouse gases and describe the greenhouse effect
- Explain the term 'global warming' and describe the future events being predicted by scientists
- Define the terms 'ODP', 'GWP' and 'TEWI'
- List the primary elements used to make CFCs, HCFCs, HFCs, HCs and HFOs, and identify a typical refrigerant type from each category
- Compare the basic environmental issues relating to each category of refrigerant (CFC, HCFC, HFC, HC and HFO)

Content

- Ultraviolet light
- The Ozone Layer
- The Greenhouse Effect
- Global Warming
- Total Equivalent Warming Impact (TEWI)
- Refrigerant categories, classifications and types

References

- AS/NZS ISO 817:2016, Refrigerants - Designation and safety classification, available at: https://store.standards.org.au/product/as-nzs-iso-817-2016
- BOC refrigerants: www.care-refrigerants.co.uk/index.htm
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 and Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, available at: https://www.environment.gov.au/protection/ozone/legislation
- UN Environment Programme (UNEP) OzonAction WhatGas? Application
- Wikipedia: http://en.wikipedia.org/wiki/Main_Page

2.1 Ultraviolet light

The Sun emits ultraviolet radiation in the UVA, UVB, and UVC bands, but because of absorption in the atmosphere's ozone layer, 99% of the ultraviolet radiation that reaches the Earth's surface is UVA.

UVA light is also known as "black light" and, because of its longer wavelength, can penetrate many windows. It also penetrates deep into the skin and is thought to be a prime cause of wrinkles.

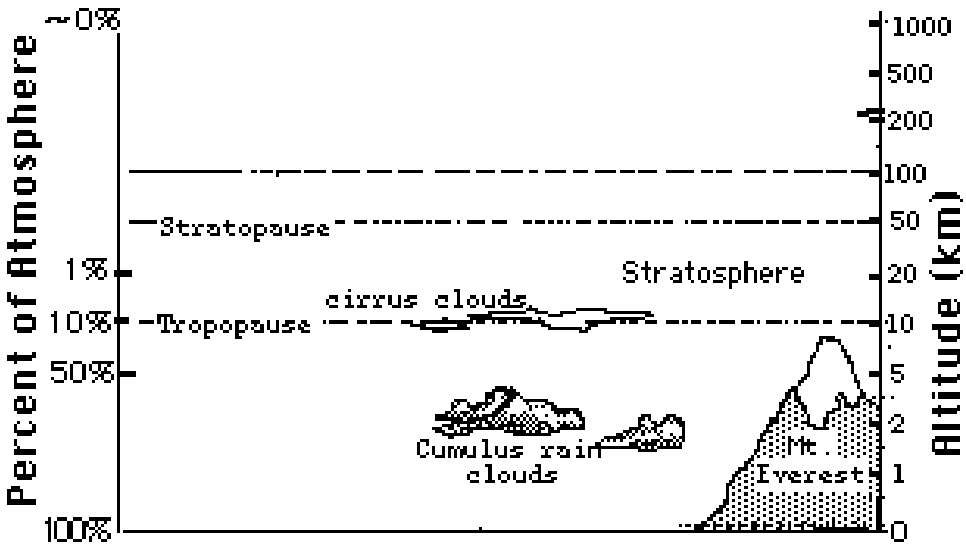
UVB light can cause skin cancer. The radiation excites DNA molecules in skin cells, which can lead to mutations and, in turn, result in cancerous growths.

UVC rays are the highest energy and therefore, most dangerous type of ultraviolet light. They have been linked to DNA breakdown which leads to human mutation.

These carcinogenic and mutagenic connections are one reason for the concern about ozone depletion and the ozone hole. The International Agency for Research on cancer of the World Health Organisation (WHO) classified all categories and wavelengths of ultraviolet radiation as group 1 carcinogens in April of 2011. This is the highest level designation for carcinogens.

2.2 The Ozone Layer

Ozone (**O_3**) is a triatomic molecule, consisting of three oxygen atoms. It is much less stable than the diatomic species O_2. Ground-level ozone is an air pollutant with harmful effects on the respiratory systems of animals. On the other hand, ozone in the upper atmosphere protects living organisms by preventing damaging ultraviolet light from reaching the Earth's surface. It is present in low concentrations throughout the Earth's atmosphere (approx. 15 – 35 km above the surface). It has many industrial and consumer applications as well as being used in ozone therapy.



Depletion of the ozone layer therefore has the potential to result in increased instances of:

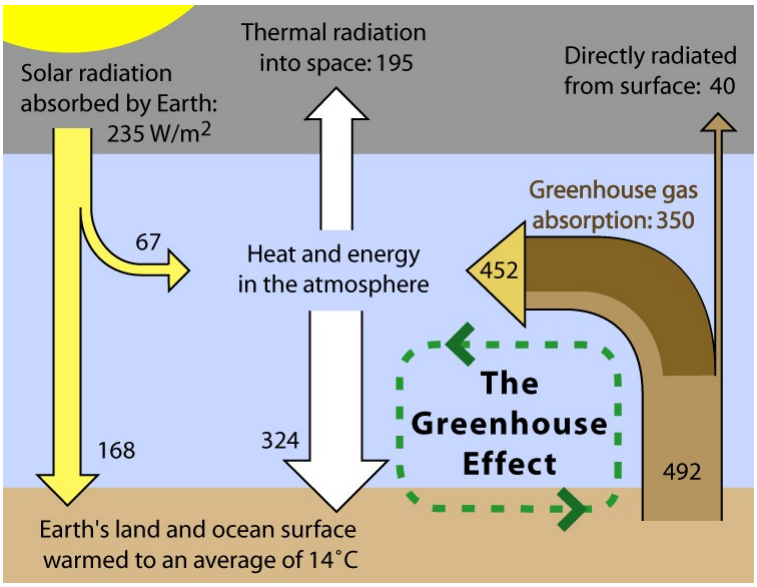
- Accelerated skin cancers (melanomas) in humans and animals
- Genetic mutation (DNA breakdown)

- Eye damage (snow-blindness and cataracts)
- Reduced plant yields (farms)
- Death of marine life (especially plankton)
- Damage to building materials and plastics.

When chlorine based chemical substances such as the CFC'S and HCFC'S used throughout the refrigeration and air conditioning industry are released into the air, they decompose and release the chlorine. Concerns were first raised back in 1974 when it was discovered that chlorine (and bromine) worked as a chemical catalyst in depleting the gases present in the ozone layer, thereby destroying it.
All Refrigerants are given a rating that indicates their ability to degrade (or damage) the ozone layer. This rating is called the 'Ozone Depletion Potential' (or ODP). R11 was used as the benchmark and was given a value of 1, while a gas that had no harmful effect was given a value of 0.

2.3 The Greenhouse Effect

The Earth receives energy from the Sun in the form of radiation. The Earth in turn, radiates much of this energy back out into space. If it were not for many of the gases present in our atmosphere, the surface temperature of the planet would be 15°C to 20°C colder than it is now. These naturally occurring, heat trapping gases are known as 'Greenhouse gases' and include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). They absorb much of the earth's radiant energy and contribute to keeping the land, atmosphere and oceans at a comfortable temperature. This is known as the Greenhouse Effect.



Copyright - Global Warming Art.

The composition of the atmospheric gases has changed rapidly throughout the 20th century with the advent of new industries and technologies, and scientists now see dramatically increased levels of not only the natural gases such as CO_2, CH_4 and N_2O but also the 'new' man made greenhouse gases such as CFC's, HCFC's and HFC's.

2.4 Global Warming

As a result of the rise in atmospheric greenhouse gases, scientists currently predict a global average temperature rise of 5°C by the middle of this century.
Such global warming would cause the polar ice caps and mountain glaciers to melt rapidly and result in appreciably higher coastal water levels. The rise in global temperature would also produce new weather patterns and extremes of drought and rainfall, seriously disrupting food production in certain regions.

The majority of countries around the world have taken a range of measures to combat these events. These events include the 1987 Montreal Protocol, which established timetables for phasing out CFC and HCFC substances, and the 1997 Kyoto Protocol, which established limits on allowable greenhouse gas emissions.

All Refrigerants were given a rating that indicates their ability to function as a greenhouse gas. This rating is called the 'Global Warming Potential' (or GWP). CO_2 was used as the benchmark and was given a value of 1, while a gas that had no warming effect was given a value of 0.

2.5 Total Equivalent Warming Impact (TEWI)

The total equivalent warming impact is a measure of the *total* impact of a refrigeration system on global warming. Refrigeration systems can contribute twice to global warming:

- Directly through emissions of those refrigerants that are greenhouse gases
- Indirectly through the use of energy generated by burning fossil fuels. This increases carbon dioxide emissions.

TEWI = direct effect + indirect effect

This value is used to gain a 'big picture' comparison of any improvements to the reduction of global warming that may be achieved by the introduction of a 'new technology' or system.

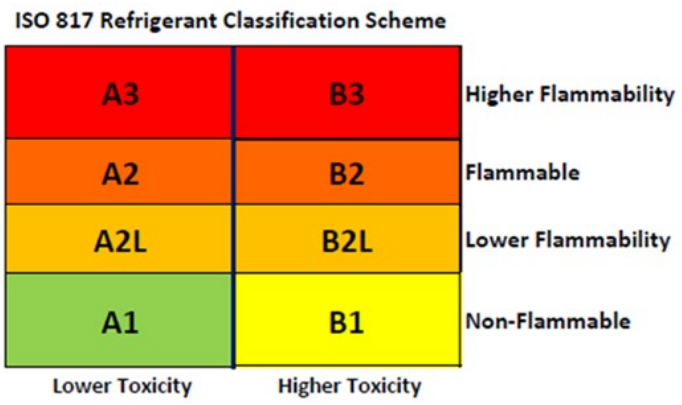
The TEWI can be reduced by:

- Using a refrigerant which has a global warming potential which is as low as possible
- Reducing emissions of that refrigerant
- Improving the energy efficiency of a system by using an efficient refrigerant as well as by implementing energy efficient techniques and technologies.

2.6 Refrigerant Categories, Classifications and Types

A vast range of refrigerants are available today. All are either a naturally occurring substance within our environment, with a common example being ammonia - R717, or have been chemically produced. The predominant refrigerants to have been used since the Second World War have all been variants of the fluorocarbon family which includes the categories of CFC's, HCFC's and HFC's.

The AS/NZS ISO 817:2016, Refrigerants - Designation and safety classification, assigns to refrigerants their “R” number, safety classification based on toxicity and flammability data, and a means of determining their concentration limit. Below is a copy of the Safety groups as determined by flammability and toxicity table.



Safety Group	Common refrigerants
A1	R134a, R404A, R410A, R477C, R449A, R513A, R744 (CO_2), R1233zd(E),
A2L	R32, R143a, R444A, R1234yf, R1234ze(E)
A2	R143a, R152a, R419B, R439A, R440A, R512A
A3	R170 (ethane), R290 (propane), R600a (butane), R-1270 (propylene)
B1	R123, R245fa, R514A, R1130(E)
B2L	R717 (Ammonia)
B2 and B3 refrigerants are not common	

CFCs

CFC refers to the category of chemically formulated 'ChloroFluoroCarbons'. It indicates that the refrigerant is composed of Chlorine, Fluorine and Carbon. These are classified as controlled substances under current Australian legislation, have been phase-out and are no longer in common use. These were Class A1 Non-Flammable/Lower Toxicity refrigerants and common examples were:

R11	R12	R502
Hi-Rise Centrifugal A/C, Solvent ODP = 1 / GWP = 4,750	Medium Temp Commercial Refrig, Domestic Fridges ODP = 1 / GWP = 10,900	Low Temp Commercial Refrig ODP = 0.33 / GWP = 4,657

CFC's typically possess a very high ODP (due to their chlorine content) and a very high GWP.

HCFCs

HCFC refers to the category of chemically formulated 'HydroChloroFluoroCarbons'. It indicates that the refrigerant is composed of Hydrogen, Chlorine, Fluorine and Carbon. These are Class A1 Non-Flammable/Lower Toxicity or Class B1 Non-Flammable/Higher Toxicity refrigerants. Only two HCFC's were commonly used in refrigeration or air conditioning systems.

R22	R123
Residential and Commercial A/C ODP = 0.055 / GWP = 1,810	Replacing R11 ODP = 0.02 / GWP = 77

Within the European Union nations, the importation or manufacture of equipment using R22 was banned from 1 January 2004 while new HCFC refrigerant was available until 2010 and

recycled refrigerant until 2015. Here in Australia, the importation of equipment using R22 was banned as of 1 July 2011. Australian imports of bulk HCFCs has reduced since 1996 and from 2016 to 2029 imports are limited to 2.5 ODPt of HCFC annually (about 45 tonnes of R22). From 1 January 2020, bulk R22 imported into Australia can only be used for servicing existing refrigeration and air conditioning equipment. From 1 January 2030, bulk R22 imports will be banned entirely.

HFCs

HFC refers to the category of chemically formulated 'HydroFluoroCarbons'. It indicates that the refrigerant is composed of Hydrogen, Fluorine and Carbon. A very large range of HFC refrigerants are available today, depending on their intended purpose, either in pure form (a single compound) or as part of the '400' series of refrigerant blends. These are Class A1 Non-Flammable/Lower Toxicity refrigerants, except for R32 which is a Class A2L Lower Flammability/Lower Toxicity refrigerant.

R134a Medium Temp Commercial Refrig and Domestic ODP = 0 / GWP = 1,430	R401A Medium Temp Commercial Refrig ODP = 0.036 / GWP = 1,182	R404A Medium and Low Temp Commercial Refrig ODP = 0 / GWP = 3,922	R32 Residential A/C ODP = 0 / GWP = 675
R408A Medium and Low Temp Commercial Refrig ODP = 0.026 / GWP = 3,152	R409A Medium Temp Commercial Refrig ODP = 0.048 / GWP = 1,585	R410A Residential A/C ODP = 0 / GWP = 2,088	

HFC's typically possess a Zero ODP but a moderately high GWP. As a result Australia commenced a HFC phase-down on 1 January 2018 which will gradually reduce the maximum amount of HFCs permitted to be imported into Australia until 2036 when it will be 15% of the 2018 import quantity. Industry has already driven significant change to reduce their direct and indirect emissions through changes in product design:

- use of lower global warming potential gases means less harmful emissions if the gas is released to the atmosphere
- more energy efficient equipment uses less power, therefore emissions from power production are reduced

The HFC phase-down covers only imports of bulk gas such as in cylinders. It does not cover gas imported in pre-charged equipment such as air-conditioners or refrigerators. HFCs contained in imported equipment are accounted for in the country of manufacture. Existing equipment that has already been imported into Australia is not affected by the phase-down.

HFOs

HFO refers to the latest category of chemically formulated 'HydroFluoro-Olefin' refrigerants. It indicates that the refrigerant is composed of Hydrogen Fluorine and Carbon but possesses different properties to HFC's due to the way in which the carbons link to each other. They have been classified as a A2/A2L slightly flammable and possess shorter atmospheric lifetimes than other synthetic refrigerants. HFO-1234yf has been used in some new vehicle automotive air conditioning systems instead of R134a and HFO-1234ze is increasingly being used in air conditioning chillers.

HFO-1234yf ODP = 0 / GWP = <1	HFO-1234ze ODP = 0 / GWP = <1	HFO-1243zf ODP = 0 / GWP = <1

HFO's typically possess a Zero ODP and very low GWP.

CO_2 and NH_3

These are Carbon Dioxide and Ammonia (respectively). They are both naturally occurring substances and were the only refrigerants available in the early years of this industry. CO_2 operates with extremely high pressures and therefore fell into disuse when the synthetic refrigerants were discovered. It is currently undergoing a revival in the supermarket industry due to the improved materials and technologies available today. Ammonia is Class B2L Lower flammability/Higher Toxicity refrigerant which has excellent heat transfer properties and has therefore remained the refrigerant of choice within the industrial refrigeration sector.

R744	R717
Carbon Dioxide	Ammonia
ODP = 0 / GWP = 1	ODP = 0 / GWP = 0

HCs

HC refers to another category of naturally occurring substances known as Hydrocarbons. It indicates that this range of refrigerants' are composed of Hydrogen and Carbon. They are Class A3 Higher flammability/Lower toxicity refrigerants with very short atmospheric lifetimes – a few weeks compared to the 100 years+ for CFC's. Once in the atmosphere they break down to carbon dioxide and water. Hydrocarbons contain no chlorine or bromine and therefore have no ozone depletion potential.

With regard to the TEWI, hydrocarbon refrigerants virtually eliminate the direct effect because of their very low global warming potentials. Their improved operating energy efficiencies also reduce the indirect effect as they typically require less electrical energy to operate.

R600a	R290	R1270
ISO-BUTANE	PROPANE	PROPYLENE (PROPENE)
ODP = 0 / GWP = <1	ODP = 0 / GWP = <1	ODP = 0 / GWP = 1

HC's typically possess a Zero ODP and very low GWP.

2.7 WhatGas? Ap

The details of refrigerants are readily available on the UN Environment Programme (UNEP) OzonAction WhatGas? Application. It provides information on each refrigerant's chemical name, type, HS code, ODP, GWP, Class, etc. it can be downloaded for free from Google Play and Apple Store.

2.8 Section Summary

- The ozone layer helps to reduce the harmful effects of the suns' radiation on the planet by blocking almost all lethal ultraviolet light.
- The greenhouse gases currently accumulating in the atmosphere could cause the planets' surface temperature to increase, resulting in a rise in ocean levels and dramatic weather shifts.
- ODP – Ozone Depletion Potential
- GWP – Global Warming Potential
- TEWI – Total Equivalent Warming Impact
- CFCs are no longer available and HCFCs are being phased out because of their harmful effects on both the ozone layer and global warming.
- HFCs are being phased down because of their high global warming potential in favour of natural or HFO refrigerants.
- A2/A2L refrigerants have been introduced as a stop gap refrigerant for the industry.
- Refrigerant categories and their issues:

Category	**ODP**	**GWP**	**Flammable**	**Issue**
CFC	Very High	Very High	No	Already Phased Out
HCFC	Low	High	No	Being Phased Out
HFC	Zero	Medium/ High	No	Being Phased Down
HFO	Zero	Insignificant	Slightly	New Synthetic Category
HC	Zero	Insignificant	Yes	Natural

- Hydrocarbon refrigerants have NO ozone depleting potential.
- Hydrocarbon refrigerants have a far lower global warming potential than any of the synthetic refrigerants in common use today.
- The TEWI rating for hydrocarbon refrigerants is also lower.

2.9 Review Questions

Question 1

Why is it important to understand the environmental impact of refrigerants?

Question 2

What is the impact of UV light on human health?

Question 3

What does the abbreviation ‘ODP’ mean and why is it an important refrigerant property?

Question 4

What does the abbreviation ‘GWP’ mean?

Question 5

Briefly explain the greenhouse effect.

Question 6

Which considerations are included in the ‘TEWI’? Which are not?

Question 7

What are the four different synthetic refrigerant classes and their typical ‘ODP’ and ‘GWP’ values?

Question 8

Which refrigerant classes are being phased out by the Montreal Protocol and why?

Question 9

Which refrigerants are being phased down?

Question 10

What are three (3) different A2/A2L refrigerants and their ‘ODP and ‘GWP’ values?

2.10 Your Notes

3. Class A2/A2L Refrigerants

Purpose

This section provides an introduction to Class A2/A2L refrigerants. You will learn about the types, their applications and their general properties. You will also learn about their flammability and compatibility issues.

Objectives

At the end of this topic you should be able to:

- State the components that join to form a Class A2/A2L refrigerant and identify the primary types.
- List typical applications suitable for the common Class A2/A2L refrigerants
- Identify the flammability region and of various A2/A2L refrigerants
- Explain the main safe handling, transport, tools and equipment required for A2/A2L refrigerants.
- Describe the factors that determine the maximum charge for A2/A2L refrigerants.
- List the typical operating pressures for R32 and R1234yf
- State the flammability and toxicity classification of R32 and R1234yf
- State the density of R32 and R1234yf relative to other comparable refrigerants
- Identify the common compressor lubricants for R32 and R1234yf
- Select compatible system construction materials for R32 and R1234yf

Content

- What is a A2/A2L refrigerant?
- Main types
- Typical applications
- Properties
- Compatibility

References

- AS/NZS ISO 817:2016, Refrigerants - Designation and safety classification, available at: https://store.standards.org.au/product/as-nzs-iso-817-2016
- AS/NZS 5149:2016, Refrigerating systems and heat pumps — Safety and environmental requirements,
  - Part 1: Definitions, classification and selection criteria
  - Part 2: Design, construction, testing, marking and documentation
  - Part 3: Installation site
  - Part 4: Operation, maintenance, repair and recovery

  Available at: https://store.standards.org.au/product/as-nzs-5149-4-2016
- Australian Refrigeration Council,
  - R32 Refrigerant information for technicians https://www.arctick.org/information/r32/
  - Emerging Automotive Refrigerants https://www.arctick.org/information/autogas/
- BOC refrigerants: www.care-refrigerants.co.uk/index.htm
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 and Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, available at: https://www.environment.gov.au/protection/ozone/legislation

3.1 What are Class A2/A2L Refrigerants?

Class A2/A2L refrigerants are single compound refrigerants or refrigerant blends that meet all of the following conditions:

Conditions	A2	A2L
Lower Toxicity		
Flammable		
Lower Flammability		
a) exhibit flame propagation when tested at 60ºC and 101.3 kPa		
b) have a LFL > 3.5% by volume		
c) have a heat of combustion < 19,000 kJ/kg		
d) have a maximum burning velocity of ≤ 10cm/s when tested at 23ºC and 101.3kPa.		

Based on AS/NZS ISO 817:2016, section 6 Safety Classifications

Lower Flammability Limit (LFL) is the minimum concentration of the refrigerant that is capable of propagating a flame through a homogeneous mixture of the refrigerant and air under the specified test conditions at 23ºC and 101.3 kPa. That is, the mixture capable of producing a flame.

3.2 Types

3.2.1 Class A2 Refrigerants

Pure refrigerants

No.	Type	Chemical Name	Chemical Formula	Boiling Point ºC	LFL g/m^3	ODP	GWP
R142b	HCFC	1-chloro-1,1-difluoroethane	CH_3CClF_2	-10	329	0	675
R152a	HFC	1,1-difluoroethane	CH_3CHF_2	-25	130	0	124

Blends

No.	Blend	Composition	Percentage	Bubble/Dew Point	LFL g/m^3	ODP	GWP
R406A	HCFC/HC	R-22/600a/142b	55/4/41	-32.7/-23.5	302	0.057	1,943
R415B	HCFC/HFC	R-22/152a	25/75	23.4/-21.8	130	0.014	546
R439A	HFC/HC	R-E170/152a/600a	60/10/30	-52/-51.8	304	0	1,983
R440A	HFC/HC	R-290/134a/152a	0.6/1.6/97.8	-25.5/-24.3	124	0	144
R512A	HFC/HC	R-134a/152a (5.0/95.0)	5/95	-24/-24	124	0	189

3.2.2 Class A2L Refrigerants

Pure refrigerants

No.	Type	Chemical Name	Chemical Formula	Boiling Point ºC	LFL% g/m^3	HFL% g/m^3	ODP	GWP
R32	HFC	Difluoromethane	CH_2F_2	-52	14.5% 307g/m^3	29.3% 620g/m^3	0	675
R143a	HFC/PFC	1,1,1-trifluoroethane	CH_3CF_3	-47	8.2% 282g/m^3		0	2,059
R1234yf	HFO	2,3,3,3-tetrafluoro-1-propene	$CF_3CF{=}CH_2$	-29.4	6.2% 289g/m^3	12.3%	0	<1
R1234ze	HFO	trans-1,3,3,3-tetrafluoro-1-propene	$CF_3CH{=}CHF$	-19	6.5% 303g/m^3	12%	0	<1

Blends

No.	Blend	Composition	Percentage	Bubble/Dew Point	LFL g/m^3	ODP	GWP
R452B	HFC/HFO	R32/R125/R1234yf	67/7/26	-51	310	0	697
R454A	HFC/HFO	R32/R1234yf	35/65	-48	278	0	237
R454B	HFC/HFO	R32/R1234yf	68.9/31.1	-51	303	0	465
R454C	HFC/HFO	R32/R1234yf	21.5/78/5	-48	293	0	146
R455A	HFC/HFO	R32/R1234yf/R744	21.5/75.5/3	-52	423	0	146

3.3 Safe Handling and Transport - Overview

For Class A2/A2L refrigerants, technicians need to take the relevant safety measures for the correct transport, storage and handling of a flammable gas. This includes ensuring that the gas is not exposed to open flames or other ignition sources. Toxic substances like hydrogen fluoride and carbon dioxide are created when all fluorinated refrigerants, are burnt. Asphyxiation and freeze burns are also a risk.

Oxygen Free Dry Nitrogen (OFDN) should always be used when brazing to displace the oxygen and prevent oxidisation on the inside of the pipework. This procedure is important as it is also required to displace the residual refrigerant and prevent concentration levels conducive to ignition.

For transportation purposes, A2/A2L refrigerants are classified as a Dangerous Goods class 2.1 flammable gas under the Australian Dangerous Goods Code and therefore requires additional handling and storage safeguards compared to class 2.2 non-flammable gases.

Under the WHS Regulation, hazardous chemicals including refrigerants are classified according to the Globally Harmonised System for the Classification and Labelling of Chemicals (GHS). The GHS is designed to provide information for the safe storage, handling and use of a hazardous chemical independent of the refrigerant gas classifications of A1/A2/B2/A3 and A2L as described in industry standards.

A refrigerant is required to have a Safety Data Sheet (SDS) developed and supplied by the manufacturer or importer which describes the hazard classification/s. The SDS provides the chemical hazard information of a product as a basis for safely managing the associated use, storage, and handling risks.

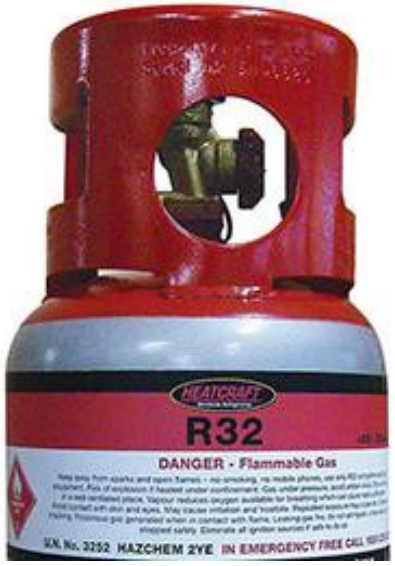
3.4 Tools and Equipment - Overview

Only use tools and equipment rated for use with (A2L or A2) flammable refrigerants. A2L refrigerants are generally Not compatible with the following current servicing tools used to work with A1 refrigerants due to the flammable nature of the refrigerant:

- Vacuum pumps

- Recovery units

Refrigerant cylinders



New or existing servicing tools needs to be assessed individually to ensure:

- It conforms with relevant International/ Australian Standards.
- The manufacturer's manual/specification states that it is designed for use with A2/A2L flammable refrigerants.
- All electrical components fitted to the device (including switches, pressure controls and motors) are sealed in a flameproof enclosure (i.e. are suitable for use in a flammable environment)

A2/A2L flammable refrigerants are compatible with the following Leak Detection Equipment:

- UV additives
- Many electronic leak detectors (check with manufacturer)
- Ultrasonic

However, the recommended leak detector for A2/A2L systems is a soapy water solution (or similar commercially available product) as currently practiced with the synthetic range of refrigerants.

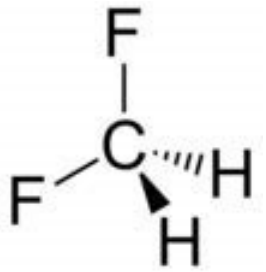
Do **not** use halide lamps (they only work with gases containing chlorine and use an open flame).

Manufacturers and suppliers are required to include additional safety information in the installation and service manuals for equipment using a flammable refrigerant. Technicians should follow these instructions.

3.5 R32

3.5.1 Chemical details:

- Name: difluoromethane
- Formula: CH_2F_2



3.5.2 Applications

R32 refrigerant is a low global warming potential (GWP) alternative to R410A commonly used in new air conditioning systems as they are both HFCs, non-ozone depleting, have similar properties, but R32 has a much lower Global Warming Potential (GWP).

Refrigerant	Composition	Boiling Point	Critical Temp.	GWP	Class
R32	R32 (100%)	-51.7°C	78.4°C	675	A2L
R410A	R32/R125 (50%/50%)	-51.0°C	72.0°C	2087.5	A1

Globally, new small air conditioning systems are rapidly transitioning from R410A to R32. In 2019, R32 systems (small, pre-charged) made up 71 per cent of the market, an increase from 52 per cent in 2018 and up from effectively zero in 2013. As manufacturers gain experience with R32, there is a general trend for it to be used with larger refrigerant charges. It is predicted that we will increasingly see the introduction of R32 in larger ducted systems over the next few years.

R32 is controlled under Australia's Ozone Protection and Synthetic Greenhouse Gas Management legislation, therefore a Refrigerant Handling Licence is required from the Australian Refrigeration Council when using R32 refrigerant, and a Refrigerant Trading Authorisation is required to acquire, possess and dispose/sell it.

R32 refrigerant, and the systems designed for it, required significant changes to the service tools, working practices, component standards and workplace safety considerations relating to install, repair, service and refrigerant recovery.

R32 is not suitable as a drop-in replacement for R410A and must only be used in systems specifically designed for R32. R410A systems are not designed to operate using a flammable refrigerant and would require extensive modification and laboratory validation to confirm that the safety level has been increased to a level that satisfies the requirements of international and national standards set for systems that use R32.
It is not just the electrical components that must be compliant with the mandatory safety requirements (i.e. AS/NZS 60335.2.40) for the refrigerant used, it is the whole air conditioner. This includes surface temperatures, operating and installation instructions, markings and warning labels, mechanical strength, etc. Anyone doing a conversion or

modification takes on the responsibilities of the designer/manufacturer and therefore must certify that the modified product is compliant with all applicable codes and standards.

Compliance with AS/NZS 60335.2.40 can only be ascertained by physical testing in a laboratory and AS/NZS 5149.1:2016 has refrigerant charge limit requirements. As a result, it is difficult for any technician to confirm compliance.

More information and video available at Australian Refrigeration Council, R32 Refrigerant information for technicians at https://www.arctick.org/information/r32 /

3.5.3 Operating pressures

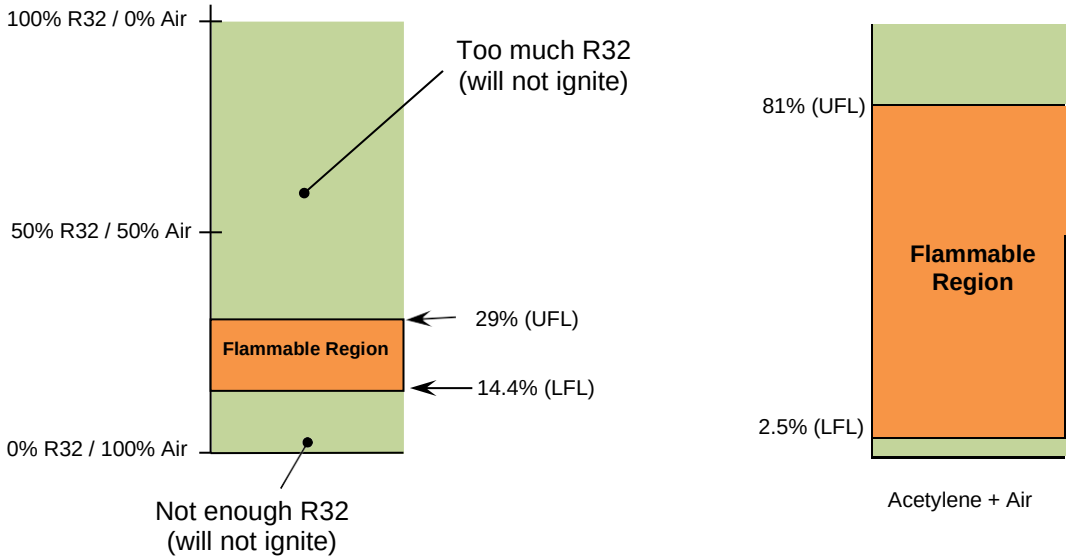
Listed below are the design operating pressures for an air conditioning application operating on R32 and R410A.

Saturation Temperature	R32	R410A
Evaporation pressure at 4°C	818kPa	806kPa
Condensing pressure at 40°C	2380kPa	2337kPa

Refer to Appendix C Properties and Application document's Pressure/Temperature chart for other saturated conditions.

3.5.4 Flammability

R32 is flammable when mixed with air (or oxygen) at a certain percentage and ignited. The quantity of R32 vapour required to make the mixture flammable sits within a narrow band of 14.4 to 29% per the diagram below.



Referring to the figure on the left above, if there is less than 14% of R32 in the air then there is insufficient fuel (the R32) for combustion. If there is more than 29% then there is insufficient oxygen for combustion. While the mixture is within these bounds it is said to be in its 'flammable region'. The bottom of this region is called the 'Lower Flammability Limit' (LFL) and conversely, the top is known as the 'Upper Flammability Limit' (UFL). Note that these values may also be expressed in kg/m^3 or g/m^3. For example, the LFL of 14% for R32 is equivalent to 307g/m^3. The UFL is equivalent to 635g/m^3. The figure on the right shows the flammability region for acetylene in air and is provided as a comparison.

Although the flammability region is narrow and usually difficult to achieve, but a dangerous situation will occur once it does, however the maximum burning velocity is slow at 6.7cm/s when tested at 23ºC and 101.3kPa.

SDS Flammability Classification

The flammability classification shown on R32 Safety Data Sheet in Appendix D, is determined in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). The GHS classification of flammable gases uses a simplistic approach: gases are classified only by the percentage concentration of gas required to create a flammable mixture in air. Other important factors, such as how easy the gas is to ignite or how it behaves once ignited, are not taken into consideration. Under the GHS classification, any gas that is ignitable at a concentration of 13% or less, or has a flammable range of at least 12 percentage points, is classified as a Category 2.1 gas and is required to carry the hazard statement “Extremely Flammable Gas”.

R32 has a flammable range of around 15 points so it meets the definition of the GHS for a Category 2.1 gas.

The Australian Dangerous Goods Code (ADG) also uses the same simplistic method for defining a flammable gas except that gases that have an LFL over 13% and a range under 12% are considered non-flammable where, as the GHS classes such gases as a “flammable gas” (i.e. not extremely flammable).

3.5.5 Toxicity

All refrigerant gasses classified in AS/NZS 817 can initiate some form of adverse health effect if the concentration is high enough, therefore it is technically incorrect to claim any classified refrigerant as “non-toxic”. However, compared to all other common refrigerants, R32 requires the highest concentration level to cause any adverse health effect and classified as A2L lower toxicity refrigerant.

However, as is the case with all fluorinated refrigerants, R32 will decompose and produce toxic by products such as hydrogen fluoride and carbon dioxide when burnt.

3.5.6 Liquid Density

R32 is nearly the same density as R410A. At 25°C, a litre of R410A (liquid) weighs 1.062 kg whereas a litre of R32 weighs 1.1kg.

3.5.7 Lubricant

Polyolester (POE) oils must be used with R32. Contact the equipment or compressor manufacturer for more information.

3.5.8 Compatibility

R32 is a HFC so it is fully compatible with the existing R410A system construction metals such as steel (ferrous), stainless steel, cast iron, aluminium, copper and brass/bronze.

R32 does not react with the current range of gasket materials, seals, O-rings or service gauge hoses suitable for HFC refrigerants.

3.5.9 Maximum Refrigerant Charge

For installation of split system air conditioners concentration levels are important, especially with ducted systems. The smallest unventilated room the system serves dictates the maximum refrigerant charge that can be safely installed.

Ducted indoor units pose an additional hazard because the indoor unit is generally in a confined space with only a small amount of room between the indoor unit and the rafters. If a gas leak occurs within the indoor unit the refrigerant can pool and become trapped, reaching flammable concentration levels.

Manufacturers and suppliers are required to include additional safety information in the installation for air conditioners using a flammable refrigerant. Technicians should follow these instructions. The allowable charge in an A2L residential or light commercial air conditioning system is specified in Australian Standard AS/NZS 60335.2.40 and takes into consideration variables such as the room floor area, height of the air conditioner, type of air conditioner, characteristics of the particular refrigerant, the level of ventilation and the application of risk mitigation devices (e.g. sensors, alarms etc).

The common room volume calculation of 20 per cent is not applicable for systems operating on R32. Considering the number of variables and the complexity of the required calculations, the Australian Standard mandates that the manufacturer shall perform the calculations and that the installation instruction will clearly show the resulting minimum floor area that the equipment can be installed into under likely installation scenarios.

The UN Environment OzonAction Quick Guide on Good Servicing Practices for Flammable Refrigerants App includes a refrigerant charge size calculator and a room size calculator for flammable refrigerants. Details are available at: https://www.unep.org/ozonaction/index.php/resources/toolkits-manuals-and-guides/good-servicing-flammable-refrigerants-quick-guide

Examples

- A R32 split air conditioning system is to be installed is a bedroom 2.5m long x 2.5m wide. Using the above App, the maximum allowable R32 charge of the system is:
  - 0.86kg if the indoor unit is floor mounted
  - 2.57kg if the indoor unit is wall mounted

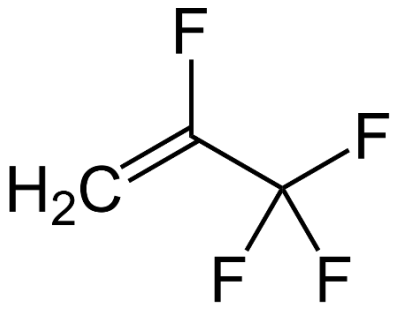
  This increase in maximum allowable change is because with the floor mounted unit, if there is a leak the refrigerant would “pool” or be more concentrated on the floor to above the 'Lower Flammability Limit” LFL.
- A 9kw split air conditioning system is pre-charged with 2kg of R32. The minimum floor area of the room is:
  - 34m^2 if the indoor unit is floor mounted
  - 3.78 m^2 if the indoor unit is wall mounted

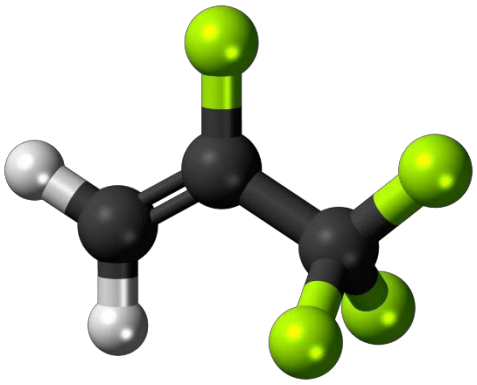
Refer to section 5.15 Limitations on the Charge of A2/A2L Refrigerants for more details of the requirements under AS/NZS 5149.1.

3.6 R1234yf

3.6.1 Chemical details:

- Name: 2,3,3,3-Tetrafluoropropene
- Formula: $C_3H_2F_4$





3.6.2 Applications

R1234yf refrigerant is a hydrofluoroolefin (HFO) are composed of hydrogen, fluorine and carbon atoms, but contain at least one double bond between the carbon atoms. Due to its composition, it has a global warming potential (GWP) of less than 1, compared to 1,430 for R-134a and 1 for carbon dioxide. However, It does break down into persistent organic pollutant short chain Perfluorinated Carboxylic Acids (PFCA).

Refrigerant	Boiling Point	Critical Temp.	GWP	Class
R1234yf	-26°C	95°C	<1	A2L
R134a	-29°C	102°C	1430	A1

R1234yf is primarily being used as a replacement for R-134a as a refrigerant in new automobile air conditioners. As of 2018, 50% of new vehicles from "original equipment manufacturers" (OEMs) are estimated to use HFO-1234yf. It is also suitable as a replacement for R-134a, without major modifications in new stationary refrigeration & air-conditioning equipment, including:

- Medium-temperature commercial and industrial refrigeration systems
- Water chillers, air conditioning, and heat pumps

R1234yf is not controlled under Australia's Ozone Protection and Synthetic Greenhouse Gas legislation. However, the Australian Refrigeration Council has a voluntary Green Scheme Accreditation program for technicians covering those refrigerants not covered by the Refrigerant Handling Licence scheme including A2/A2L R1234yf, Ammonia, Carbon Dioxide and Hydrocarbons. The details are available at: https://www.arcltd.org.au/green-scheme-accreditation/

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 (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.

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 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.

More information and video available at Australian Refrigeration Council, Emerging Automotive Refrigerants: https://www.arctick.org/information/autogas/

3.6.3 Operating pressures

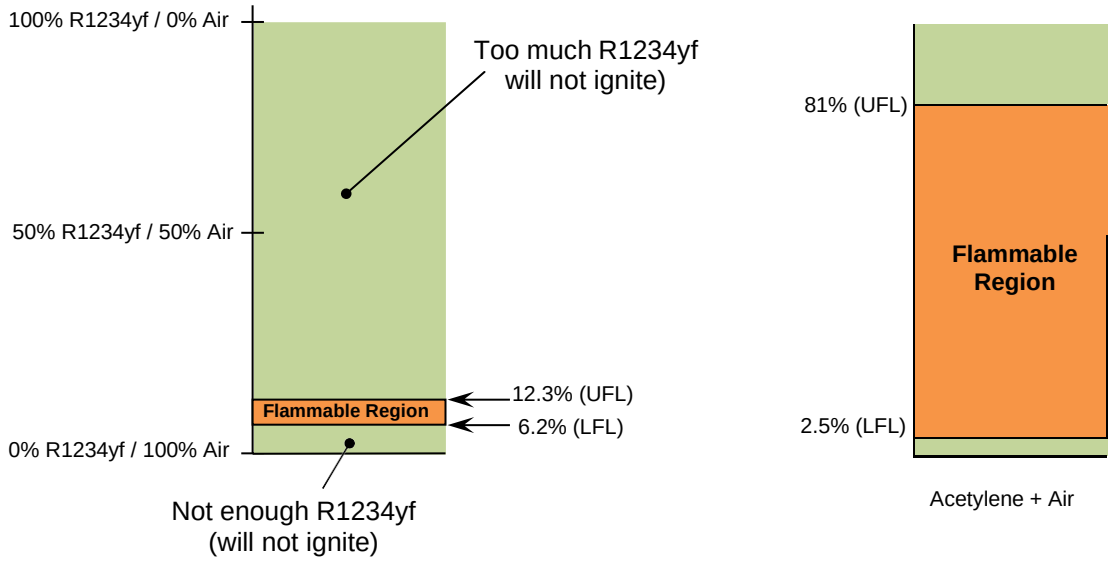
Listed below of the design operating pressures for an air conditioning application for R1234yf and R134a.

Saturation Temperature	R1234yf	R134a
Evaporation pressure at 4°C	361kPa	338kPa
Condensing pressure at 40°C	1018kPa	1017kPa
Condensing pressure at 60°C	1642kPa	1680kPa

Refer to Appendix D R1234yf Pressure/Temperature Chart for other saturated conditions.

3.6.4 Flammability

R1234yf is flammable when mixed with air (or oxygen) at a certain percentage and ignited. The quantity of R1234yf vapour required to make the mixture flammable sits within a narrow band of 6.2 to 12.3% per the diagram below.



Referring to the figure on the left above, if there is less than 6.2% of R1234yf in the air then there is insufficient fuel (the R1234yf) for combustion. If there is more than 12.3% then there is insufficient oxygen for combustion. While the mixture is within these bounds it is said to be in its 'flammable region'. The bottom of this region is called the 'Lower Flammability Limit'

(LFL) and conversely, the top is known as the 'Upper Flammability Limit' (UFL). Note that these values may also be expressed in kg/m^3 or g/m^3. For example, the LFL of 6.2% for R1234yf is equivalent to 289g/m^3. The UFL is equivalent to 573g/m^3. The figure on the right shows the flammability region for acetylene in air and is provided as a comparison.

Although the flammability region is narrow and usually difficult to achieve, but a dangerous situation will occur once it does, however the maximum burning velocity is very slow at 1.5cm/s when tested at 23°C and 101.3kPa.

Although the product is classified slightly flammable, several years of testing by the Society of Automotive Engineers (SAE) proved that the product could not be ignited under conditions normally experienced by a vehicle. In addition, several independent authorities evaluated the safety of the product in vehicles and some of them concluded that it was as safe to use as a substitute for R134a.

SDS Flammability Classification

The flammability classification shown on R1234yf Safety Data Sheet in Appendix F, is determined in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). The GHS classification of flammable gases uses a simplistic approach: gases are classified only by the percentage concentration of gas required to create a flammable mixture in air. Other important factors, such as how easy the gas is to ignite or how it behaves once ignited, are not taken into consideration. Under the GHS classification, any gas that is ignitable at a concentration of 13% or less, or has a flammable range of at least 12 percentage points, is classified as a Category 2.1 gas and is required to carry the hazard statement “Extremely Flammable Gas”.

As R1234yf is ignitable at a concentration of 13% or less (12.3%) it meets the definition of the GHS for a Category 2.1 gas.

The Australian Dangerous Goods Code (ADG) also uses the same simplistic method for defining a flammable gas except that gases that have an LFL over 13% and a range under 12% are considered non-flammable where, as the GHS classes such gases as a “flammable gas” (i.e. not extremely flammable).

3.6.5 Toxicity

All refrigerant gasses classified in AS/NZS 817 can initiate some form of adverse health effect if the concentration is high enough, therefore it is technically incorrect to claim any classified refrigerant as “non-toxic”. It has a similar toxicity to R134a.

However, as is the case with all fluorinated refrigerants, R1234yf will decompose and produce toxic by products such as hydrogen fluoride and carbon dioxide when burnt.

3.6.6 Liquid Density

R1234yf has a slightly lower density than R134a. At 25°C, a litre of R134a (liquid) weighs 1.2 kg, whereas a litre of R1234yf weighs 1.09kg.

3.6.7 Lubricant

Modified Polyolester (POE) oils must be used with R1234yf. Contact the equipment or compressor manufacturer for more information.

3.6.8 Compatibility

R1234yf is a HFO so it is fully compatible with the existing R134a system construction metals such as steel (ferrous), stainless steel, cast iron, aluminium, copper and brass/bronze. R1234yf also does not react with the current HFO range of gasket materials, seals, O-rings or service gauge hoses.

3.6.9 Maximum Refrigerant Charge

The smallest unventilated enclosed space or room the system serves dictates the maximum refrigerant charge that can be safely installed to ensure the atmosphere does not reach the refrigerants Lower Flammability Limit (LFL).

Automotive manufacturers would have met this refrigerant charge requirement as part of their air conditioning system design. Technicians should never over charge the system.

3.7 Additional Information

- **Australian Refrigeration Council website:**
  - R32, https://www.arctick.org/information/r32/
  - R1234fy, https://www.arctick.org/information/autogas/r1234yf-refrigerant/

- **Flammable Refrigerants Safety Guide**
  The Flammable Refrigerants Safety Guide developed by the Australian Institute of Refrigeration, Air Conditioning and Heating outlines the occupational health and safety risks associated with refrigeration and air conditioning equipment and systems that use flammable refrigerants. Module 8 covers cylinder handling, storage and transport. Refer to the updated 2018 edition available at:
  https://www.airah.org.au/Web/Resources/Technical_Resources/Flammable_Refrigerants_Safety_Guide/AIRAH/Navigation/Resources/Flammable_Refrigerants_Safety_Guide/Flammable_Refrigerants_Safety_Guide.aspx?hkey=be013b97-33ae-45a2-95f6-59303d6803ac

- **WorkSafe**
  Check with the relevant state-based WorkSafe agencies and refer to the relevant material safety data sheets available from refrigerant wholesalers for specific safeguards when handling flammable refrigerants.

- **Flammable refrigerant gases – position paper**
  This paper by the Heads of Workplace Safety Authorities (HWSA) covers information on the obligations of work health and safety duty holders with respect to the use of flammable refrigerant gases at workplaces. It is available at:
  http://www.dmp.wa.gov.au/Documents/Dangerous-Goods/DMIRS_IS_FlamRefrigGases.pdf

- **Regulation of Flammable Refrigerants Report**
  This report, commissioned by Refrigerants Australia, provides an overview of the regulatory and quasi-regulatory instruments which control the use and handling of flammable refrigerants in the different jurisdictions around the country. It is available at:
  https://www.refrigerantsaustralia.org/images/news/flammable%20report%202020/FINAL%20Report%20(16%20December)%20.pdf
  The Infographics that accompany a report lets you click on each type of regulation to view a list of relevant authorities or view specific requirements for your industry sector by starting with the 'choose your sector' infographic. It is available at:
  https://www.refrigerantsaustralia.org/overview-infographic.html

- **UN Environment OzonAction Quick Guide on Good Servicing Practices for Flammable Refrigerants - App**
  This Apple and Android App provides easy reference to the key safety classifications and technical properties of flammable refrigerants that are available in the market. It also provides important safety guidance for the installation and servicing of room air-conditioners designed to use flammable refrigerants. The application also includes a refrigerant charge size calculator and a room size calculator for flammable refrigerants. Details are available at:
  https://www.unep.org/ozonaction/index.php/resources/toolkits-manuals-and-guides/good-servicing-flammable-refrigerants-quick-guide

3.8 Section Summary

- A2/A2L refrigerants are flammable when mixed in the correct proportions with air.
- They are finding wide use in areas such as small capacity self-contained and split systems air conditioning equipment, and automotive air conditioning equipment in numerous countries around the world.
- A2/A2L refrigerants are fully compatible with current materials, components, lubricants and most servicing equipment.
- They will only ignite when within a certain % mixture with air.
- Operating costs will typically be lower due to improved energy efficiency.
- Existing systems must not be retrofitted with A2/A2L refrigerants.
- Existing vacuum pumps and recovery units must be checked before using them with A2/A2L refrigerants to ensure:
  - The manufacturer's manual/specification states that it is designed for use with A2/A2L flammable refrigerants.
  - All electrical components fitted to the device are sealed in a flameproof enclosure.
- Modified servicing techniques are essential due to the increased flammability risk of A2/A2L refrigerants.
- Additional precautions are required to minimise refrigerant leakage.
- Check for sources of ignition around the system including:
  (a) a naked flame
  (b) exposed incandescent material
  (c) hot surfaces
  (d) radiant heat
  (e) a spark from mechanical friction
  (f) a spark from static electricity (including clothing that may generate static)
  (g) an electrical arc as produced by contactors, relays and general switches
  (h) any electrical, electronic, mechanical or other equipment.

3.9 Review Questions

Question 1

For which applications are A2/A2L refrigerant currently used?

Question 2

Due to which properties make R32 such an excellent refrigerant?

Question 3

What types of lubricants used for A2/A2L refrigerant?

Question 4

If released into the air, will A2/A2L refrigerant rise upwards or stay low to the ground?

Question 5

Explain the dangerous properties of A2/A2L refrigerants.

Question 6

What are typical operating pressures for a R32 air conditioning system?

Question 7

Explain the term ‘LFL’ and ‘UFL’

Question 8

What is the flammable range of?
- R1234yf
- R32

Question 9

Explain the difference between a leak in a liquid and vapour part of a A2/A2L refrigeration system?

Question 10

What does ‘SDS’ stand for and what information does it include?

3.10 Your Notes

4. Acts, Regulations and Codes

Purpose

In this topic you will learn about the National and State/Territory legal implications of using A2/A2L refrigerants. You will also learn about the relevant licensing requirements across Australia.

Objectives

At the end of this topic you should be able to:

- Identify the various components that combine to form the framework of Australian legislation
- Explain the fundamental purpose of an Act, a Regulation, a Code of Practice, a Standard and an Industry Guideline
- Explain the term 'Duty of Care'

Content

- Australian Legislation explained
- Acts
- Regulations
- Codes of Practice
- Standards
- Industry Standards/Codes of Practice & National Guidance notes.
- Duty of Care
- Who does the law protect?
- Who is responsible?
- Can you be found personally liable?

References

Acts and Regulations

- National Acts and Regulations http://www.comlaw.gov.au/
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 and Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, available at: https://www.environment.gov.au/protection/ozone/legislation
- ACT Acts and Regulations http://www.legislation.act.gov.au/
- NSW Acts and Regulations https://legislation.nsw.gov.au/
- NT Acts and Regulations https://education.nt.gov.au/publications/legislation
- QLD Acts and Regulations http://www.legislation.qld.gov.au/
- SA Acts and Regulations http://www.legislation.sa.gov.au/index.aspx
- Tas Acts and Regulations https://www.legislation.tas.gov.au/
- VIC Acts and Regulations http://www.legislation.vic.gov.au/
- WA Acts & Regulations https://www.parliament.wa.gov.au/WebCMS/WebCMS.nsf/content/wa-acts-and-regulations#:~:text=WA%20acts%20and%20regulations%20The%20Parliamentary%20Counsel%E2%80%99s%20Office,and%20subsidiary%20legislation%20%28including%20regulations%2C%20by-laws%20et%20cetera%29.

Codes of Practice

- Refrigerant Handling Codes of Practice https://www.arctick.org/refrigerant-handling-licence/codes-of-practice/
- National Standards and Codes of Practice http://safeworkaustralia.gov.au/Pages/default.aspx
- ACT Codes of Practice https://www.worksafe.act.gov.au/laws-and-compliance/codes-of-practice
- NSW Codes of Practice https://www.safework.nsw.gov.au/resource-library/list-of-all-codes-of-practice
- NT https://worksafe.nt.gov.au/forms-and-resources/bulletins/codes-of-practice-and-other-guidance-material
- QLD Codes of Practice https://www.worksafe.qld.gov.au/laws-and-compliance/codes-of-practice
- SA Codes of Practice https://www.safework.sa.gov.au/workplaces/codes-of-practice
- Tas Codes of Practice https://worksafe.tas.gov.au/topics/laws-and-compliance/codes-of-practice
- Victorian Codes of Practice https://www.worksafe.vic.gov.au/
- WA Codes of Practice https://www.commerce.wa.gov.au/worksafe/codes-practice#:~:text=A%20code%20of%20practice%20is%20a%20document%20prepared,references%20to%20occupational%20safety%20and%20health%20laws.%20

SafeWork Australia

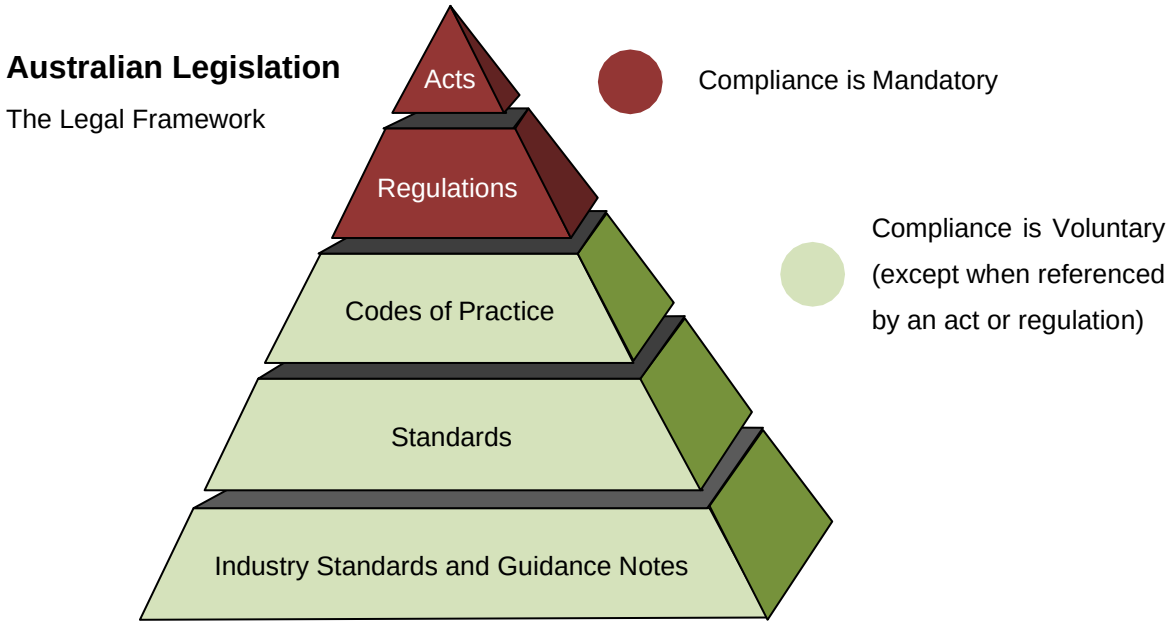
- Hazardous Substances Information System http://hcis.safeworkaustralia.gov.au/
- Progress on adopting national WHS model https://www.safeworkaustralia.gov.au/doc/model-whs-act-cross-comparison-table

Standards

- AS/NZS ISO 817:2016, Refrigerants - Designation and safety classification, available at: https://store.standards.org.au/product/as-nzs-iso-817-2016
- AS/NZS 5149:2016, Refrigerating systems and heat pumps — Safety and environmental requirements,
    - Part 1: Definitions, classification and selection criteria
    - Part 2: Design, construction, testing, marking and documentation
    - Part 3: Installation site
    - Part 4: Operation, maintenance, repair and recovery
- AS/NZS 60335.2.40:2019, Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

4.1 Australian Legislation Explained

Australian law is governed by a framework of Acts, Regulations and support material including codes of practice and standards.



4.1.1 Acts

"Who makes them?"
These are made by parliament and are enforced by government departments.

"What do they do?"
They set out legal rules that govern workplaces in order to minimise the chances of people in workplaces suffering injury or illness.

"Where do they apply?"
Any place where people perform work. A workplace is not necessarily a building; it can be a factory or a vehicle. It is anywhere defined by the Act as a workplace.

"When are they enforced?"
Not complying with an Act is considered an offence and can result in a fine, the issuing of an improvement notice or a prohibition notice. Note that a breach does not only result *after* an accident or injury has occurred. Performing an act or function that *may lead* to an accident or injury will also constitute a breach (e.g. using a dangerous piece of unguarded machinery).

4.1.2 Regulations

"Who makes them?"
A Regulation is made under the principal Acts governing WH&S legislation.

What do they do?"
Regulations support an Act by outlining how the general obligations of the Act will be applied in the workplace. Not complying with a regulation can result in a fine, issuing of an improvement notice or prohibition notice or imprisonment.

"Where do they apply?"
Where the principal Act applies.

"When are they enforced?"
Like an Act, any section of a regulation can be breached at any time and does not have to result from a serious accident.

4.1.3 Codes of Practice

"Who makes them?"
They can be made by industry bodies, associations or Australian Standards.
State and Territory governments are able to approve these COP's through the powers of the principal Act (at which point they become a mandatory requirement).

"What do they do?"
They are the supporting material additional to Acts and regulations. They give practical advice and guidance on how to comply with the general obligations set out in the Act and Regulations.

"When are they enforced?"
A breach of a code of practice will only be a direct breach of an Act or Regulation when it is referenced by that Act or Regulation. However all codes of practice can be used as evidence in court to demonstrate what an employer should have been doing to comply with the obligations under the Act or Regulations to ensure a safe workplace.
For this reason it is best to comply with the requirements of a code of practice, unless another solution achieves the same or better outcome.

4.1.4 Standards

"Who makes them?"
There are two main sources of standards relevant to health and safety:

1. National Standards produced by the National Occupational Health and Safety Commission, in consultation with state and territory authorities, employee unions and employer associations.
2. Australian Standards produce by Standards Australia, in consultation with overseas standards bodies, Australian employer and employee organisations, and representatives from state and territory governments.

"What do they do?"
National Standards usually deal with workplace problems such as noise or dangerous working environments. Exposure Standards are guides which are used in controlling exposure to hazardous substances in the workplace. Australian Standards usually provide technical and design guidance notes.

"Where do they apply?"
National Standards are adopted by States and territories into their WH&S legislation.

When are they enforced?"
Standards are only enforceable by law when they are specifically included in a National/State/Territory regulations, including health and safety regulation. Be aware that current legal practices with regard to litigation make it essential that the individual applies the practices recommended by the most stringent standard. This may include international standards.

4.1.5 Industry Specific Standards/Codes of Practice and National Guidance Notes

"Who makes them?"
Relevant employer associations, trade unions and industry bodies. The federal government statutory agency known as *Safe Work Australia* is responsible for Guidance Notes.

"What do they do?"
They provide practical advice and guidelines for controlling hazards and risks.

"Where do they apply?"
Guidance Notes will apply to any workplace in Australia

"When are they enforced?"
They are not enforceable by law. Industry specific standards usually aim to achieve the same or better result than general national standards or codes of practice.

4.1.6 Duty of Care

What is duty of care?
Duty of care places into a legal form a moral duty to anticipate possible causes of injury and illness and to do everything reasonable to remove or minimise these possible causes of harm.

Duties within the Work Health and Safety Act are to be complied with so far as 'reasonably practical'. This allows the duty holder to choose the most efficient means of controlling risk from a range of possibilities. A number of factors are taken into account to determine what would be reasonable and practical. These factors include the:

- Nature and severity of the hazard

- Knowledge of severity of the hazard
- Knowledge of solutions
- Availability of solutions
- Common standards of practice
- Cost of solutions

In summary, employers, manufacturers, designers, supplier's, persons in control of workplaces and persons who erect, service, maintain or install plant and equipment must ensure:

- Safe property: this includes premises, safe plant and equipment, materials and substances (raw materials, chemicals, products, stock etc.)
- Safe systems of work: this includes work practices, manufacturing practices, standard operating procedures and administration procedures.
- Safe people: this includes providing staff with suitable information, instruction, training, supervision, tools and PPE.

4.1.7 Who does the law protect?

Each state/territory has a central piece of law, the principal WH&S Act, which protects all persons in all workplaces. This includes:

- Employees – casuals, seasonal workers, permanent staff and employed family members.
- Contractors – all maintenance and repair services provided in your business.
- Other persons – this covers all visitors to your workplace no matter how short the visit e.g., volunteers, the general public, customers, the police, government inspectors, couriers and delivery persons. One State even covers trespassers.

4.1.8 Who is responsible?

The WHS Act specifies who is responsible in relation to their role in the workplace. A person may be responsible in more than one capacity, for example, an employer and manufacturer. It is not a defence to argue that someone else had an overlapping responsibility. The requirements typically cover;

- Employers (referred to as a PCBU)
- Persons in control of workplaces
- Manufacturers, designers and suppliers
- Persons who erect and install equipment
- Employees (referred to as Workers)

Remember: No one person's obligations in the workplace outweigh or supersede another person's obligations.

4.1.9 Can you be found personally liable?

WHS legislation allows for directors and officers of a business to be held personally accountable for a breach of an Act. Managers and employees can also be held individually accountable for a breach of an Act.
There is some simple advice:

- Managing directors must visibly and actively demonstrate that they support their managers in achieving health and safety solutions.
- Managers must ensure that they support their supervisors in achieving health and safety solutions.
- Supervisors must ensure that they allow employees to raise health and safety issues and follow up on these issues. They must also ensure that employees act in accordance with the training and information that has been provided for them.
- Employees must co-operate with management and their efforts to comply with their health and safety responsibilities.

Remember!! Every level of management (managing director to lowest ranking employee) is responsible for health and safety.
This responsibility cannot be delegated.

4.2 Review Questions

Question 1

What do Acts do? Where do they apply? When are they enforced?

Question 2

What do Regulations do? Where do they apply? When are they enforced?

Question 3

What do Codes of Practice do? Where do they apply? When are they enforced?

Question 4

What do Standards do? Where do they apply? When are they enforced?

Question 5

What do Industry Specific Standards/COP's do? Where do they apply? When are they enforced?

Question 6

Explain the term 'Duty of Care'.

Question 7

Who is responsible for compliance?

Question 8

Who does the law protect?

Question 9

What information can you find in the 'HSIS'?

Question 10

What is included in the 'ADG' code and to which class does ammonia belong?

4.3 Your Notes

5. The Acts, Standards & Codes Applicable to A2/A2L Refrigerants and Equipment

Purpose

In this topic you will learn about the legislative and guiding documents that may (or do) pertain to the handling and storage of A2/A2L refrigerants and the associated systems/appliances as produced by federal and state governments.
Note that this information is offered as guidance on the various and numerous legislative requirements created to date but is not to be construed as a replacement or legal interpretation in any way. Refer to the originating document at all times.

Objectives

At the end of this topic you should be able to:

- Identify National and State legislation that pertains to A2/A2L refrigerants and their systems
- Interpret relevant standards, codes and regulations
- State the requirements for record keeping with regard to A2/A2L refrigerants.
- Determine the relevant toxicity and flammability groupings for A2/A2L refrigerants
- Implement relevant standards, codes and regulations
- Determine the maximum charge of an A2L refrigerant for a given enclosed space

Content

- National Legislation
- State/Territory Legislation
- Australian Standards
- Toxicity and flammability groupings for A2/A2L refrigerants
- Occupancy Classification
- Limitations on the charge of refrigerants

References

Acts and Regulations

- National Acts and Regulations http://www.comlaw.gov.au/
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 and Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, available at: https://www.environment.gov.au/protection/ozone/legislation
- ACT Acts and Regulations http://www.legislation.act.gov.au/
- NSW Acts and Regulations https://legislation.nsw.gov.au/
- NT Acts and Regulations https://education.nt.gov.au/publications/legislation
- QLD Acts and Regulations http://www.legislation.qld.gov.au/
- SA Acts and Regulations http://www.legislation.sa.gov.au/index.aspx
- Tas Acts and Regulations https://www.legislation.tas.gov.au/
- VIC Acts and Regulations http://www.legislation.vic.gov.au/
- WA Acts & Regulations https://www.parliament.wa.gov.au/WebCMS/WebCMS.nsf/content/wa-acts-and-regulations#:~:text=WA%20acts%20and%20regulations%20The%20Parliamentary%20Counsel%E2%80%99s%20Office,and%20subsidiary%20legislation%20%28including%20regulations%2C%20by-laws%20et%20cetera%29.

Codes of Practice

- Refrigerant Handling Codes of Practice https://www.arctick.org/refrigerant-handling-licence/codes-of-practice/
- The Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code) https://www.ntc.gov.au/codes-and-guidelines/australian-dangerous-goods-code
- National Standards and Codes of Practice http://safeworkaustralia.gov.au/Pages/default.aspx
- ACT Codes of Practice https://www.worksafe.act.gov.au/laws-and-compliance/codes-of-practice
- NSW Codes of Practice https://www.safework.nsw.gov.au/resource-library/list-of-all-codes-of-practice
- NT https://worksafe.nt.gov.au/forms-and-resources/bulletins/codes-of-practice-and-other-guidance-material
- QLD Codes of Practice https://www.worksafe.qld.gov.au/laws-and-compliance/codes-of-practice
- SA Codes of Practice https://www.safework.sa.gov.au/workplaces/codes-of-practice
- Tas Codes of Practice https://worksafe.tas.gov.au/topics/laws-and-compliance/codes-of-practice
- Victorian Codes of Practice https://www.worksafe.vic.gov.au/
- WA Codes of Practice https://www.commerce.wa.gov.au/worksafe/codes-practice#:~:text=A%20code%20of%20practice%20is%20a%20document%20prepared,references%20to%20occupational%20safety%20and%20health%20laws.%20

SafeWork Australia

- Hazardous Substances Information System http://hcis.safeworkaustralia.gov.au/
- Progress on adopting national WHS model https://www.safeworkaustralia.gov.au/doc/model-whs-act-cross-comparison-table

Standards

- AS/NZS ISO 817:2016, Refrigerants - Designation and safety classification, available at: https://store.standards.org.au/product/as-nzs-iso-817-2016
- AS/NZS 5149:2016, Refrigerating systems and heat pumps — Safety and environmental requirements,
    - Part 1: Definitions, classification and selection criteria
    - Part 2: Design, construction, testing, marking and documentation
    - Part 3: Installation site
    - Part 4: Operation, maintenance, repair and recovery
- AS/NZS 60335.2.40:2019, Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

The following Acts, Regulations, Standards and Codes of Practice were current in October 2021 but these may change over time and the latest versions must be applied.

5.1 National Legislation

5.1.1 Ozone Protection & Synthetic Greenhouse Gas Management Act 1989

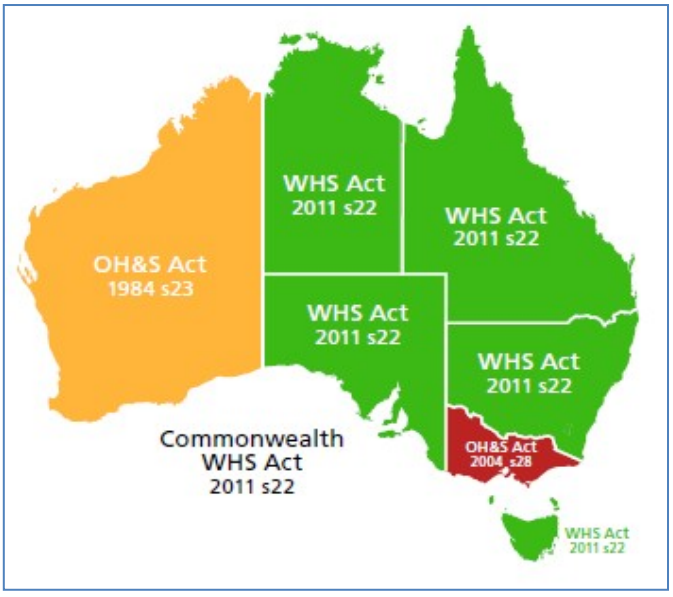
This national Act describes the system of controls that must be used in the handling, use, manufacture, import and export of substances that deplete ozone in the atmosphere and identifies the substances under its control, this includes R32.
The HFO series of refrigerants, for example R1234yf have a GWP of less than 1, therefore they do not fall within the scope of this Act.

5.1.2 Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995

This Regulation deals with fluorocarbon refrigerant handling licensing and refrigeration trading authorisation for controlled substances, these include R32.
The HFO series of refrigerants, for example R1234yf have a GWP of less than 1, therefore they do not fall within the scope of this Regulation.

5.1.3 Work Health and Safety Act 2011

The main object of this Act is to provide for a balanced and nationally consistent framework to secure the health and safety of workers and workplaces.
Under a COAG (Council of Australian Governments) initiative, all of the States and Territories of Australia have agreed to adopt and implement this national model.
The model WHS laws have been implemented in the Australian Capital Territory, New South Wales, the Northern Territory, Queensland, South Australia, Tasmania and the Commonwealth. Some jurisdictions have made minor variations to make sure the legislation is consistent with their relevant drafting protocols and other laws and processes.



5.1.4 Work Health and Safety Regulation 2011

The object of this Regulation is to prescribe matters under the *Work Health and Safety Act 2011* to enable that Act to come into operation on 1 January 2012.
The provisions of this Regulation are substantially uniform with the '*Model' Work Health and Safety Regulations 2011* prepared by Safe Work Australia. All of the states and territories of Australia have agreed to adopt and implement this model.

This model has been implemented in the Australian Capital Territory, New South Wales, the Northern Territory, Queensland, South Australia, Tasmania and the Commonwealth. Some jurisdictions have made minor variations to make sure the legislation is consistent with their relevant drafting protocols and other laws and processes.
This regulation applies to all places of work. It describes the duties of employers (now referred to as PCBU's) and workers with regard to workplace safety. It contains no direct reference to the A2/A2L refrigerants or the associated appliances. Regardless of the licensing provisions, employers have a duty of care to ensure that their workers are appropriately trained and have the necessary equipment to use A2L refrigerants.

5.1.5 Hazardous Substances Information System (HCIS)

The HCIS is an internet advisory service that assists you to find information on chemicals that have been classified in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) by an authoritative source, such as the European Chemicals Agency (ECHA) or the Australian Industrial Chemicals Introduction Scheme (AICIS), formerly the National Industrial Chemicals Notification and Assessment Scheme (NICNAS). On 1 January 2021, Australia will begin a two-year transition to the 7th revised edition of the GHS (GHS 7). During the transition, manufacturers and importers may use either GHS 3 or GHS 7 to prepare classifications, labels and SDS for workplace hazardous chemicals
Exposure Standards can be search at:
http://hcis.safeworkaustralia.gov.au/ExposureStandards
Refer to SDS for R32 in Appendix D and R1234yf in Appendix F for their exposure information.

5.1.6 Australian Code for Transport of Dangerous Goods by Road and Rail

This Code is also as the 'ADG' code is currently in its 7.7th edition which can be used from 1 October 2020 and is compulsory from 1 October 2021.
It identifies in Table 4.1.4.1B Liquified Gases and Dissolved Gases each of the Hydrocarbon refrigerants and A2/A2L refrigerants as dangerous goods and provides the following Information.

UN No.	Substance	Class or Div'n	Special Prov's	Packaging Instructions	Test Period (Years)	Test Press. (kPa)	Fill Ratio
1	2	3	4	5	6	7	8
1005	AMMONIA, ANHYDROUS	2.3	23	P200	5	2900	0.54
1018	R22	2.2		P200	10	2700	1.03
3159	R134a	2.2		P200	10	1800	1.05
1035	ETHANE	2.1		P200	10		
1077	PROPYLENE	2.1		P200	10	2700	0.43
1969	ISOBUTANE	2.1		P200	10	1000	0.49
1978	PROPANE	2.1	AU03	P200	10	2300	0.43
3252	R32	2.1		P200	10	4800	0.78

Note: R1234yf is not listed in the ADG, but all A2/A2L refrigerants are classified under the ADG as 2.1 Flammable Gases.

Explanations:

Column 1: This code parallels the United Nations 'Recommendations on the Transport of dangerous goods'. This is the number that the UN has associated with each Product/Substance in the Dangerous Goods List.

Column 2: The name of the Product or Substance.

Column 3: The Class or Division No. Allocated to the substance

- 2.1 A Flammable Gas
- 2.2 A Gas that is not flammable and not toxic but can cause asphyxiation

2.3 A Toxic Gas

Column 4: Special Provisions

23 Flammable but only under extreme fire conditions in confined areas

AU03 Transport of un-odorised LP gas is prohibited. A leak detector must accompany the substance if it is not odorised. (An Australian requirement only)

Column 5: Packaging Instructions required for the transport of the substance.

P200 A lengthy and detailed packaging code that specifies among other things, the information shown in columns 6, 7 and 8

Column 6: Bottles, cylinders and tanks must be tested at the frequencies specified in this column

Column 7: The pressure at which the bottle, cylinder or tank must be pressure tested to ensure integrity

Column 8: The ratio required to safely fill a bottle, cylinder or tank. Multiply the Water Capacity (WC) of the cylinder by this ratio to determine the safe mass that the cylinder can hold

Further to the above, Appendix ZB of AS/NZS 5149.1:2016 provides examples of relationship between ISO 817 (refrigerant Safety Classification as used in AS/NZS 5149 to the Australian Dangerous Goods (ADG) Code & GHS Classification

Application of refrigerant in refrigeration or air conditioning systems		Transport of refrigeration systems	Transport and storage of refrigerants in cylinders		
ISO 817 Class	**Examples**	**UN number**	**ADG Code#**	**UN number**	**GHS classification[3]**
A1	R134a R22 R404A R407C R407F[1] R410A R438A[1] R507A[1] R744	UN 2857—(Refrigerating machines containing non-flammable, non-toxic gases or ammonia solutions)	2.2	UN3159 UN1018 UN3337 UN3340 UN3163 UN1078 UN3163 UN3163 UN1013 UN3163	Compressed gas, liquefied gas and dissolved gas, H280
A2L	R1234ze[1,2] R1234yf R32	UN 3358—(Refrigerating machines containing flammable, non-toxic, liquefied gas	2.1	UN3161 UN3252 UN1030 UN1978 UN1969 UN1077	Flammable gases Category 1, H220
A2	R152A				
A3	R290 R600a R1270				
B1	*		2.3	UN1005	Acute inhalation toxicity (gas) Category 3, H331
B2L	R717	UN 2857			
B2	*				
B3	*				

* No refrigerant in common use that meets this classification.

\# For land transport requirements in New Zealand consult Standard NZS 5433—*Transport of dangerous goods on land.*

NOTES:

1 No specific UN number assigned to these refrigerants, UN 3163 is 'Liquefied gas, n.o.s'.

2 R1234ze is classified as 'Lower flammability—A2L' by ISO 817 but under the ADG code it is classed as non-flammable, non-toxic and hence is 2.2 and UN 2857 for transport of pre-charged systems.

3 For detailed hazard statements refer to the SDS for the applicable refrigerant.

5.1.7 Heads of Workplace Safety Authorities (HWSA)

The HWSA produced a "Flammable refrigerant gases – position paper" in which covers information on the obligations of work health and safety duty holders with respect to the use of flammable refrigerant gases at workplaces. It is available at: http://www.dmp.wa.gov.au/Documents/Dangerous-Goods/DMIRS_IS_FlamRefrigGases.pdf

5.18 Regulation of Flammable Refrigerants Report 2020

This report was commissioned by Refrigerants Australia and conducted by Bronwyn Weir and Krista Weymouth. It provides an overview of the regulatory and quasi-regulatory instruments which control the use and handling of flammable refrigerants in the different jurisdictions around the country. It is available at:
https://www.refrigerantsaustralia.org/images/news/flammable%20report%202020/FINAL%20Report%20(16%20December)%20.pdf
Infographics accompany the report provides an overview of the regulatory and quasi-regulatory instruments that control the use and handling of flammable refrigerants in different jurisdictions around Australia. Click on each type of regulation to view a list of relevant authorities or view specific infographics for your industry sector. It is available at:
https://www.refrigerantsaustralia.org/overview-infographic.html

5.2 NSW Legislation

Dangerous Goods (Road and Rail Transport) Regulation 2009

The main objects of this Regulation are to set out the obligations of persons involved in the transport of dangerous goods by land transport, and to reduce as far as practicable the risks of personal injury, death, property damage and environmental harm arising from the transport of dangerous goods by land transport, and to give effect to the standards, requirements and procedures of the ADG Code so far as they apply to the transport of dangerous goods by land transport, and to promote consistency between the standards, requirements and procedures applying to the transport of dangerous goods by land transport and other modes of transport.
This Regulation does not apply to the transport by a person of a load of dangerous goods if the load does not contain dangerous goods in a receptacle with a capacity of more than 500 litres.

5.3 Australian Capital Territory Legislation

Dangerous Goods (Road Transport) Act 2009

The purpose of this Act and its associated regulation 'Dangerous Goods (Road Transport) Regulation 2010' is to regulate the transport of dangerous goods by road in order to promote public safety and protect property and the environment. They contain no direct reference to A2/A2L refrigerants, the appliances they are used in, or Class 2.1 flammable gases.

Dangerous Substances Act 2004

The purpose of this Act is to protect the health and safety of people, and to protect property and the environment from damage, from the hazards associated with dangerous substances. It contains no direct reference to the A2/A2L refrigerants, the appliances they are used in, or Class 2.1 flammable gases.

Gas Safety Act 2000

This act and its associated regulation 'Gas Safety Regulation 2001' deal with the installations and work methods performed by a gasfitter.

They contain no direct reference to the A2/A2L refrigerants or the appliances they are used in or Class 2.1 flammable gases. The term 'Hydrocarbon' exists within the dictionary description of a 'gas' but has no other occurrence.

5.4 Queensland Legislation

Dangerous Goods Safety Management Act 2001

This Act establishes requirements for the safe storage and handling of dangerous goods and combustible liquids and the safe operation of major hazard facilities in Queensland. It does not deal with flammable gases.

Petroleum and Gas (Production and Safety) Act 2004

In Queensland the use of hydrocarbon refrigerants is controlled under this act and its associated regulation 'Petroleum and Gas (Production and Safety) Regulation 2004'. This includes approval of a hydrocarbon refrigerant refrigerating device before it can be sold and authorisation to undertake gas work on the refrigeration device. It does not cover Class 2.1 flammable gases.
Further information and relevant forms can be found here:
https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/petroleum-gas/gas-work-devices/guidelines/hydrocarbon-refrigerants

5.5 Victorian Legislation

Dangerous Goods Act 1985

This 'principle act', together with its associated 'Dangerous Goods Amendment (Transport) Act 2008' and 'Dangerous Goods (Transport by road and rail) Regulations 2008 are issued to promote the safety of persons and property in relation to the manufacture, storage, transport, transfer, sale and use of dangerous goods and the import of explosives into Victoria.
The principle act contains a statement under part 5 'Accidents and Security' Item no. 4 to the effect that:

> *A person who carries out any work involving the installation, alteration, repair, maintenance or testing of equipment, piping, fittings or appliances which are not prescribed as exempt for the purposes of this sub-section shall take all reasonable precautions to ensure that the equipment, piping, fittings or appliances:*
>
> *(a) are safe for use; and*
>
> *(b) will not cause or contribute to a fire, explosion, leakage or spillage involving dangerous goods.*

Dangerous Goods (Storage and Handling) Interim Regulations 2011

This regulation contains the following conditions:

- Class 2.1 dangerous goods in containers of not more than 500 litres are classified as 'packaged dangerous goods'
- These Regulations do not apply to dangerous goods at premises that are not a **workplace** for compressed gases of Class 2.1 in an aggregate cylinder capacity of not more than 50L when used as part of a welding set or portable flame torch.
- If a retailer supplies packaged dangerous goods into a container provided by the purchaser, the retailer must in the case of Class 2 dangerous goods, ensure that

the container meets the requirements of the Dangerous Goods (Transport by Road or Rail) Regulations 2008 that relate to packages for dangerous goods.

- An occupier of premises where dangerous goods are stored and handled must ensure that any storage of packaged dangerous goods that exceeds 500 litres is placarded in accordance with this regulation.

Using flammable refrigerants

This website provides information on how to manage the risks associated with gases containing class 2.1 flammable refrigerants in refrigeration and air conditioning systems**.**
https://www.worksafe.vic.gov.au/using-flammable-refrigerants

5.6 South Australian Legislation

Dangerous Substances Act 1979

This Act regulates the keeping, handling, transporting, conveyance, use and disposal, and the quality, of dangerous substances.

Dangerous Substances Regulations 2002

- For the purposes of section 14 of the Act, a person is permitted to keep liquefied petroleum gas (LPG), up to 250 kilograms for any purpose provided that it is contained in cylinders or tanks, in any premises without a licence provided that the person complies with the provisions of this regulation.
- An annually renewable licence is required to keep more than 560 litres (WC) of a Class 2 gas.
- A person must not sell liquefied petroleum gas unless it complies with the requirements as to odour and quality as set out in "Liquefied Petroleum Gas Specifications and Test Methods" revised (Metric) edition dated 11 September 1973.

5.7 Western Australian Legislation

Dangerous Goods Safety Act 2004

An Act relating to the safe storage, handling and transport of dangerous goods and for related purposes in Western Australia. No direct references found in this act.

Dangerous Goods Safety (General) Regulations 2007

This regulation deals mainly with infringement notices and required forms.

Dangerous Goods Safety (Road and Rail Transport of Non-explosives) Regulations 2007

Part 7 applies to the transport of gases of UN Class 2 dangerous goods but contains no reference to the use of hydrocarbons as a refrigerant or the associated appliances.

5.8 Northern Territory Legislation

Dangerous Goods Act

This is an act to provide for the safe storage, handling and transport of certain dangerous goods. No direct references found in this act.

Dangerous Goods Regulations

Part 3 of this regulation has been removed and is now replaced by the *Work Health and Safety (National Uniform Legislation) Regulations*.

5.9 Tasmanian Legislation

Dangerous Substances (Safe Handling) Act 2005

An Act to provide for the safe handling of dangerous substances, for the safe management of places where dangerous substances are handled and for the safe management of incidents and emergencies involving dangerous substances and for related purposes.

Dangerous Goods (Road and Rail Transport) Act 2010

An Act to regulate by nationally consistent legislation the transport of dangerous goods by road and rail in order to promote public safety and protect property and the environment, to repeal the Dangerous Goods (Safe Transport) Act 1998 and for related and consequential purposes.

5.10 International Standards

Always refer to the latest current Standard and any Amendments.

IEC 60335-2-40: Household and similar electrical appliances — Safety — Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

This Standard deals with the safety of electric heat pumps, including sanitary hot water heat pumps, air conditioners, and dehumidifiers incorporating motor-compressors and hydronic fan coils units, their maximum rated voltages being not more than 250 V for single phase appliances and 600 V for all other appliances. Partial units are within the scope of this International Standard.

ISO 817: Refrigerants — Designation and safety classification

Provides an unambiguous system for assigning designations to refrigerants. It also establishes a system for assigning a safety classification to refrigerants based on toxicity and flammability data, and provides a means of determining the refrigerant concentration limit toxicity and flammability data, and provides a means of determining the refrigerant concentration limit.

ISO 5149: Refrigerating Systems and Heat Pumps – Safety and Environmental Requirements

This 4 part international standard:

- Part 1: Definitions, classification and selection criteria
- Part 2: Design, construction, testing, marking and documentation
- Part 3: Installation site
- Part 4: Operation, maintenance, repair and recovery

5.11 Australian Standards

Always refer to the latest current Standard and any Amendments

AS/NZS 60335.2.40 Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

The objective of this Standard is to provide manufacturers, designers, regulatory authorities, testing laboratories and similar organizations with safety requirements designed to give the user protection against hazards that might occur during normal operation and abnormal operation of the appliance and which may be used as the basis for approval for sale or for connection to the electricity supply mains in Australia and New Zealand. Annex GG applies where flammable refrigerants are used in the appliance.

AS/NZS ISO 817: Refrigerants — Designation and safety classification

This Standard replaces AS/NZS 1677.1:1998 Refrigerating Systems, Part 1: Refrigerant Classification. It is identical with, and has been reproduced from ISO 817:2014, Refrigerants - Designation and safety classification. It provides an unambiguous system for assigning designations to refrigerants. It also establishes a system for assigning a safety classification to refrigerants based on toxicity and flammability data, and provides a means of determining the refrigerant concentration limit. This Standard is to be read in conjunction with the relevant legislation, regulation and national Refrigeration Industry Codes of Practice.

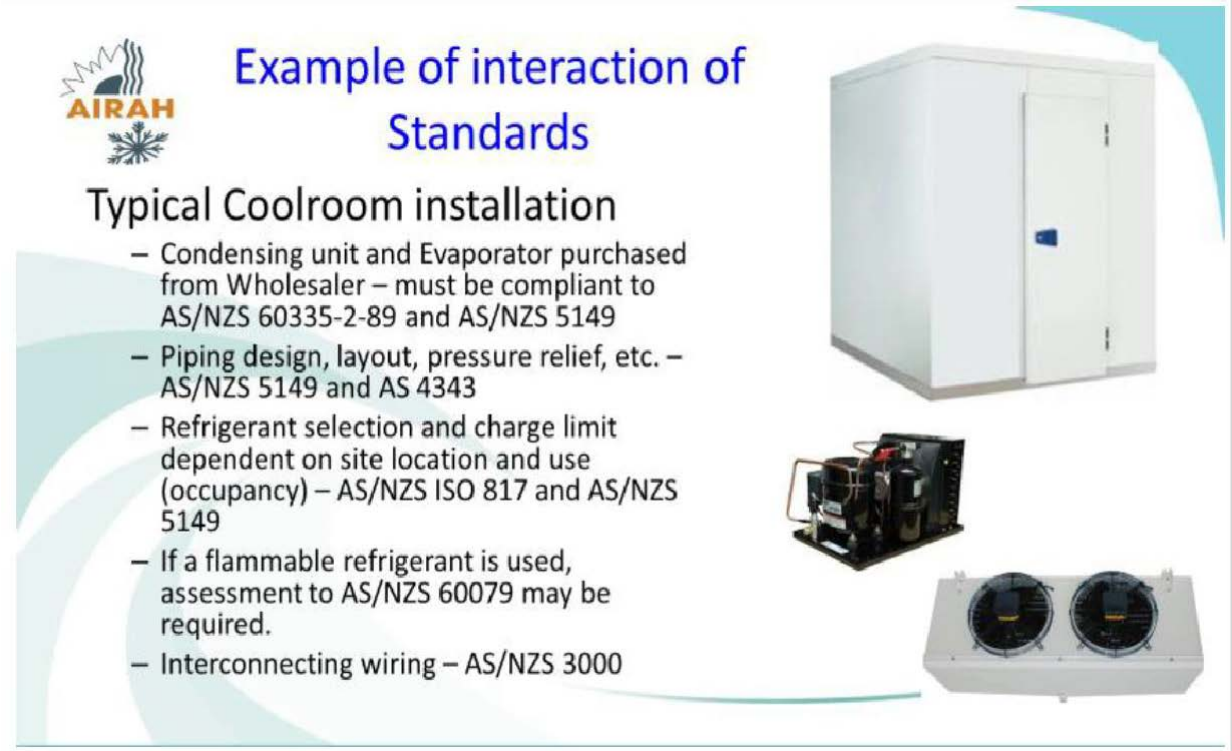
AS/NZS 5149: Refrigerating Systems and Heat Pumps – Safety and Environmental Requirements

This 4 part standard replaces AS/NZS 1677 2. Refrigerating Systems - Part 2 Safety Requirements for Fixed Applications. It is based on the International Standard (ISO 5149) with modifications to account for Australian/New Zealand conditions :

- Part 1: Definitions, classification and selection criteria
- Part 2: Design, construction, testing, marking and documentation
- Part 3: Installation site
- Part 4: Operation, maintenance, repair and recovery

Allowable charge limits for room, split, multi-split and VRF air conditioners using flammable refrigerants are defined in AS/NZS 60335.2.40, so AS/NZS 5149 Annex A and Clause A.5 is not applicable to those appliances. When installing air conditioners and heat pumps in compliance with AS/NZS 60335.2.40 it is that standard’s rules and procedures that must be followed, not AS/NZS 5149.

Any room, split, multi-split and VRF split system air conditioner installed in Australia must comply with the requirements of AS/NZS 60335.2.40 and AS/NZS 5149. Where any contradiction between the two standards exists, AS/NZS 60335.2.40 will take precedence.



Typical interaction of standards - installation of a coolroom

AS 1940 The storage and handling of flammable and combustible liquids

This Standard deals with combustible liquids that have been placed in class 3 of the ADG list. It does not deal with class 2 or 2.1 refrigerants so has no application.

AS 2030.1 Gas cylinders - General Requirements

This standard specifies the requirements for the design, verification and manufacture of all gas cylinders for the storage and transport of compressed, dissolved and liquefied gases, of water capacity ranging from 0.1 kg to 3000 kg. It also provides safe fill ratios for various gases.

AS 2030.5 Gas cylinders, Part 5: Filling, inspection and testing of refillable cylinders

Specifies requirements for the filling, inspection and testing of refillable gas cylinders for the storage and transport of compressed and liquefied gases, of water capacity ranging from 0.1 kg to 3000 kg.

AS 2931 Selection and use of emergency procedure guides for the transport of dangerous goods

The purpose of this Standard is to enable prospective users of EPGs (Emergency Procedure Guides) to select and use the correct EPG for the type of dangerous goods cargo. It is intended as a guide, stemming from *AS 1678 Emergency Procedure Guides* and the *ADG Code*.

AS 4211.3 Gas recovery or combined recovery and recycling equipment

This Standard is pending revision and is Part 3 in a series of Standards which provide minimum equipment requirements for recovery or combined recovery and recycling equipment. The objective of this Part is to provide manufacturers of recovery or combined

recovery and recycling equipment to be used on commercial and domestic systems with minimum equipment requirements. Test methods to determine equipment performance are also included.

AS 4332 The storage and handling of gases in cylinders

This Standard sets out requirements and recommendations for the safe storage and handling, in cylinders, of all gases that are classified as Class 2 (i.e. 2.1, 2.2, 2.3) substances in the ADG Code (i.e. gases that are compressed, liquefied or dissolved under pressure, including refrigerated liquefied gases, mixtures of one or more gases with vapours or liquids of substances of other classes, articles charged with a gas and aerosols having a capacity of greater than 1L) Its contents are discussed further in the last chapter of this manual (Cylinders and Storage).

AS 4484 Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding (as amended)

This Standard specifies the legible identification of the cylinder with the name or abbreviated symbol or, where applicable, the refrigerant number of the contained gas and specified colours for the external cylinder surfaces. It is referenced by the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995

AS/NZS 60079 Explosive Atmospheres

The objective of this series of standards is to set out the requirements for the design, selection and erection of electrical installations in hazardous areas associated with explosive atmospheres. These requirements are in addition to the requirements for electrical installations in nonhazardous areas.
Examples of relevant Standards is this series:

- AS/NZS 60079.0 Equipment – General requirements
- AS/NZS 60079.1 Equipment protection by flameproof enclosures ‘d’
- AS/NZS 60079.10.1 Classification of Areas – Explosive gas atmospheres
- AS/NZS 60079.11 Equipment protection by intrinsic safety ‘i’
- AS/NZS 60079.12 Electrical Apparatus for Explosive Gas Atmospheres – Classification of mixtures of gases or vapours with air according to their maximum experimental safe gaps and minimum igniting currents
- AS/NZS 60079.14 Design selection, erection and initial inspection
- AS/NZS 60079.15 Explosive Atmospheres – Equipment protection by type of protection ‘n’
- AS/NZS 60079.17 Electrical Installations inspection and maintenance
- AS/NZS 60079.29.1 Gas detectors — Performance requirements of detectors for flammable gases

AS/NZS 60335.2 Household and Similar Electrical Appliances – Safety

The objective of this series of Standards is to provide manufacturers, designers, regulatory authorities, testing laboratories and similar organizations with safety requirements designed to give the user protection against hazards that might occur during normal operation and abnormal operation of the appliance and which may be used as the basis for approval for sale or for connection to the electricity supply mains in Australia and New Zealand. Examples of relevant Standards is this series:

- **AS/NZS 60335.1:** Household and similar electrical appliances — Safety, Part 1: General requirements
- **AS/NZS 60335.2.24** Particular requirements for refrigerating appliances, ice cream appliances and ice makers
- **AS/NZS 60335.2.34** Particular requirements for motor compressors
- **AS/NZS 60335.2.40** Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
- **AS/NZS 60335.2.75** Particular requirements for commercial dispensing appliances and vending machines
- **AS/NZS 60335.2.89** Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or motor-compressor

5.12 AIRAH Flammable Refrigerants Safety Guide

This free online guide is designed to improve awareness of how to best manage the health and safety risks associated with the use and management of flammable refrigerants in stationary refrigeration and air conditioning equipment.

- Register online to gain access to the resource – available for desktop, mobile and tablet devices
- Watch the eight module videos at your own pace and to your own schedule
- Use the assessment feature to test your understanding
- Download all of the Flammable Refrigerant Safety Guide resources including the 2018 update

It is free to access at:
https://www.airah.org.au/Web/Resources/Technical_Resources/Flammable_Refrigerants_Safety_Guide/AIRAH/Navigation/Resources/Flammable_Refrigerants_Safety_Guide/Flammable_Refrigerants_Safety_Guide.aspx?hkey=be013b97-33ae-45a2-95f6-59303d6803ac

AIRAH also has available an R32 Common Questions fact sheet, which was prepared by the Air-conditioning and Refrigeration Equipment Manufacturers Association of Australia (AREMA) and the Consumer Electronics Supplier Association (CESA) as a service to the air conditioning industry, the general public and other stakeholders who have an interest in technologies to reduce the environmental impact of air conditioning appliances. It is available at: https://www.airah.org.au/Content_Files/TechnicalPublications/R32-Common-Questions-Sept-2014.pdf

5.13 Toxicity and Flammability Groupings for A2/A2L Refrigerants

AS/NZS ISO 817:2016 Refrigerants — Designation and safety classification, in section 6.1.3 Flammability classification puts refrigerants into the following **flammability** Classes as follows:

6.1.3.2 Class 1 (no flame propagation)

Single compound refrigerants or refrigerant blends WCF and WCFF that do not exhibit flame propagation when tested in air at 60 °C and 101,3 kPa.

6.1.3.3 Class 2L (lower flammability)

Single compound refrigerants or refrigerant blends (WCF and WCFF) that meet all of the following conditions:

a) exhibit flame propagation when tested at 60 °C and 101,3 kPa,

b) have a LFL > 3,5 % by volume (see 6.1.3.6 if the refrigerant has no LFL at 23 °C and 101,3 kPa.),

c) have a heat of combustion < 19 000 kJ/kg (see 6.1.3.7), and.

d) have a maximum burning velocity of ≤ 10 cm/s when tested at 23 °C and 101,3 kPa.

6.1.3.4 Class 2 (flammable)

Single compound refrigerants or refrigerant blends (WCF and WCFF) that meet all of the following conditions:

a) exhibit flame propagation when tested at 60 °C and 101,3 kPa,

b) have a LFL > 3,5 % by volume (see 6.1.3.6 if the refrigerant has no LFL at 23 °C and 101,3 kPa.), and

c) have a heat of combustion < 19 000 kJ/kg (see 6.1.3.7).

6.1.3.5 Class 3 (higher flammability)

Single compound refrigerants or refrigerant blend WCF and WCFF that meet the following conditions:

a) exhibit flame propagation when tested at 60°C and 101,3 kPa and

b) have a LFL ≤ 3,5 % by volume (see 6.1.3.6 if the refrigerant has no LFL at 23°C and 101,3 kPa); or have a heat of combustion that is ≥ 19 000 kJ/kg.

Both R32 and R1234yf are Class 2L refrigerants because:

- R32's LFL is 14.4%, HFL is 29% and max. burning velocity is 6.7cm/s
- R1234yf's LFL is 6.2%, HFL is 12.3% and max. burning velocity is 1.5cm/s

It further states in section 6.1.2 Toxicity Classification that:

Refrigerants shall be assigned to one of two classes, A or B, based on allowable exposure:

— class A (lower chronic toxicity) signifies refrigerants that have an occupational exposure limit of 400 ppm[1)] or greater;

— class B (higher chronic toxicity) signifies refrigerants that have an occupational exposure limit of less than 400 ppm.

Both R32 and R1234yf are Class A refrigerants because:

- R32 has an acute-toxicity exposure limit (ATEL) of 222,000
- R1234yf has an acute-toxicity exposure limit (ATEL) of 100,000

These two groups were joined to form the following table:

	Safety group	
Higher Flammability	A3	B3
Flammable	A2	B2
Lower flammability	A2L	B2L
No flame Propagation	A1	B1
	Lower Toxicity	Higher Toxicity

Therefore:

- The common synthetics such as R134a, R22, R404A and R410A are all in Class A1.
- R32 and R1234yf are Class A2L refrigerants, which means they have a lower flammability and lower toxicity.
- All hydrocarbon refrigerants fall into the safety group Class A3. They are highly flammable but not toxic.

5.14 Classifications

AS/NZS 5149.1: 2016 Refrigerating Systems and Heat Pumps – Safety and Environmental Requirements, Part 1: Definitions, Classification and Selection Criteria, contains following Clauses and Tables for:

- **5.1 Occupancy classification**

For the purpose of this International Standard, occupancy classification shall be determined according to Table 1.

Machinery rooms shall not be considered as an occupied space except as defined in ISO 5149-3:2014, 5.1.

Table 1 — Categories of occupancy

Categories	General characteristics	Examples[a]
General occupancy a	Rooms, parts of buildings, building where — sleeping facilities are provided, — people are restricted in their movement, — an uncontrolled number of people are present, or — to which any person has access without being personally acquainted with the necessary safety precautions.	Hospitals, courts or prisons, theatres, supermarkets, schools, lecture halls, public transport termini, hotels, dwellings, and restaurants
Supervised occupancy b	Rooms, parts of buildings, buildings where only a limited number of people can be assembled, some being necessarily acquainted with the general safety precautions of the establishment.	Business or professional offices, laboratories, places for general manufacturing, and where people work
Authorized occupancy c	Rooms, parts of buildings, buildings where only authorized persons have access, who are acquainted with general and special safety precautions of the establishment and where manufacturing, processing, or storage of material or products take place.	Manufacturing facilities, e.g. for chemicals, food, beverage, ice, ice-cream, refineries, cold stores, dairies, abattoirs, and non-public areas in supermarkets

[a] The list of examples is not exhaustive.

As an example, a high wall split or ducted air conditioning system for a home would fall into the General Occupancy (a) category, whereas a corner shop or milk bar would fall under Supervised Occupancy (b) category. Abattoirs, where members of the public would not normally be present, would sit in the Authorized Occupancy (c) category.

5.2 Systems classification

5.2.1 General

Refrigerating systems are classified according to

— the method of extracting heat from the atmosphere (cooling),

— the method of adding heat to the atmosphere (heating),

— the substance to be treated, or

— the refrigerant leak entering the occupied space.

5.2.2 Direct releasable system, are divided into the following types:

- 5.2.2.1 Direct system
- 5.2.2.2 Open spray system
- 5.2.2.3 Direct ducted system
- 5.2.2.4 Open vented spray system

5.2.3 Indirect systems are divided into the following types:

- 5.2.3.1 Indirect closed system
- 5.2.3.2 Indirect vented system
- 5.2.3.3 Indirect vented closed system
- 5.2.3.4 Double indirect system
- 5.2.3.5 High-pressure indirect system

As examples,

- high wall split air conditioner would be a Direct System because the indoor unit is located within the occupied space
- a direct ducted air conditioning system would also be a Direct Ducted System because the conditioned air is in direct contact with the refrigerant containing heating/cooling coil.

5.3 Location classification of refrigerating systems

5.3.1 General

Charge limit requirements for refrigerating systems shall be calculated in accordance with the location class, as specified in 5.3.2 to 5.3.5, and the toxicity and/or the flammability of the refrigerant as specified in Annex A.

5.3.2 Class IV: ventilated enclosures

If all refrigerant-containing parts are located in the ventilated enclosures, then the requirements for a class IV location shall apply. The ventilated enclosures shall fulfil the requirements of ISO 5149-2 and ISO 5149-3.

5.3.3 Class III: machinery room or open air

If all refrigerant-containing parts are located in a machinery room or open air, then the requirements for a class III location shall apply. The machinery room shall fulfil the requirements of ISO 5149-3.

EXAMPLE Water-cooled chiller.

5.3.4 Class II: compressors in machinery room or open air

If all compressors and pressure vessels are either located in a machinery room or in the open air, then the requirements for a class II location shall apply unless the system complies with the requirements of 5.3.3. Coil-type heat exchangers and pipework, including valves, can be located in an occupied space.

EXAMPLE Cold store.

5.3.5 Class I: mechanical equipment located within the occupied space

If the refrigerating system or refrigerant-containing parts are located in the occupied space, then the system is considered to be of class I unless the system complies with the requirements of 5.3.4.

5.4 Refrigerant classification

The refrigerant classification according to ISO 817:2014 shall be applied.

As examples,

- high wall split air conditioner would be a Class 1 location because the indoor unit is located within the occupied space
- a direct ducted air conditioning system would be a Class 1 location because the refrigerant in the fan coil unit would leak into the occupied space through the ductwork.

5.15 Limitations on the Charge of A2/A2L Refrigerants

The maximum charge of refrigerant allowed in any specific application is calculated in accordance with the procedures of the applicable design standard. There are the following a refrigerating system safety standard and an electrical safety appliance standard and it is important to know which standard to apply:

- Annex GG of *AS/NZS 60335.2.40 Household and similar electrical appliances - Safety Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers for appliances,* for air conditioning for household and similar use; and
- Annex A of AS/NZS 5149.1 Refrigerating systems and heat pumps – Safety and environmental requirements Part 1 Definitions, classification and selection criteria, for all other refrigerating and air conditioning systems.

This maximum quantity refers to the largest charge of refrigerant, that can be released into an occupied space, from any single refrigerating system. Each separate system or independent refrigerant circuit is considered separately. Simultaneous failure of multiple systems is not a safety criterion that is considered.

Under AS/NZS 5149.1, maximum refrigerant quantities cannot be calculated for appliances already covered by IEC or ISO product standards that specify refrigerant quantity limits. For example, allowable charge limits for room, split, multi-split and VRF air conditioners using flammable refrigerants are defined in AS/NZS 60335.2.40, so AS/NZS 5149 Annex A and Clause A.5 is not applicable to those appliances.

When installing air conditioners and heat pumps in compliance with AS/NZS 60335.2.40 it is that standard’s rules and procedures that must be followed, not AS/NZS 5149.

Any room, split, multi-split and VRF split system air conditioner installed in Australia must comply with the requirements of AS/NZS 60335.2.40 and AS/NZS 5149. Where any contradiction between the two standards exists, AS/NZS 60335.2.40 will take precedence. Where AS/NZS 60335.2.40 does not apply, then AS/NZS 5149.1 must be applied.

AS/NZS 5149.1: 2016 Refrigerating Systems and Heat Pumps – Safety and Environmental Requirements, Part 1: Definitions, Classification and Selection Criteria, contains following relevant Clauses and Tables:

6 Quantity of refrigerant per occupied space

6.1 The amount of a refrigerant charge that could enter into the occupied space shall be determined as follows.

— For occupied spaces, the refrigerant quantity shall not exceed the amounts specified in Tables A.1 and A.2.

— The refrigerant quantity is the quantity that can be released in an occupied space, and shall be the largest charge of any single refrigerating system, unless otherwise specified in this International Standard.

6.2 Where IEC or ISO product standards exist for particular types of systems and where these product standards refer to refrigerant quantities limits, such quantities shall overrule the requirements of this part of ISO 5149.

AS/NZS 5149.1: 2016 Annex A Location of Refrigerating Systems, contains the sections: A1 General

A.2 Charge limit requirements for refrigerating systems

Refrigerant charge limits shall be calculated according to Tables A.1 and A.2, depending on the toxicity and/or the flammability of the refrigerant.

The following method shall be applied to determine the charge limit of a refrigerating system.

1) Define which occupancy category (a, b, or c, according to 5.1) applies and which location class (I, II, III, or IV, according to 5.3) the system is used in.

2) Define the toxicity class of the refrigerant (A or B, according to Tables B.1 and B.2) used in the refrigerating system. The toxicity limit equals ATEL/ODL values or practical limits whichever is higher. Where dual classification exists, the more restrictive classification is used.

3) Determine the charge limit for the refrigerating system based on Table A.1.

4) Define the flammability class of the refrigerant (1, 2L, 2, 3, etc., according to Tables B.1 and B.2) used in the refrigerating system and the corresponding LFL. Where dual classification exists, the more restrictive classification is used.

5) Determine the charge limit for the refrigerating system based on Table A.2.

6) The lowest refrigerant charge obtained according to 3) and 5) is applied. For determination of charge limits for refrigerants of flammability class 1, 5) can be omitted.

The charge limits in Table A.2 are capped to a limit based upon the LFL of the refrigerant. In the case of flammability class 2 or 3 refrigerants, the basic cap factor is m_1, m_2, and m_3. For flammability class 2L refrigerants, the basic cap factor is increased by a factor of 1,5 in recognition of the lower burning velocity of these refrigerants, which lead to a reduced risk of ignition and impact. The cap factor used in

Table A.2 can be increased where occupants are familiar with the safety requirements for the building (for example, occupancy class b or c), or where risk of leakage is reduced.

The cap factors given in Table A.2 shall be calculated as follows:

$$m_1 = 4\text{m}^3 \times \text{LFL} \quad \text{(A.1)}$$

$$m_2 = 26\text{m}^3 \times \text{LFL} \quad \text{(A.2)}$$

$$m_3 = 130\text{m}^3 \times \text{LFL} \quad \text{(A.3)}$$

where LFL equals the lower flammable limit in kg/m3 according to Annex B.

NOTE The cap factor of 26 is based on a charge of 1 kg of R-290.

For refrigerants of flammability class 2L, there are no room volume restrictions for refrigerant charges below or equal to m_1 × 1,5. For refrigerants of flammability classes 2 and 3, there are no room volume restrictions for refrigerant charges below or equal to m_1.

A copy of Table A.2 for A2 and A2L refrigerants from AS/NZS 5149.1: 2016 Appendix ZZ is on the following page.

For example, for a split air conditioning systems in an Occupancy Category (a) General Occupancy – Human Comfort in location classification of:

- I Mechanical equipment located within occupied space
  The charge limit must be “According to A.4 and not more than m_2^a x 1.5”
- II Compressor in machine room or open air
  The charge limit must be “According to A.4 and not more than m_2^a x 1.5 or according to A.5 and not more than m_3^b x 1.5”
- III Machinery room or open air:
  “No charge restriction”
- IV Ventilated enclosures:
  The charge limit must be “Refrigerant charge not more than m_3^b x 1.5”

Some common flammable refrigerants are heavier than air and can tend to pool at floor level. This means that even with charge restrictions of 20 per cent of the LFL, flammable zones can still exist in poorly ventilated rooms. This is of special concern for installations which are occupied by sleeping or incapacitated people such as in bedrooms, nursing homes etc. For this reason, extra conditions on allowable charge limits are applied to air-conditioners and heat pumps classified for use as for ‘Human Comfort’. AS/NZS 5149.1 introduces the concept of a “Charge Cap Factor” based on the LFL for;

- Class A2L refrigerants there are no room volume restrictions for charges below or equal to m1 × 1.5, for example: R32 $m_1 = 4m^3$ x 0.307 (LFL) x 1.5 = 1.842kg
- Class A2/A3 refrigerants there are no room volume restrictions for charges below m1, for example: R600 $m_1 = 4m^3$ x 0.038 (LFL) = 0.152kg or 152g

Where design charge limits for A2L refrigerants are exceeded in a space, then the system can still comply if special provisions are made within the system to ensure at least an equivalent level of safety is achieved. These special provisions are detailed in paragraph A5 of annex A where the allowable refrigerant charge can be increased using QLMV (Quantity Limit with Minimum Ventilation) or QLAV (Quantity Limit with Additional Ventilation). Special provisions can include natural or mechanical ventilation, safety shut-off valving, and safety alarms used in conjunction with refrigerant gas detection.

TABLE A.2

CHARGE LIMIT REQUIREMENTS FOR REFRIGERATING SYSTEMS BASED ON FLAMMABILITY

Flammability class	Occupancy category			Location classification			
				I	II	III	IV
2L	a	Human comfort		According to A.4 and not more than m_2[a] × 1.5	According to A.4 and not more than m_2[a] × 1.5 or according to A.5 and not more than m_3[b] × 1.5	No charge restriction[c]	Refrigerant charge not more than m_3[b] × 1.5
		Other applications		20 % × LFL × Room volume and not more than m_2[a] × 1.5	20 % × LFL × Room volume and not more than m_2[a] × 1.5 or according to A.5 and not more than m_3[b] × 1.5		
	b	Human comfort		According to A.4 and not more than m_2[a] × 1.5	According to A.4 and not more than m_2[a] × 1.5 or according to A.5 and not more than m_3[b] × 1.5		
		Other applications		20 % × LFL × Room volume and not more than m_2[a] × 1.5	20 % × LFL × Room volume and not more than 25 kg[c] or according to A.5 and not more than m_3[b] × 1.5		
	c	Human comfort		According to A.4 and not more than m_2[a] × 1.5	According to A.4 and not more than m_2[a] × 1.5 or according to A.5 and not more than m_3[b] × 1.5		
		Other applications		20 % × LFL × Room volume and not more than m_2[a] × 1.5	20 % × LFL × Room volume and not more than 25 kg[c] or according to A.5 and not more than m_3[b] × 1.5		
		<1 person per 10 m²		20 % × LFL × Room volume and not more than 50 kg[a]	No charge restriction[c]		
2	a	Human comfort		According to A.4 and not more than m_2[a]		No charge restriction[c]	Refrigerant charge not more than m_3[b]
		Other applications		20 % × LFL × Room volume and not more than m_2[a]			
	b	Human comfort		According to A.4 and not more than m_2[a]			
		Other applications		20 % × LFL × Room volume and not more than m_2[a]			
	c	Human comfort		According to A.4 and not more than m_2[a]			
		Other applications	Below ground	20 % × LFL × Room volume and not more than m_2[a]			
			Above ground	20 % × LFL × Room volume and not more than 10 kg[c]	20 % × LFL × Room volume and not more than 25 kg[c]		

[a] $m_2 = 26\ m^3 \times LFL$.

[b] $m_3 = 130\ m^3 \times LFL$.

[c] ISO 5149-3:—, 5.2 and 8.1 applies.

A.4 Charge limitations due to flammability for A/C systems or heat pumps for human comfort: refrigerant-containing parts in an occupied space

When the charge of refrigerants with flammability class 2L is greater than $m_1 \times 1{,}5$, the charge in the room shall be in accordance with Formula (A.4). When the maximum charge of refrigerants with flammability classes 2 and 3 is greater than m_1, the charge in the room shall be in accordance with Formula (A.4).

$$m_{max} = 2{,}5 \times \mathrm{LFL}^{5/4} \times h_0 \times A^{1/2} \qquad \text{(A.4)}$$

where

m_{max} is the allowable maximum charge in a room, expressed in kilograms;

m is the refrigerant charge amount in the system, expressed in kilograms;

A_{min} is the required minimum room area, expressed in square metres;

A is the room area, expressed in square metres;

LFL is the Lower Flammability Limit, expressed in kilograms per cubic metre;

h_0 is the height factor based upon the method of mounting the appliance.

NOTE For guidance, the following height can be considered:

— 0,6 m for floor location;

— 1,0 m for window mounted;

— 1,8 m for wall mounted;

— 2,2 m for ceiling mounted.

If Formula (A.4) produces the larger value, the required minimum floor area A_{min}, in square metres, to install a system with refrigerant charge m, in kilograms, shall be in accordance with Formula A.5:

$$A_{min} = \left(\frac{m}{2{,}5 \times \mathrm{LFL}^{5/4} \times h_0} \right)^2 \qquad \text{(A.5)}$$

where LFL is expressed in kilograms per cubic metre (see Annex B) and the relative molar mass of the refrigerant is greater than 42.

A.5 Alternative for risk management of refrigerating systems in occupied spaces

A.5.1 General

Where the combination of location classification and occupancy classification shown in Tables A.1 and A.2 allow the use of the alternative provisions, then the designer can choose (for some or all of the occupied spaces served by the equipment) to calculate the allowable refrigerant charge using the RCL, QLMV, or QLAV values given in A.5.2 instead of the practical limit values given in Tables B.1 and B.2. All occupied spaces, where refrigerant-containing parts are located, shall be considered in calculating the system charge.

Example:

1. A RAC technician would like to install an R32 wall mounted air conditioner in a $30m^2$ room, but must determine the maximum refrigerant charge permitted.

   Formula: $m_{max} = 2.5 \times LFL^{5/4} \times ho \times A^{1/2}$

   $= 2.5 \times 0.307^{1.25} \times 1.8 \times 30^{0.5}$

   $= 5.63$ kg

   Plus check this amount is not more than $m_{2^a} \times 1.5$

   $= 26m^3 \times 0.307$ LFL $\times 1.5$

   $= 11.97$ kg

   Therefore, the Maximum Charge = 5.63 kg

2. R32 wall mounted air conditioner has a refrigerant charge of 5.63kg, What is the minimum size enclosed space that it can be installed in?

   Formula: $Amin = \dfrac{m}{2.5 \times LFL^{5/4} \times ho}^{2}$

   Formula: $Amin = \dfrac{5.63kg}{2.5 \times 0.307^{1.25} \times 1.8}^{2}$

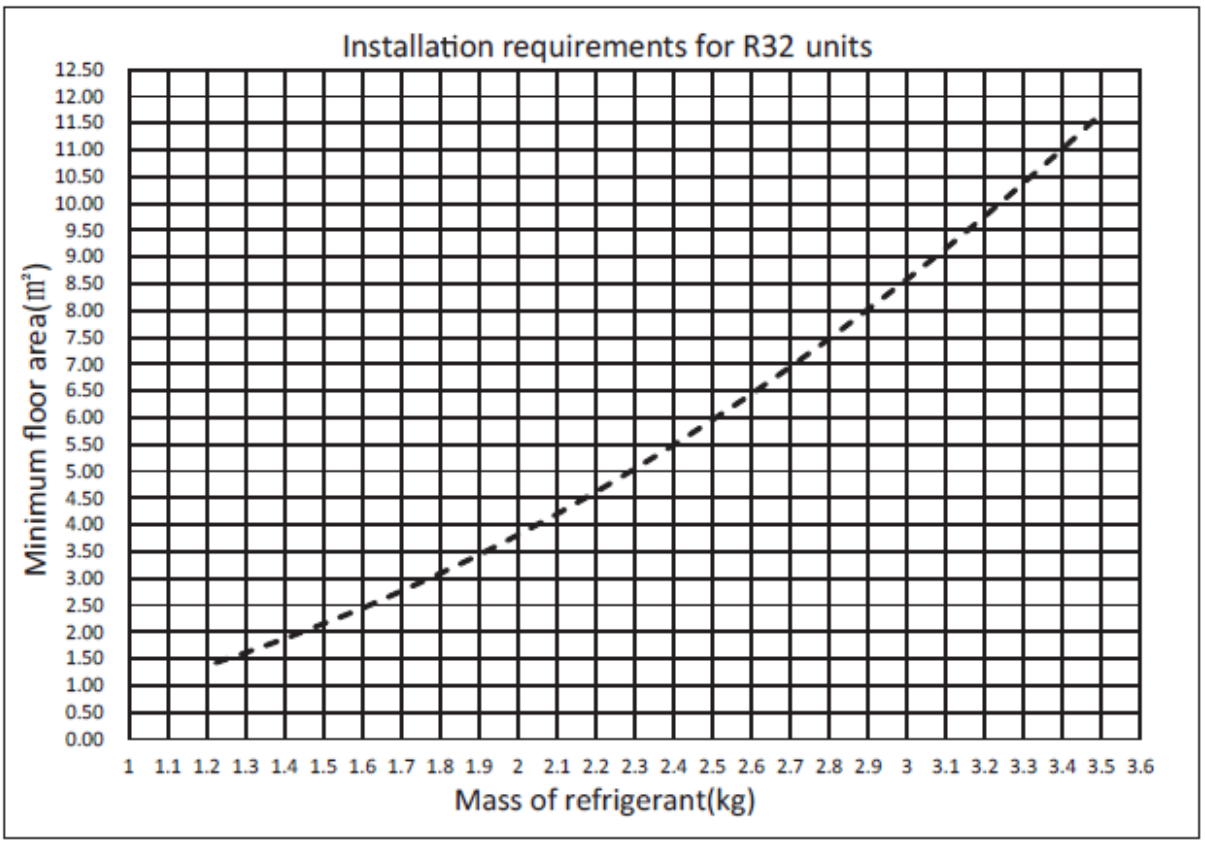
   $= \dfrac{5.63}{1.02833}^{2} = 29.97m^2$

However, it should be noted that the room volume calculation must only consider the 'free' volume of a room. Any substantial volume taken up by fixtures, fittings, equipment or stored produce is not included in the calculation.

There are simpler methods that can also be used:

1. The **United Nations: Good Servicing Practices for Flammable Refrigerants App.** This user-friendly application includes safe handling practices, a refrigerant charge size calculator and a room size calculator for flammable refrigerants including R32 based on ISO 5149. More details are available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/27136/8017Smartapp2.pdf?sequence=1&isAllowed=y

2. Manufacturers Tables and Graphs which specifies the minimum floor area (m^2) for a system's R32 refrigerant charge based the installation height of indoor unit.
   For example, the Table and Graph below and in Appendix N from Hitachi, specifies that the minimum floor area is 3.81 m^2 for a split air conditioning system's R32 refrigerant charge of 2kg, based on the installation height of 1.8m for a wall-mounted unit.



Minimum floor area for equipment installed inside			
m(kg)	A_{min}(m²)	m(kg)	A_{min}(m²)
1.224	-	2.4	5.49
1.225	1.43	2.5	5.96
1.3	1.61	2.6	6.44
1.4	1.87	2.7	6.95
1.5	2.15	2.8	7.47
1.6	2.44	2.9	8.02
1.7	2.76	3.0	8.58
1.8	3.09	3.1	9.16
1.9	3.44	3.2	9.76
2.0	3.81	3.3	10.38
2.1	4.20	3.4	11.02
2.2	4.61	3.5	11.68
2.3	5.04	3.6	12.36

For more information refer to AIRAH's Flammable Refrigerant Safety Guide – 2018 Update – Module 4: Design Rules for flammable refrigerants for more information and examples, available at:
https://www.airah.org.au/Web/Resources/Technical_Resources/Flammable_Refrigerants_Safety_Guide/AIRAH/Navigation/Resources/Flammable_Refrigerants_Safety_Guide/Flammable_Refrigerants_Safety_Guide.aspx?hkey=be013b97-33ae-45a2-95f6-59303d6803ac

5.16 Section Summary

- Acts and Regulations are legal documents produced by federal and state governments to protect the individual members of their societies.
- Codes, Standards and Guides are documents produced by interested parties to provide a clearer explanation of a Regulation (or Act) and to offer examples in its application.
- Codes and standards may become legal documents if referenced by an Act or Regulation.
- 'Duty of care' is a legal term that is used to entreat every citizen within a society to accept and execute their moral duty to anticipate possible causes of injury and illness to their fellow citizens and remove or minimise these causes whenever reasonably possible.
- Every individual within an organisation is responsible for everyone else's health and safety and it cannot be delegated
- The storage, handling, use or application of some A2/A2L refrigerants, for example R32 are within the scope of the Ozone Protection Act, its associated Regulation and COP's, but R1234yf is NOT
- Regardless of the licensing provisions, employers have a duty of care to ensure that their workers are appropriately trained and have the necessary equipment to use A2/A2L refrigerants.
- For additional occupational and work health and
- safety licensing requirements, check with the relevant
- state-based licensing authorities.
- The ADG Code identifies all A2/A2L refrigerants as Class 2.1 Flammable gases.
- Every state and territory within Australia have (or will be), adopting the National WHS Act and Regulations.
- People working in Queensland must apply for an authorisation (permit) to sell, repair, maintain and service appliances containing a hydrocarbon refrigerant, but not A2/A2L refrigerants
- The following International Standards were released in 2014
    - ISO 817:2014 Refrigerants — Designation and safety classification
    - *ISO 5149 - Refrigerating Systems and Heat Pumps – Safety and Environmental Requirements*,
- The relevant Australian Standards:
    - AS/NZS 60335.2.40 Household and similar electrical appliances - Safety Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers for appliances, for air conditioning for household and similar use
    - AS/NZS/ISO 817 Refrigerants — Designation and safety classification
    - AS/NZS 5149 Refrigerating systems and heat pumps – Safety and environmental requirements, parts 1 to 4.

  These Standards set the requirements for the maximum refrigerant charge for an enclosed space and the minimum room size for a given refrigerant charge.

5.17 Review Questions

Question 1

Which of the following A2L refrigerants are covered under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995?

a) R1234yf
b) R32
c) R1234ze
d) R143a

Question 2

What does safety group A2L mean?

a) Flammable and low toxicity
b) Lower flammability and low toxicity
c) Non-flammable and higher toxicity
d) **F**lammable and higher toxicity

Question 3

What is the safety group classification of all hydrocarbon refrigerants?

a) A2L
b) A2
c) A3
d) B2

Question 4

In which States/Territories is an authorisation (permit) required to sell, repair, maintain and service appliances containing a hydrocarbon refrigerant?

Question 5

What Class does the ADG Code identify the A2/A2L refrigerants as and what does it mean?

Question 6

Which current Australian/New Zealand standards replaced ASNZ1677?

a) EN378 and EN425
b) AS/NZS ISO 817 and
c) ISO 817 and AS/NZS 5149
d) AS/NZS 4125 and AS/NZS ISO 817

Question 7

What does the acronym “ADG7” stand for?

Question 8

What does the acronym GHS stand for?

Question 9

Under AS/NZS 5149.1, for A2L refrigerants there are no room volume restrictions for charges below or equal to:

a) $m_1 \times 1.5$

b) $m_2 \times 1.5$

c) m_1

d) $m_1 \times 2.5$

Question 10

Under AS/NZS 5149.1 where can a factory sealed refrigerating system with less than 0.15 kg of A2 or A3 refrigerant be located?

Question 11

A RAC technician would like to install an R32 wall mounted air conditioner in a $40m^2$ room, determine the maximum refrigerant charge permitted.

Question 12

R32 wall mounted air conditioner has a refrigerant charge of 4kg, Determine the minimum enclosed space that it can be installed in?

5.18 Your Notes

6. Emergency Procedures and Incident Management

Purpose

In this topic you will learn how to identify and deal with the major hazards peculiar to A2/A2L refrigerants.

Objectives

At the end of this topic you should be able to:

- Briefly describe the body known as 'Workcover' and identify their governing powers
- Identify the processes known as 'Hazard Control' and 'Risk Assessment'
- Describe the risks that may occur during an emergency situation
- Identify the actions that may be taken during an emergency situation
- Produce a typical emergency response plan for a given scenario or situation
- List the recommended PPE items to be worn while working with A2/A2L refrigerants

Contents

- WorkSafe
- A2/A2L refrigerants
- Hazard Control and Risk Assessment
- Typical emergency response plans

References

- RSES - Safety first when working with refrigerants
  https://www.rses.org/rsesjournal/safetyfirstwhenworkingwithrefrigerants.aspx
- SafeWork Australia, Hazardous Chemical Information System (HCIS)
  http://hcis.safeworkaustralia.gov.au/About
- SafeWork NSW: https://www.safework.nsw.gov.au/
  - Code of Practice on Managing Work Health and Safety Risks.
    https://www.safework.nsw.gov.au/__data/assets/pdf_file/0012/50070/How-to-manage-work-health-and-safety-risks-COP.pdf
  - Confined spaces
    https://www.safework.nsw.gov.au/hazards-a-z/confined-spaces
  - Flammable refrigerant gases position paper
    https://www.safework.nsw.gov.au/resource-library/hazardous-chemicals/flammable-refrigerant-gases-position-paper
  - Hazardous chemicals
    https://www.safework.nsw.gov.au/hazards-a-z/hazardous-chemical
  - Managing hazards and risks
    https://www.safework.nsw.gov.au/legal-obligations/employer-business-obligations/managing-hazards-and-risks

  Other States/Territories have similar documentation

6.1 WorkSafe

There is a WorkCover or SafeWork authority in every State/Territory to promote productive, healthy and safe workplaces for workers and employers.

Their main statutory function is to administer work health and safety, injury management, return to work and workers compensation laws and manage the workers compensation system.

They oversee:

- work health and safety
- licensing and registration of high risk activities
- workers compensation insurance
- workers compensation benefits
- sustainable return to employment for injured workers
- management of the Workers Compensation Insurance Fund.

6.2 Synthetic Class A1 Refrigerants

Fire and Explosion

Auto-ignition temperature	Approx. 730°C
Flammable limits	
Upper (UFL)	Not Applicable
Lower (LFL)	Not Applicable
Possible Decomposition products	Hydrogen Fluoride - becomes Hydrofluoric acid on contact with water Hydrogen Chloride - becomes Hydrochloric acid on contact with water Carbon Monoxide Chlorine
ADG Code classification	2.2 (non-flammable & non-toxic)
Exposure Limit	1000ppm or 4240mg/m^3 TWA

These gases may decompose on contact with flames or extremely hot surfaces (approx. 370°C), to produce highly toxic and corrosive by-products.
Some mixtures of HCFC's and/or HFC's and air may be combustible if pressurised and exposed to heat or flame.

Spill or Leak

- Evacuate any enclosed spaces or low areas such as cellars and pits
- Disperse gas with forced air ventilation at floor level
- Extinguish all sources of ignition (taking care not to create any new ignition sources as a direct result of your actions (e.g. arcing switch contacts when you isolate electrical motors etc.)
- Use halogen detector or other suitable means to locate leak source.
- Keep upwind of spills.
- Do not smoke or operate internal combustion engines
- Exhaust vapours to external atmosphere
- Contact Emergency Services if necessary

Personal Protection

- Glasses
- Skin protection including gloves (preferably leather)
- Positive pressure respirator in emergency situations
- Observe exposure limits

6.3 Class A2/A2L Refrigerants

Fire and Explosion

Auto-ignition temperature	From 370 to 650°C
Flammable limits	
Upper (UFL)	Up to 30%
Lower (LFL)	From 5%
Possible Decomposition products	Hydrogen Fluoride – becomes Hydrofluoric acid on contact with water Carbonyl halides
ADG Code classification	2.1 (Flammable gas)
Exposure Limit	n/a

These include HFC R32 and HFO's R1235yf, etc. that are slightly flammable and will break down into highly caustic hydrogen fluoride and carbonyl halides when exposed to flame, fire or sufficient heat.

These gases are slightly flammable. Keep away from open flame and sources of ignition. Do not smoke in storage areas or when handling.

Spill or Leak

- Evacuate all personnel paying particular attention to enclosed spaces or low areas such as cellars and pits
- Disperse gas with forced air ventilation at floor level (ensure flammable concentrations do not build up in low spots (pits) or drainage points in the floor)
- Extinguish all sources of ignition (taking care not to create any new ignition sources as a direct result of your actions (e.g. arcing switch contacts when you isolate electrical motors etc.)
- Use soapy water or similar to locate source of leak.
- Keep upwind of spills.
- Do not smoke or operate internal combustion engines
- Exhaust vapours to external atmosphere
- Contact Emergency Services if necessary

Personal Protection

- Glasses
- Skin protection including gloves (preferably leather)
- Positive pressure respirator in emergency situations

Flammable refrigerant gases position paper

This position paper was developed by the Heads of Workplace Safety Authorities (HWSA) and provides information on the use of flammable refrigerant gases at workplaces. A copy is included in Appendix I.

6.4 Risk assessment

Risk assessment is a systematic approach to analysis of what can go wrong in a complex system. It is a fundamental requirement of both National and State WH&S laws that a work place risk assessment and hazard analysis be carried out for each task in a workplace. For further information refer to your relevant see WorkCover or WorkSafe organisation.

Risk management approach

Risk management is the process of determining and implementing appropriate measures to control the risks associated with hazards and risks identified for a site.

Site owners, managers and workers all have a duty to ensure that any risks associated with their premises or work activities they are responsible for are controlled. The primary duty is to eliminate these risks. If this is not possible, the risk must be reduced as far as is practicable.

The risk management process involves the following steps:

- Establish the context – this helps to define the scope and identify key stakeholders
- Identify hazards – find out what could cause harm;
- Assess the hazards – understand the nature of the harm that could be caused by the hazard, identify the risk factors;
- Evaluate the risks – how serious the harm could be and the likelihood of it happening, can the risk be controlled (avoided, reduced or transferred);
- Control risks – implement the most effective control measure(s) that is reasonably practicable in the circumstances, and monitor performance;
- Review control measures to ensure they are working as planned.

Hazard assessment for flammable gas atmospheres should be in accordance with AS/NZS 60079.14 and AS/NZS 60079.10.1.

Standardised risk controls

To simplify and standardise the process of developing risk controls for refrigeration and air conditioning applications, refrigeration safety standards AS/NZS 5149 (parts 1 to 4) and appliance safety standard AS/NZS 60335.2.40 have been produced to provide a recipe for controlling risks associated with the application and use of flammable refrigerants.

The primary control measures applied in the standards are:

- Charge minimisation – to reduce the likelihood of a hazardous atmosphere developing
- Control of ignition sources – to reduce the consequence of a flammable gas leak
- Provision of ventilation - to reduce the likelihood of a hazardous atmosphere developing
- Refrigerant detection and alarm- to reduce the consequence of a flammable gas leak

Constructing an emergency plan:

- Ensure that sufficient space exists between walls, fixtures and other structures so as to allow access for maintenance and emergencies
- Ensure that a means of allowing refrigerant vapours to be directed to the outside atmosphere exits
- Ensure adequate water supplies exist
- Identify all suitable evacuation routes
- Nominate one or more suitable assembly points
- Ensure that you have provided sufficient and suitable protection for those personnel responding to the emergency
- Identify and clear one or more access routes for the emergency services
- Create one or more procedures to deal with containment of leaks and spills
- Make sure you have considered all of the potential hazard situations that may arise including Fire, Explosion, Natural disasters (earthquake or vehicle collision etc.) and Chemical reactions on release of dangerous goods
- Ensure your plan is appropriate to the size and complexity of your Installation, Resources and Personnel
- Perform regular reviews and update your plan as necessary
- Ensure all Personnel are familiar with the contents of the emergency plan and trained where necessary to cope with each situation that you have identified

General A2/A2L Refrigerant Safety

A2/A2L refrigerants have a Low Flammability, therefore care must be taken to ensure it is not ignited.

However, in many respects the safety issues for A2/A2L refrigerants are the same as for CFC, HCFC and HFC refrigerants

- Contact with liquid refrigerant will cause a "cold" burn (similar to frost bite) which should be treated by bathing the area with cold water. Medical attention is necessary.
- Gloves, safety glasses and clothes which cover the body should be worn when handling refrigerant, e.g., when charging refrigerant into a system or removing refrigerant charge from a system.
- A2/A2L refrigerants are heavier than air and so will collect in chest freezer / refrigerator cabinets, pits, trenches and basements. These areas should be ventilated to help get rid of the built up refrigerant.
- A2/A2L refrigerants will displace air and this can cause suffocation. The refrigerant is listed as an asphyxiant. If affected, a person should be removed to an uncontaminated area and kept warm and still. Artificial respiration or oxygen may be needed. Medical attention is necessary.
- Do not expect to detect leaking A2/A2L refrigerant by smell.

6.5 Section Summary

- WorkCover or WorkSafe administer and enforce compliance with Work Health and Safety (WHS) legislation in every State/Territory.
- The common synthetic Class A1 refrigerants have an auto ignition temperature of 730°C. It ranges from 370 to 650°C °C for Class A2/A2L refrigerants
- Highly Toxic and corrosive gases are produced when HCFC's, HFC's and HFO's decompose as a result of exposure to heat or flame.
- The synthetics have an exposure limit of 4.2 grams per 1000 litres of air.
- Recommended PPE requirements are the same for both refrigerant types: glasses, gloves and covered skin.
- Recommended Spill or leak procedures are virtually the same for both refrigerant types. A2/A2L refrigerants require higher ventilation rates.
- Direct bodily contact with all refrigerants in both the liquid and vapour states have the same result, that is asphyxiation and burns.
- Refrigerants will collect in low areas (e.g. drain lines) and can travel very long distances.
- The use of a A2/A2L refrigerant is a process that starts with the identification of possible hazards for a work activity. A risk matrix is then applied to determine the degree of risk associated with each hazard.
- Hazard control is the final step in the process. Methods or procedures are devised to control each hazard, starting with the ones carrying the highest degree of risk.
- These form the basis of your WH&S management plan.

6.6 Review Questions

Question 1

What is the purpose of WorkCover?

Question 2

What is the main safety hazard with A2/A2L refrigerants?

Question 3

List 5 actions required if there is A2/A2L refrigerant leak.

Question 4

List 4 items of PPE required when working with A2/A2L refrigerant

Question 5

What does direct bodily contact with A2/A2L refrigerant cause?

Question 6

What is the purpose of a Risk Assessment?

Question 7

What is a Job Safety Analysis?

Question 8

What is an Emergency Plan?

Question 9

What substances are produced when A2/A2L refrigerants are burnt?

Question 10

What substances are produced when HFC and HFO refrigerants are burnt?

6.7 Your Notes

7. First Aid for A2/A2L Exposure

Purpose

In this topic you will learn how to recognise and deal with the effects of exposure to Class A2/A2L refrigerants.

Objectives

At the end of this topic you should be able to:

- List the short term effects of contact with A2/A2L refrigerants
- List the long term effects of contact with A2/A2L refrigerants
- Identify the first aid issues/symptoms that result from swallowing, splashing or inhaling A2/A2L refrigerant
- Explain the DRSABCD method of dealing with an unconscious person

Content

- Introduction
- Acute exposure (Short Term)
- Chronic exposure (Long Term)
- First Aid issues
- DRSABCD

References

- DRSABCD Action Plan: https://www.stjohnnsw.com.au/cpr-chart/
- Frost Bite: https://www.stjohnnsw.com.au/guides-frost-bite

7.1 Introduction

A2/A2L refrigerants are HFC and HFO type refrigerants which have a low flammability and therefore care must be taken to ensure they are not ignited but apart from this, in all other aspects, the first aid issues for A2/A2L refrigerants are the same as for any of the synthetic Class A1 refrigerants (i.e. CFC's, HCFC's and HFC's)

7.2 Acute exposure (Short Term)

Cryogenic or frostbite "burns" may be experienced when handling A2/A2L refrigerants. Prolonged breathing of cold vapour may damage lung tissues. There are no other recorded short term effects.

7.3 Chronic exposure (Long Term)

Prolonged exposure to an oxygen deficient atmosphere (below18% oxygen) may affect the heart and the nervous system.

7.4 First Aid Issues

Swallowed: Liquid A2/A2L refrigerant may cause freezing injuries similar to burns to the mouth, oesophagus and stomach accompanied by a severe burning sensation. Vaporisation of the liquid in the organs of the abdomen will also generate excessive quantities of gas leading to extreme discomfort. Severe burning of tissue and eventually death may result. Symptoms include bleeding, vomiting, abdominal pain, diarrhoea and a fall in blood pressure. Cold A2/A2L refrigerant gas will cause severe irritation and burns to the gastrointestinal tract. Damage may appear days after exposure.

Eyes: The A2/A2L refrigerant gases are not irritating to the eyes. Liquid A2/A2L refrigerant will cause freezing of the eye. Permanent eye damage or blindness could result. Cold A2/A2L refrigerant gas will cause severe irritation and burns, leading to redness and pain in the eyes. Permanent eye damage or blindness may result.

If product comes in contact with eyes:

- Remove the patient from gas source or contaminated area.
- Take the patient to the nearest eye wash, shower or other source of clean water.
- Open the eyelid(s) wide to allow the material to evaporate.
- Gently rinse the affected eye(s) with clean, cool water for at least 15 minutes.
- Have the patent lie or sit down and tilt the head back.
- Hold the eyelid(s) open and pour water slowly over the eyeball(s) at the inner corners, letting the water run out of the outer corners.
- The patient may be in great pain and wish to keep the eyes closed. It is important that the material is rinsed from the eyes to prevent further damage.
- Ensure that the patent looks up, and side to side as the eye is rinsed in order to better reach all parts of the eye(s)
- Transport to hospital or doctor.
- Even when no pain persists and vision is good, a doctor should examine the eye as delayed damage may occur.
- If the patient cannot tolerate light, protect the eyes with a clean, loosely fitted bandage.
- Ensure verbal communication and physical contact with the patient.

- DO NOT allow the patient to rub the eyes
- DO NOT allow the patient to tightly shut the eyes
- DO NOT introduce oil or ointment into the eye(s) without medical advice
- DO NOT use hot or tepid water.

Skin: The A2/A2L refrigerant gases are not skin irritants. Liquid A2/A2L refrigerant will cause severe burns and necrosis. Symptoms of mild frostbite include numbness, prickling and itching of the affected area. Symptoms of more severe frostbite include a sensation of stiffness of the affected area. The skin may become waxy white or yellow. Blistering, tissue death and gangrene may also develop in severe cases. Cold gas will cause freezing injury similar to a burn, leading to irritation, redness, itching and blistering.
If skin contact occurs:

- Immediately remove all contaminated clothing, including footwear.
- Flush skin and hair with running water (and soap if available).
- Seek medical attention in event of irritation.
- In case of cold burns (frostbite):
    - Move casualty into warmth before thawing the affected part; if feet are affected carry if possible
    - Bathe the affected area immediately in lukewarm water (not more than 35 deg C) for 10 to 15 minutes, immersing if possible and without rubbing
    - DO NOT apply hot water or radiant heat.
- Apply a clean, dry, light dressing of "fluffed up" dry gauze bandage
- If a limb is involved, raise and support this to reduce swelling
- If an adult is involved and where intense pain occurs provide pain killers such as paracetamol
- Transport to hospital, or doctor
- Subsequent blackening of the exposed tissue indicates potential of necrosis, which may require amputation.

Inhalation: Inhalation of liquid A2/A2L refrigerant or cold gas, will result in freezing injury similar to burns, leading to irritation to the nose and upper respiratory tract. Lesions of the nasal septum and pulmonary oedema may result. Symptoms include coughing, sore throat and shortness of breath. Damage may occur days after exposure. Severe scarring of tissue and death may result due to inhalation of liquid A2/A2L refrigerant.

Following exposure to gas:

- Remove the patient from the gas source or contaminated area.
  NOTE: Personal Protective Equipment (PPE), including positive pressure self-contained breathing apparatus may be required to assure the safety of the rescuer.
- Prostheses such as false teeth, which may block the airway, should be removed, where possible, prior to initiating first aid procedures.
- If the patient is not breathing spontaneously, administer rescue breathing.
- If the patient does not have a pulse, administer CPR.
- If medical oxygen and appropriately trained personnel are available, administer 100% oxygen.
- Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or Poison Control Centre for further instruction.

- Keep the patient warm, comfortable and at rest while awaiting medical care.
- MONITOR THE BREATHING AND PULSE, CONTINUOUSLY.
- Administer rescue breathing (preferably with a demand valve resuscitator, bag valve
- Mask device, or pocket mask as trained) or CPR if necessary.

7.5 DRSABCD Action Plan

These letters are an abbreviation of the steps or procedures that must be carried out if a first aid person (or emergency personnel), come across a person who is unconscious.

D – Danger (to yourself or casualty)	One casualty is enough don't become a casualty yourself.
R – Response (shake and shout)	If the casualty does not respond move to the next step. Get bystander to contact emergency services.
S – Send for Help	Call 000 (Triple Zero) for an ambulance or ask someone else to make the call.
A – Airway (Is it clear?)	Check that the tongue or other objects are not blocking the airway. Remove if necessary.
B – Breathing (look, listen and feel)	Check if the casualty is breathing. Place patient in the recovery position if they are breathing. If not, move to the next step instead.
C – CPR (Cardiopulmonary Resus.)	Perform 2 rescue breaths. If no signs of life, Commence CPR. Clasp hands in lower part of breast bone and do 30 compressions then 2 breaths (pushing down approx. 1/3 of body depth). Same procedure for adults and babies
D – Defribulation	Performed by emergency services crew.

Source: DRSABCD Action Plan: https://www.stjohnnsw.com.au/cpr-chart/

7.6 Section Summary

- Short term bodily exposure to A2/A2L refrigerant will usually result in cold burns at the very least and frostbite in the more severe cases (especially if it's in a liquid state)
- Long term exposure can cause Asphyxiation, nervous system depression and also lead to an increase in calcium deposits under the skin.
- Swallowing a A2/A2L refrigerant is highly unlikely but would cause major freeze burns throughout the mouth and down into the stomach. Death would most likely occur (swiftly one would hope).
- Contact with the eyes would most likely result in blindness.
- Skin contact may result in 1st 2nd or 3rd degree burns.
- Inhalation is also highly unlikely but would again result in freeze burns to the nostrils and down into the lungs. Again, death would be most likely.
- DRSABCD is a code word designed to help people remember the steps in reviving an unconscious person.

7.7 Review Questions

Question 1
What does DRSABCD stand for?

Question 2
What are the effects of acute exposure (Short Term) for A2/A2L refrigerant?

Question 3
What are the effects of chronic exposure (Long Term) for A2/A2L refrigerant?

Question 4
What are the effects inhaling A2/A2L refrigerant?

Question 5
What are the main dangers of working with A2/A2L refrigerant?

7.8 Your Notes

8. Classification of Workplace Hazardous Chemicals and Safety Data Sheets

Purpose

In his topic you will learn how to identify and read the material safety data sheets and Hazchem codes relevant to the A2/A2L refrigerant.

Objectives

At the end of this topic you should be able to:

- Explain the need for Safety Data Sheets (SDS)
- Identify groups of data that can be found on SDS
- Identify a typical SDS for a given substance and specify critical information provided by the sheet.
- Use the Classification of Workplace Hazardous Chemicals to interpret a A2/A2L refrigerant product label.

Content

- Classification of Workplace Hazardous Chemicals
- Safety Data Sheets
- Hazchem codes

References

- SafeWork Australia:
  - Model WHS Laws https://www.safeworkaustralia.gov.au/law-and-regulation/model-whs-laws
  - Safety data sheets https://www.safeworkaustralia.gov.au/sds
  - Understanding Safety Data Sheets for Hazardous Chemicals https://www.safeworkaustralia.gov.au/system/files/documents/1702/understanding_sds_fact_sheet.pdf
- SafeWork NSW
  - WHS Act and Regulation: https://www.safework.nsw.gov.au/legal-obligations/legislation
  - WHS Toolkit, tools and templates to improve health and safety. https://www.safework.nsw.gov.au/easywhs-beta/safe-working-environment/template
  - Australian Code for the Transport of Dangerous Goods by Road & Rail https://www.ntc.gov.au/codes-and-guidelines/australian-dangerous-goods-code
  - Flammable Refrigerants Safety Guide https://www.airah.org.au/Web/Resources/Technical_Resources/Flammable_Refrigerants_Safety_Guide/AIRAH/Navigation/Resources/Flammable_Refrigerants_Safety_Guide/Flammable_Refrigerants_Safety_Guide.aspx?hkey=be013b97-33ae-45a2-95f6-59303d6803ac
  - Flammable refrigerant gases – position paper http://www.dmp.wa.gov.au/Documents/Dangerous-Goods/DMIRS_IS_FlamRefrigGases.pdf

8.1 Classification of workplace hazardous chemicals

The HAZCHEM Code system was developed by the British Fire Service for use on vehicles transporting dangerous substances in bulk to provide immediate action advice when attending an incident was adopted by all States in Australia for bulk dangerous substances transport, generally through adoption of the Australian Code for the Transport of Dangerous Goods by Road and Rail. The safety obligations that existed under this previous legislation for hazardous substances and dangerous goods at workplaces are now incorporated into the safety obligations for hazardous chemicals.

Under current Work Health and Safety Regulations, hazardous chemicals must be classified according to the Globally Harmonised System for the classification and labelling of chemicals (GHS).

The GHS/ADG quick guide provides an example of GHS and ADG Code labelling, comparable symbols and a quick reference to dangerous goods and compatibility in storage. https://www.worksafe.qld.gov.au/ data/assets/pdf_file/0011/17111/ghs-adg-quick-guide-web.pdf.pdf

Safety duties

WHS regulation regulates hazardous chemicals and imposes duties on manufacturers, importers and suppliers of hazardous chemicals in relation to classification, packing and labelling, safety data sheets, and disclosure of chemical identities. In addition, it prohibits the supply of certain carcinogenic substances.

Person conducting a business or undertaking

A person conducting a business or undertaking (PCBU) at a workplace, which uses, handles, stores or generates hazardous chemicals, must ensure that:

- all hazardous chemicals are correctly labelled
- safety data sheets applying to hazardous chemicals are obtained, updated as necessary and made accessible
- a register of all hazardous chemicals at the workplace is provided and maintained
- health monitoring is conducted where there is a significant risk of exposure for a worker using, storing or handling specific hazardous chemicals in a workplace
- information, training, instruction and supervision is provided to workers who may be exposed to hazardous chemicals.

The NSW Work Health & Safety Regulation states that:

8.2 Safety Data Sheets (SDS)

Clause 330 Manufacturer or importer to prepare and provide safety data sheets

4) The manufacturer or importer of the hazardous chemical must provide the current safety data sheet for the hazardous chemical to any person, if the person—
   a) is likely to be affected by the hazardous chemical, and
   b) asks for the safety data sheet

Clause 344 Person conducting business or undertaking to obtain and give access to safety data sheets*:*

1) A person conducting a business or undertaking at a workplace must obtain the current safety data sheet for a hazardous chemical prepared in accordance with this Regulation from the manufacturer, importer or supplier of the hazardous chemical

(3) The person must ensure that the current safety data sheet for the hazardous chemical is readily accessible to—

a) a worker who is involved in using, handling or storing the hazardous chemical at the workplace, and

b) an emergency service worker, or anyone else, who is likely to be exposed to the hazardous chemical at the workplace

A similar set of statements exist in equivalent State and Territory regulations.

Employers must ensure that labels are appropriate and make SDS accessible to employees who may be exposed to hazardous substances. All hazardous substances used in the work place must be listed in a register together with the relevant SDS. Employees must have access to this register.

The Hazardous Substances Regulation also requires that employers provide instruction and training to help employees understand the information on labels and SDS and how to apply this information in the workplace.

Format

A Safety Data Sheet (SDS) is a form containing data regarding the properties of a particular substance. They are an important component of workplace safety, and are intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner. This includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, personal protective equipment, and spill handling procedures.

SafeWork Australia's - What is a Safety Data Sheet (SDS) fact sheet states:

An SDS is a document that provides detailed information about a hazardous chemical, including:

- *the identity of the chemical product and its ingredients,*
- *the hazards of the chemical including health hazards, physical hazards and environmental hazards,*
- *physical properties of the chemical, like boiling point, flash point and incompatibilities with other chemicals,*
- *workplace exposure standards for airborne contaminants,*
- *safe handling and storage procedures for the chemical,*
- *what to do in the event of an emergency or spill,*
- *first aid information, and*
- *transport information.*

What does a SDS look like and what is it saying?

Below is a copy of SafeWork Australia's - What is a Safety Data Sheet fact sheet

UNDERSTANDING SAFETY DATA SHEETS FOR HAZARDOUS CHEMICALS

FACT SHEET

April 2012

Overview

This fact sheet will help you understand the information contained in a safety data sheet (SDS), what each section in the SDS means and how to check if a SDS complies with the Work Health and Safety (WHS) Regulations.

By reading, understanding and following the information and instructions in an SDS, all chemicals should be able to be used safely in the workplace.

What is a Safety Data Sheet (SDS)?

An SDS is a document that provides detailed information about a hazardous chemical, including:

- the identity of the chemical product and its ingredients,
- the hazards of the chemical including health hazards, physical hazards and environmental hazards,
- physical properties of the chemical, like boiling point, flash point and incompatibilities with other chemicals,
- workplace exposure standards for airborne contaminants,
- safe handling and storage procedures for the chemical,
- what to do in the event of an emergency or spill,
- first aid information, and
- transport information.

The information in an SDS is arranged under 16 headings to allow relevant information to be easily located by the person using the chemical. The 16 sections of an SDS are described in further detail below.

Why should I read the SDS?

The SDS is a key information resource for workers and persons conducting a business or undertaking in managing the risks of a hazardous chemical in a workplace. It is important that workers read the SDS carefully and understand its contents before working with a hazardous chemical so that it can be safely stored, handled or used in the workplace.

Not all information about the hazards of a chemical or instructions for safe storage, handling and use may be provided on labels. In most cases, the SDS will contain much more information about a hazardous chemical than appears on the label.

The SDS can be used to assist in assessing specific risks associated with a chemical and in training workers on how to use a chemical safely.

Where do I get an SDS from?

The supplier of a hazardous chemical must provide, free of charge, a copy of the manufacturer or importer's SDS with the chemical on first supply to the workplace or when asked to do so. If the supplier has not provided you with an SDS for the chemical you are using, you should ask for it before working with that chemical. If the supplier will not provide you with an SDS after being asked for it, then contact your local work health and safety (WHS) regulator.

Check if the SDS complies with the WHS Regulations

You should always check that the SDS relates to the chemical that you have received or are using. This can easily be done by checking that the product or chemical name on the SDS is the same as on the product label of the container.

www.safeworkaustralia.gov.au

Before using a chemical in the workplace, you should also make some simple checks to see whether it complies with the WHS Regulations.

- Is the SDS written in English?
- Does the SDS contain 16 separate headings? These, and the contents of each section, are further discussed below.
- Does the SDS state the name, address and business telephone number of the Australian importer or manufacturer?
- Does the SDS give an Australian business telephone number from which further information about the chemical can be obtained in an emergency?
- Was the SDS prepared within the last five years?

If you cannot answer yes to all of the above questions, the SDS you have been given does not comply with the WHS Regulations. In this instance, you should contact the supplier, importer or manufacturer for an up-to-date and compliant SDS and refrain from using the chemical until you obtain the correct SDS.

If the supplier cannot or will not provide a compliant SDS, contact your local work health and safety regulator.

Keeping SDS in the workplace

A register of hazardous chemicals used, handled or stored at the workplace must be prepared and kept up-to-date at the workplace and must also include the current SDS for each of these chemicals.

This register must be readily available to all workers who use or may be affected by the chemicals at the workplace.

What information is on an SDS?

An SDS which complies with the WHS Regulations contains the following 16 separate sections each with specific information relating to the chemical being used, handled, stored, transported or disposed.

Section 1 - Identification:

Contains the product identifier or tradename, contact details of the manufacturer or importer responsible for supplying the chemical, and the telephone number to contact in case of an emergency. The information in this section should be consistent with the label.

Section 2 – Hazard(s) identification

Gives details on the potential health and physical hazards of the chemical. This information can be used to help assess the risks to the health and safety of workers, other people, and the environment. The information in this section should be consistent with the information on the label. In some cases there may be more information on the SDS than on the label.

SAFETY DATA SHEET
Flammosol

1. IDENTIFICATION

Product identifiers

Product name :	Flammosol	**Product Number :**	100000
Brand :	Madeup Chemical Co.	**Index-No. :**	000-000-00-01
CAS-No. :	001-01-0		

Recommended use of the chemical and restriction on use

Company Details
Madeup Chemical Company
999 Chemical Street
Chemical Town, My State
Tel No. : 1300 000 000
Email: info@madeupchemical.gov.au
Website: www.madeupchemicalcompany.com.au

Emergency telephone number
Emergency Tel No. : 1300 000 001

2. HAZARDS IDENTIFICATION

Classification of the substance or mixture
Flammable liquids (Category 2)
Acute Toxicity - Oral (Category 3)
Skin corrosion / Irritation (Category 2)

Label elements
Pictograms:

Signal word: Danger
Hazard statement(s):
H225 Highly flammable liquid and vapour
H301 Toxic if swallowed
H302 Harmful if swallowed
H315 Causes skin irritation

Precautionary statement(s):
P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233 Keep container tightly closed
P241 Use explosion proof electrical equipment
P242 use only non sparking tools
P243 Take precautionary measures against static discharge
P264 Wash hands thoroughly after handling
P270 Do not eat, drink or smoke when using this product
P281 Use personal protective equipment as required

IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.

Store in a well-ventilated place. Keep cool.

Page 1 of 3

Section 3 - Composition and information on ingredients

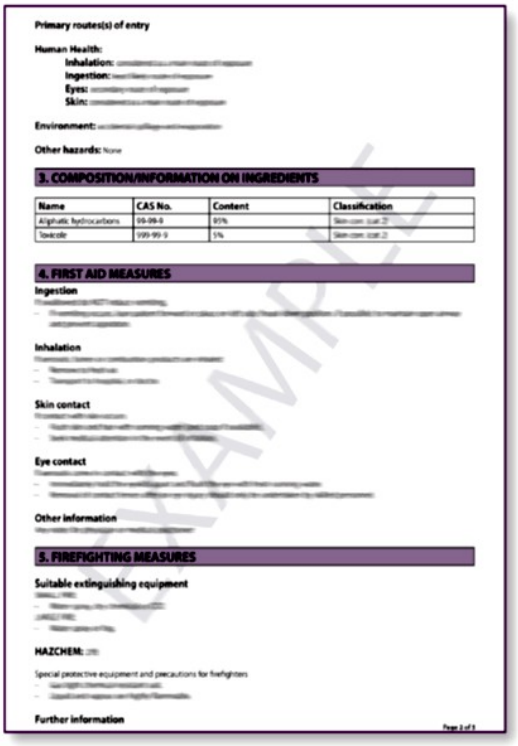
If the chemical is a mixture, this section should provide the information on the identity and proportions of hazardous ingredients in the mixture.

Section 4 - First-aid measures

Describes the necessary first aid measures to be taken in case of an accident.

Section 5 - Fire-fighting measures

Gives specific information on fighting a fire involving the chemical, including the most suitable extinguishing media and other protective measures.



Primary routes(s) of entry

Human Health:
Inhalation:
Ingestion:
Eyes:
Skin:

Environment:

Other hazards: None

3. COMPOSITION/INFORMATION ON INGREDIENTS

Name	CAS No.	Content	Classification
Aliphatic hydrocarbons	99-99-9	95%	
Toxicole	999-99-9	5%	

4. FIRST AID MEASURES

Ingestion

Inhalation

Skin contact

Eye contact

Other information

5. FIREFIGHTING MEASURES

Suitable extinguishing equipment

HAZCHEM:

Special protective equipment and precautions for firefighters

Further information

Section 6 - Accidental release measures

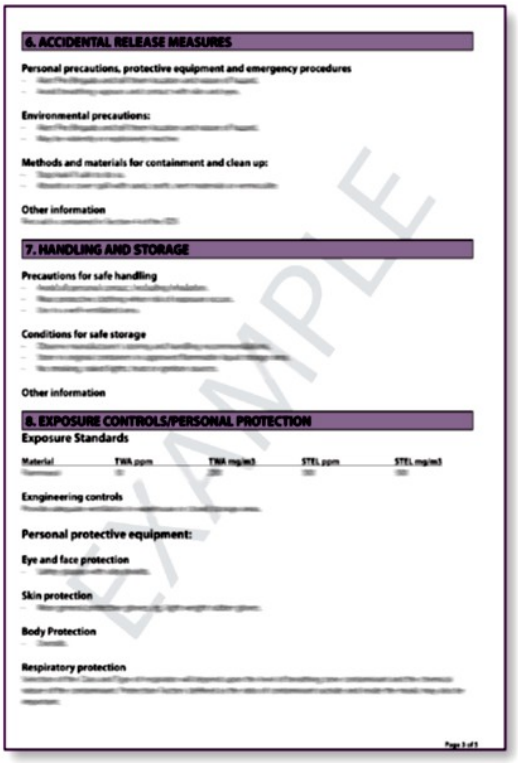
Describes what actions need to be taken if there is an accidental release or spill of the chemical to minimise harm to people, property and the environment.

Section 7 - Handling and storage

Contains details on how to handle and store the chemical safely to minimise the potential risks to people, property and the environment.

Section 8 - Exposure controls and personal protection

Provides information on control measures that can be used to reduce exposure, for example, engineering controls, information on exposure standards and guidance on required personal protective equipment (PPE).



6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Environmental precautions:

Methods and materials for containment and clean up:

Other information

7. HANDLING AND STORAGE

Precautions for safe handling

Conditions for safe storage

Other information

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Standards

Material	TWA ppm	TWA mg/m3	STEL ppm	STEL mg/m3

Exngineering controls

Personal protective equipment:

Eye and face protection

Skin protection

Body Protection

Respiratory protection

Section 9 - Physical and chemical properties

Provides detailed information on the physical and chemical properties of the chemical, for example, appearance, odour, pH, flash point, melting/ boiling point or any other relevant physical data.

Section 10 - Stability and reactivity

Contains details of any hazardous reactions that may occur if the chemical is used under certain conditions and details of any incompatible materials

Section 11 - Toxicological information

Provides detailed information on the toxicological properties of the chemical. This section is used primarily by medical professionals, toxicologists and WHS professionals.


9. PHYSICAL AND CHEMICAL PROPERTIES
General information
Appearance
Odour
Odour Threshold
pH
Melting point/freezing point
Boiling point
Flash point
Evaporation rate
Upper/lower flammability or explosive limits
Upper explosion limit (%)
Lower explosion limit (%)

10. STABILITY AND REACTIVITY
Reactivity
Chemical stability
Possibility of hazardous reactions
Conditions to avoid
Incompatible materials

11. TOXICOLOGICAL INFORMATION
Information on toxicological effects
Acute effects
Eye contact
Skin contact
Ingestion
Inhalation
Chronic effects
Toxicity and irritation

Section 12 - Ecological information

Provides detailed information on the ecological hazard properties of the chemical.

Section 13 - Disposal considerations

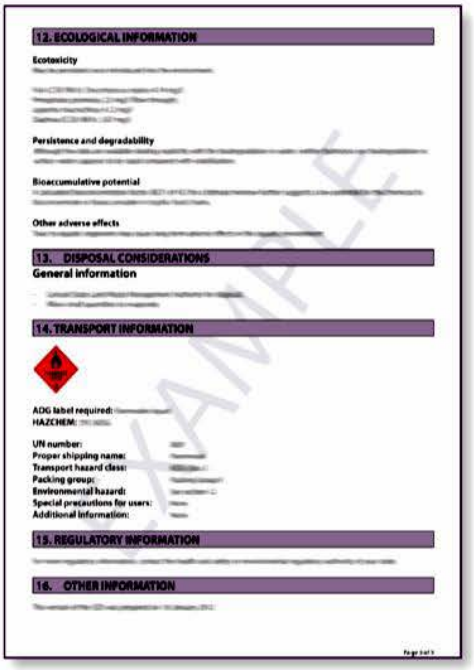
Explains how the chemical should be disposed of correctly or recycled or reclaimed.

Section 14 - Transport information

Contains basic classification information like UN number and transport hazard classes and packing groups that relate to the transport of the chemical by road, rail, sea or air.

Section 15 - Regulatory information

Provides advice on other international or national regulatory information specific to the chemical, such as the Montreal protocol (ozone depleting substances), the Stockholm Convention (Persistent organic pollutants), Poisons scheduling or any other applicable Australian prohibition, notification or licensing requirements.


12. ECOLOGICAL INFORMATION
Ecotoxicity
Persistence and degradability
Bioaccumulative potential
Other adverse effects

13. DISPOSAL CONSIDERATIONS
General information

14. TRANSPORT INFORMATION
ADG label required:
HAZCHEM:
UN number:
Proper shipping name:
Transport hazard class:
Packing group:
Environmental hazard:
Special precautions for users:
Additional information:

15. REGULATORY INFORMATION

16. OTHER INFORMATION

Section 16 - Any other relevant information

Provides any other information relevant to the preparation of the SDS, including the date of its preparation, a key or legend to abbreviations acronyms and references used.

Refer to Appendix:

- D. R32 - Safety Data Sheet
- F. R1234yf - Safety Data Sheet

8.3 Hazchem Codes

The HAZCHEM Code system was developed by the British Fire Service for use on vehicles transporting dangerous substances in bulk to provide immediate action advice when attending an incident.

HAZCHEM Codes are developed and assigned to dangerous substances after careful study of their properties and characteristics.
The HAZCHEM Code system has been adopted by all States in Australia for bulk dangerous substances transport, generally through adoption of the Commonwealth Government publication titled Australian Code for the Transport of Dangerous Goods by Road and Rail.

The Hazchem guidance notes from Workcover NSW state that "Erecting Hazchem placarding for substances not classified as dangerous goods, or placarding quantities well below exemption limits, (in our case for a flammable gas, 500 Litres) could result in an incorrect response by emergency crews, therefore endangering lives and property" Although the requirement for using this system is outside the scope of this course, an example Hazchem form is provided in the Appendix A. Glossary of useful terms.

8.4 Section Summary

- Manufacturers, Suppliers and Occupiers (Premises owners) must produce and or provide SDSs on all dangerous or hazardous goods.
- All states and territories have specified the minimum information that must be shown on an SDS
- SDS should be reviewed at least every 5 years.
- Employers must make SDS readily available to anyone involved in the handling of the dangerous product.
- Employers must provide training to help employees understand SDS's
- Hazchem codes are required by emergency services units (esp. Fire brigades)
- Hazard identification is required by emergency services units (esp. Fire brigades) on any vehicle transporting bulk quantities of a dangerous substance (over 500 Litres).
- Refrigerant cylinders must always be securely fastened and upright in a well-ventilated location within the service vehicle.

8.4 Review Questions

Question 1
What safety precautions must be followed when working with A2/A2L refrigerant?

Question 2
List 5 items of information provided on an SDS

Question 3
What are HAZCHEM Codes and what are they used for?

Question 4
What is HAZCHEM Code for Class A2L refrigerant and what does it mean?

Question 5
What are Hazard Pictograms and what are they used for?

Question 6
What are the GHS Label Element - Hazards for R32 refrigerant?

Question 7
What are the main dangers of working with A2/A2L refrigerant?

8.5 Your Notes

9. Cylinders and Storage

Purpose

In his topic you will learn how to safely store cylinders containing a A2/A2L refrigerant. This section also looks at cylinder labelling and environmentally acceptable methods for disposal of the refrigerant.

Objectives

At the end of this topic you should be able to:

- Identify the requirements for storage of A2/A2L refrigerant.
- List the general provisions that should be considered when assessing a site's suitability for the storage of A2/A2L refrigerant.
- List typical sources of ignition surrounding a vessel containing A2/A2L refrigerant.
- Describe the practices required to correctly mark and identify vessels containing A2/A2L refrigerant.
- Explain the processes considered environmentally suitable for the disposal of A2/A2L refrigerant.

Content

- Introduction
- Storing Class 2.1 gases
- Cylinder safety
- Storage
- Site suitability
- Sources of Ignition
- Marking/identifying cylinders
- Transporting cylinders
- Disposal of A2/A2L refrigerant

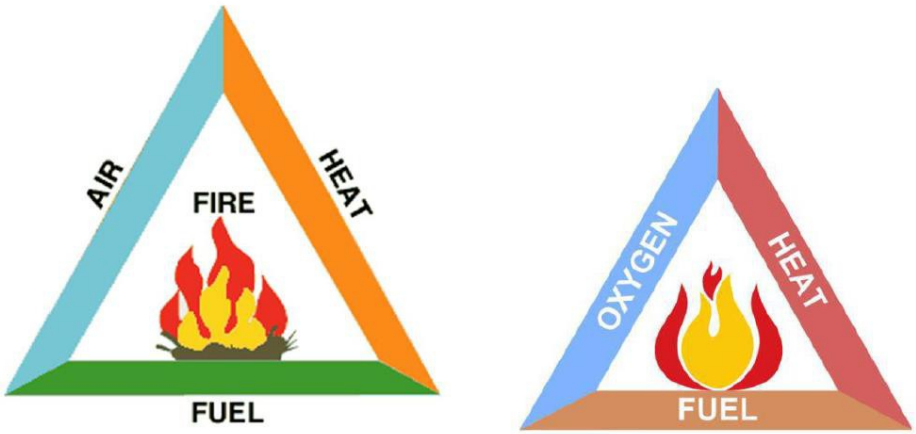
References

- AS 4332 The storage and handling of gases in cylinders
- AS 4484 Gas cylinders for industrial, scientific, medical and refrigerant use—Labelling and colour coding
- AS/NZS 1596 The Storage and Handling of LP Gas
- WorkSafe Victoria - Storing gas cylinders in vehicles https://www.worksafe.vic.gov.au/safety-alerts/storing-gas-cylinders-vehicles

9.1 Introduction

AS 4332 The storage and handling of gases in cylinders, covers this chapter of the manual in detail and should be referred to at all times. Section 2 of the standard describes the 'minor storage' requirements which correspond with the scope of this manual. It states that quantities of Class 2.1 gases up to a maximum aggregate of 500 litres shall be classified as minor storage quantities.

Remember, in order for a fire to occur in any situation, the following three elements must be present:
1. A fuel or combustible material.
2. An ignition or heat source.
3. Oxygen in sufficient quantities to support combustion.
These three elements are what is called the Fire Triangle



Fire Triangle

9.2 Storing Class 2.1 gases

9.2.1 Cylinder Safety

The standard procedures apply to A2/A2L refrigerant cylinders that apply to all refrigerant cylinders:

- Do not remove or obscure labelling on a cylinder
- Do not store or use cylinders in excessive heat or enclosed spaces
- Do not expose cylinders to direct sources of heat such as steam or electric radiators
- Do not repair or modify cylinder valves
- Do not use machine oil to lubricate valve connections or fittings
- Always use a cylinder trolley to move large cylinders, even for a short distance – never roll cylinders along the ground
- Only use approved cylinder accessories
- Never contaminate cylinders, i.e. take precautions to avoid oil, water or foreign matter entering cylinders
- If it is necessary to warm a cylinder use only water or air, not naked flames or radiant heaters. The temperature of the air/water must not exceed 50°C
- Always weigh the cylinder to check if it's empty – its pressure is not an accurate indication of the amount of refrigerant remaining in the cylinder

- Do not use cylinders as rollers
- Do not force connections on cylinders
- Keep all cylinder valves capped off
- Always secure cylinders in a vertical position when not being moved
- Avoid static electricity build up

9.2.2 Storage

A2/A2L refrigerant should be stored in the same way as other flammable gases. It is best to store these gases in an external location with the following precautions:

- In a secure, locked compound protected from the weather, direct sun and any other sources of heat or ignition
- Kept clear of any combustible materials, vegetation and refuse for a distance of 3m from any cylinder
- The cylinders should not be stored next to the windows of an adjacent building in case leaking refrigerant is drawn inside the building
- The cylinders should be stored upright and the cylinders secured to the enclosure
- A cylinder used for the storage of Class 2.1 dangerous goods, when empty, shall be stored:
    - with the valve closed; and
    - away from a public place or protected place

The storage of A2/A2L refrigerant indoors is discouraged, however the guidelines listed below should be followed in situations where it is necessary:

- The cylinders must be stored at ground level, never below ground and should be easily accessible in the event of an emergency
- The cylinder valves must be closed and capped
- A flammable gas alarm should be fitted next to the cylinders at low level to give an alarm in the event of a leak

AS/NZS 1596 specifies requirements for the location, design, construction, commissioning and operation of installations for the storage and handling of LP Gas, and includes the management of emergencies. The objective of this Standard is to provide designers, planners, operators and regulators with technical and procedural requirements for installations for the safe storage and handling of LP Gas. Although this standard targets bulk storage facilities, it is a valuable resource in the identification of hazards and possible remedies.

9.3 Site Suitability

Applying the following basic principles will assist in determining the suitability of your chosen flammable substances storage site.

Ventilation

Is there plenty of fresh air where flammable liquids or gases are stored and used? Good ventilation will mean that any vapours given off from a spill, leak, or release from any process, will be rapidly dispersed. If your storage quantities are increasing, you might need to consider the installation of a forced ventilation system.

Ignition

Have all the obvious ignition sources been removed from the storage and handling areas? Ignition sources can be varied and they include sparks from electrical equipment or welding and cutting tools, hot surfaces, open flames from heating equipment, smoking materials etc.

Containment

Are your flammable substances kept in suitable containers? If you have a spill, will it be contained and prevented from spreading to other parts of the working area? Use of lidded containers and spillage catchment trays, for example, can help to prevent spillages spreading.

Separation

Are flammable substances stored and used well away from other processes and general storage areas? Can they be separated by a physical barrier, wall or partition? Separating your hazards in this manner will contribute to a safer workplace.

Levels

Always avoid storing Class 2.1 gases below ground level. Look for un-trapped floor waste pipes that may allow large quantities of vapour to travel long distances underground.

Access

Ensure there is adequate access to the area for the emergency services crews that may arrive in an emergency. Also ensure that suitable fire protection equipment is readily available and easily accessible (*Minor stores having an aggregate capacity of less than 1000 L may be protected with a single, permanently connected water hose, provided that it is capable of depositing water on any part of the store*).

9.4 Sources of Ignition

All known sources of ignition must be eliminated in areas that contain, or may contain, flammable gases.

Electrical Equipment

A major source of ignition that is easily overlooked is electrical equipment.
When used or installed in hazardous locations, this equipment may need to be explosion-proof and properly installed. Electrical equipment includes not only the more obvious equipment such as:

- Motors
- Generators
- Motor controls
- Switches
- lighting fixtures

But also the not so obvious equipment such as:

- Alarm systems
- Remote controls
- Telephones and other communication systems

- The ignition key or light switch that makes as soon as a door is opened in a service vehicle.

Including the ones that only occur while repair work is being done:

- The use of portable electric tools
- Temporary lighting systems

All possible sources of static electricity should be anticipated to prevent its build-up and discharge. Several methods of control may be used. It is necessary that conductive parts of a system be bonded together to eliminate the difference in potential between the parts, and the whole system grounded to eliminate the difference in potential between the system and ground.

Hot Surfaces

This includes any device that may attain a surface temperature of 450°C or higher. For example:

- Thermal, MIG or TIG Welding equipment
- Braze welding equipment (silver soldering)
- Heater elements
- Open fire places
- Cooking surfaces
- Petrol engines
- Pilot light in gas hot water heating systems.

Sparks

Are often created by electrical equipment such as switches but can also result by:

- Moving metal over concrete while:
    - Positioning a steel ladder
    - Opening or closing a steel gate
    - Dragging metal pipes/tubes to another location
- Running petrol engines, pumps or compressors

This list has been provided as a guide to assist with ideas in hazard identification but should not be considered to contain a complete and comprehensive listing of all possible ignition sources.

9.5 Marking/Identifying Cylinders

It is important that each and every cylinder containing a dangerous gas or liquid is very clearly labelled to show its contents.

AS 4484 Gas cylinders for industrial, scientific, medical and refrigerant use—Labelling and colour coding, classifies the refrigerants and describes the requirements for cylinder identification as follows:

"Gases that are compressed, liquefied or dissolved under pressure are classified in the ADG Code as dangerous goods of Class 2. Class 2 includes refrigerated liquefied gases... Cylinders shall be marked and labelled in accordance with the ADG Code and other relevant regulatory requirements."

AS 4484 also describes the labeling requirements as:

"The contents of a cylinder shall be primarily identified by the label, and the colours of the cylinder shall be a secondary means of identification. Identification is achieved by symbols and characters either directly printed or the cylinder's surface."

Note: Due to the 'secondary' requirement for colour coding and the large variety of refrigerants available on the market today (especially blends), a number of refrigerant suppliers have ceased applying a colour code to their cylinders.

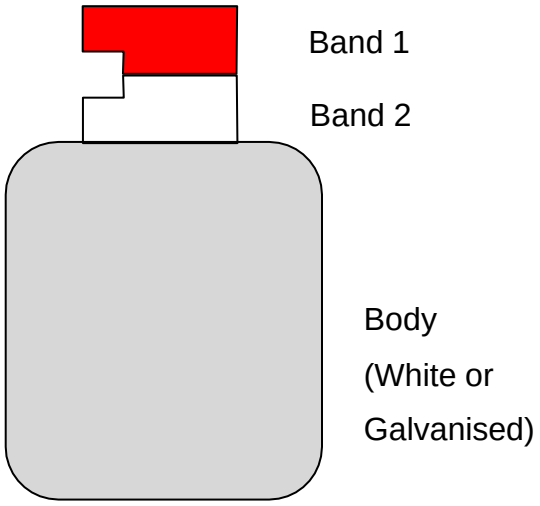
Colour Coding

The general basis of the colour code is to identify the characteristics of the gas. The ADG Code specifies the following:

Toxic…… Hues of Yellow
Flammable..... Hues of Red
Oxidizing..... Hues of Black, White, or bright Blue
Non-flammable, non-toxic..... Hues of Brown, Green or dark Blue

Table 4 of AS 4484 shows the colour code for flammable refrigerants as:

Band 1	Band 2	Body of Cylinder
Red	White	Galvanised or White



Cylinder Types and Sizes

The A2/A2L refrigerants can be purchased in the 9kg and 4.5kg returnable cylinders rated at a minimum of 42 bar (4,500 kPa) and display the following GHS marking:

They are fitted with DIN 477-1 access valves with a left-handed thread outlet.

9.6 Transporting Cylinders

The transport of A2/A2L refrigerants in a service vehicle is to be treated the same as for existing requirements for Class 2.1 gases (e.g. Acetylene). Following is an extract of WorkSafe Victoria website titled “Storing gas cylinders in vehicles”.

Safe Transporting of Small Gas Cylinders of Flammable Gas

This Safety Alert provides advice about how to manage the risk of explosion from leaking portable flammable gas cylinders inside work vehicles. This fact sheet is for motorists or trades people using flammable gases (e.g. LP Gas (propane) or acetylene), and who transport small cylinders in their own vehicles. Examples of small cylinders are typically those of the type used with barbecues (4.5 and 9 kg of LP Gas), acetylene cylinders (E size), and cartridges and aerosols designed for use with attachments.

Dangers

Serious accidents have resulted from gas leaking from cylinders while inside trade vehicles or cars. Leaking gas can explode when ignited - injuring the driver and damaging the vehicle.

Leaks can occur if the valves used to regulate the flow of gas are not properly turned off or are faulty. Ignition sources can include electrical equipment in the vehicle, for example, using a remote locking mechanism. Lighting a cigarette in or near the vehicle could also ignite the gas.

How to transport small gas cylinders

Ventilation is the key to reducing risk of fire or explosion.

Don't

- Transport or keep cylinders in an unventilated van, unless in a purpose built compartment or cabinet.
- Permanently store cylinders inside vehicles unless suitable ventilation is provided.
- Attach the cylinder to the external body of the vehicle because of the potential risk of damage in a collision.

Do

- Check for leaks from valves, connections and equipment by applying soapy water and looking for bubbles. Smell alone is not a reliable test. Relying on the valves to prevent leakage during transport is not sufficient on its own.
- Ensure windows of the vehicle are wound down for cross flow ventilation.
- If you are transporting the cylinder inside a trade vehicle, keep the cylinder in a purpose built compartment or cabinet that provides adequate drainage or ventilation of any leaking gas to the outside of the vehicle. A side-mounted compartment with its own door (for example a well-side body) is suitable, provided the cylinder remains upright. Alternatively, an open vehicle such as a utility provides the best ventilation and avoids the risks of gas accumulation.
  - Secure cylinders and keep them upright (the exception are those designed to be mounted on forklifts, but only when kept with the correct “TOP” orientation).(Insert: *liquefied flammable gas must always be positioned so that the safety relief device communicates directly with the vapour space within the cylinder*
  - Unload the cylinder from inside the vehicle immediately on reaching your destination, unless the vehicle has a suitable compartment or cabinet.

9.7 Disposal of A2/A2L Refrigerants

Some A2/A2L refrigerants for example R32 are a controlled substance under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, which is administered by the Australian Refrigeration Council (ARC), therefore it is mandatory to recover this refrigerant from end-of-life air conditioning and refrigeration systems or during maintenance on the refrigeration circuit. Refer to section 11.5 Refrigerant Recovery.

Other A2/A2L refrigerants for example R1234yf are NOT a controlled substance under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, however is can still be recover this refrigerant from end-of-life air conditioning and refrigeration systems or during maintenance on the refrigeration circuit.

Refrigerant Reclaim Australia (RRA) is a not-for-profit organisation created to work nationally with industry to share the responsibility for, and costs of, recovering, reclaiming and destroying surplus and unwanted refrigerants. A2/A2L refrigerants should be recovered into specially manufactured reclaim bottles and returned to your wholesale outlets, who will return the refrigerant to RRA. The RRA website specifically states:

> *RRA reserves the right to reject any Recovered Refrigerant which contains substantial quantities of water, hydrocarbons, ammonia, methyl bromide or other flammable and/or toxic substances.*
> *Before decanting to RRA supplied cylinders the Recovered Refrigerant must first be tested for flammable substances using suitable gas analyser.*
>
> *When the refrigerant gas analyser indicates a level of 5% or greater Hydrocarbon and/or 40% or greater flammable HCFC/HFC/HFO, Recovered Refrigerant must only be decanted into an approved cylinder suitable for flammable refrigerants using apparatus and equipment appropriately rated for use with flammable refrigerants.*

9.8 Section Summary

- Refer to AS 4332 for any information pertaining to the storage of class 2.1 gases.
- All of the procedures and good practices currently used when working with cylinders containing synthetic refrigerants still apply to those containing A2/A2L refrigerants
- The requirements for the storage of cylinders are also similar.
- Check for any sources of ignition and ensure that any leakages cannot accumulate in low areas.
- Storing A2/A2L refrigerant indoors is strongly discouraged.
- Good ventilation and separation from ignition sources and other flammable items are the primary elements of safe storage.
- The list of ignition sources can be vast and varied.
- AS 4484 describes the labeling and colour code requirements for refrigerant cylinders.
- Cylinders containing flammable refrigerants should have a red band then a white band around the neck.
- Refrigerant Reclaim Australia requires that when the refrigerant gas analyzer indicates a level of 40% or greater flammable HCFC/HFC/HFO, Recovered Refrigerant must only be decanted into an approved cylinder suitable for flammable refrigerants using apparatus and equipment appropriately rated for use with flammable refrigerants.

9.9 Review Questions

Question 1
What does AS 4484 describe?

Question 2
What are the main requirements for storing A2/A2L refrigerant?

Question 3
What colour bands should be on cylinders containing flammable refrigerants?

Question 4
When transporting A2/A2L refrigerant cylinders what precautions should be followed?

Question 5
How should A2/A2L refrigerant cylinders not be transported?

9.10 Safety Systems Practical Exercise

Task : Inspect a A2/A2L applance and locate/identify the following safety related items:

1. The refrigerant type and charge quantity
2. Refrigerant SDS
3. Personal protection equipment
4. Fire protection equipment
5. Emergency exits and meeting point

9.11 Your Notes

10. Installation requirements for A2/A2L Air Conditioning/ Refrigeration Systems

Purpose

In this section you will learn about the special installation requirements for Class A2/A2L systems that are different to a typical Class A1 synthetic refrigerant systems.

Objectives

At the end of this topic you should be able to:

- Identify any potential hazards that may preclude the installation of a A2/A2L air conditioning or refrigeration systems
- Identify the relevant AS Standards applicable to the installation of A2/A2L air conditioning or refrigeration systems
- Identify the manufacturers installation requirements.

Content

- Potential ignition sources, especially those that are not obvious, such as other equipment located nearby, light switches or heaters
- Practical limit for A2/A2L refrigerants and charge limitations
- Installing Air Conditioning/Refrigeration Systems
    - Where to Flare
    - Using Oxygen Free Dry Nitrogen
- Pressure testing
- Evacuation
- Commissioning
- Leak testing
- Labelling

References

- AS/NZS 60079:2009 Explosive atmospheres
- AS/NZS 60335.2.40:2019, Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
- AS 2030.1 Gas cylinders - General Requirements
- AS 2381.1 Electrical equipment for explosive gas atmospheres
- AS/NZS 2430.3.1:2004 Classification of hazardous areas Examples of area classification - General.
- AS/NZS 3000:2018 Electrical installations “Wiring Rules”
- AS NZS 3500:2015 Plumbing and drainage
- AS 4332 The storage and handling of gases in cylinders
- AS 4484 Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding
- AS/NZS 5149.1:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Definitions, classification and selection criteria
- AS/NZS 5149.2:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Design, construction, testing, marking and documentation
- AS/NZS 5149.3:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Installation site

- AS/NZS 5149.4:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Operation, maintenance, repair and recovery
- "AIRAH Flammable refrigerant safety guide" and Fact Sheet on Installing systems with flammable refrigerants, freely available at: https://www.airah.org.au/Web/Resources/Technical_Resources/Other_Technical_Resources/AIRAH/Navigation/Resources/Other_Technical_Resources/Other_Technical_Resources.aspx?hkey=74c8e56d-58ba-4cc4-9069-ea4f03b49c4c#FRSG
- AIRAH's Flammable Refrigerant Safety Guide – 2018 Update available at: https://www.airah.org.au/Content_Files/FRSG/FRSG-2018-Update.pdf?pdf=Flammable-Refrigerants-Update-One

Refer to:

- Appendix A Check Lists of AIRAH's Flammable Refrigerant Safety Guide – 2018 Update check lists, bearing in mind they cover Class A3 and A2/A2L refrigerants:
  - A1 High wall split system check list
  - A2 Coolroom refrigeration system check list
  - A3 Plantroom-based refrigeration system check list
  - A4 Checklist for emergency plans

  It is available at: https://www.airah.org.au/Content_Files/FRSG/FRSG-2018-Update.pdf?pdf=Flammable-Refrigerants-Update-One

- Refer to Appendix N: Manual for R32 Refrigerant Air Conditioner, from Hitachi for its requirements for the installation and servicing R32 split system air conditioning systems.

Note:
Under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, the RSS03 Restricted Split System Refrigerant Handling Licence issued by the Australian Refrigeration Council only permits the holder to handle a refrigerant for the installation and decommissioning of split systems less than 18kW. It does not permit them to handle a refrigerant for the servicing split systems, this requires the RAC01 Full Refrigeration and Air Conditioning Refrigerant Handling Licence.

10.1 Introduction

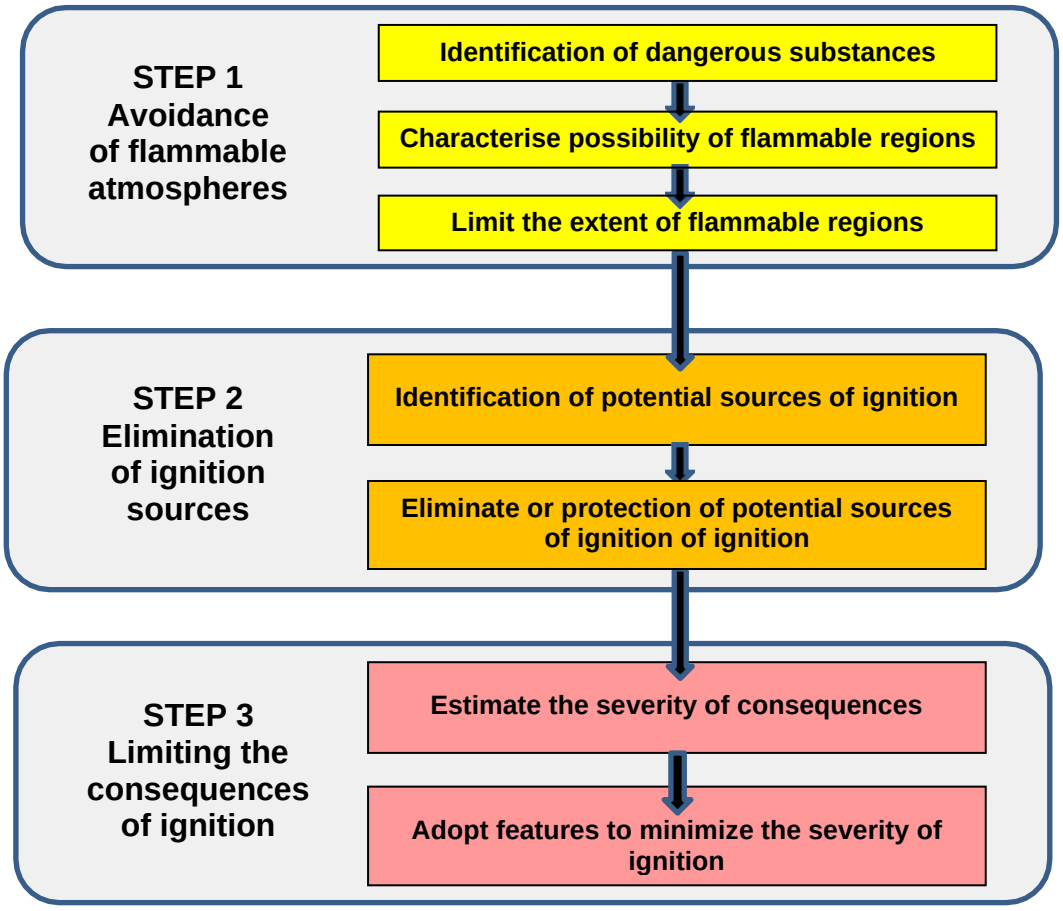
Due to the flammability of the refrigerant, different precautions equipment and procedures are required to install Class A2/A2L refrigerant refrigeration and air conditioning systems than those use with typical Class A1 synthetic refrigerant systems to meet the relevant Regulations, Standards and manufacturers requirements, In particular:

- AS/NZS 5149.4:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Operation, maintenance, repair and recovery
- AS/NZS 60335.2.40:2019, Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
- Refrigerant handling code of practice 2007

AS/NZS 5149.2 requires refrigerating systems using flammable refrigerants to be constructed and installed so that in the event of a leak the refrigerant "will not flow or stagnate in the vicinity of electrical components which could be a source of ignition".

The assessment of the installation should be in accordance with AS/NZS 60079.10.1 where areas are classified as hazardous, Zones 0, 1 or 2, or not hazardous as appropriate. The assessment includes hazardous areas created during or after a leak of the refrigerant charge, not just during normal operation. Any electrical component identified in the assessment that could be a source of ignition when exposed to leaked refrigerant must be selected and installed in accordance with AS/NZS 60079.14.

The following diagram provides an overview of the basic steps for flammability risk assessment process.



10.2 Potential ignition sources

It is important for the installer to review the positions of the indoor unit/s and outdoor unit location to ensure that potential ignition sources have been eliminated from the immediate area prior to the installation of the equipment. Especially those that are not obvious, such as other electrical equipment located nearby, light switches or heaters, plus obvious ones are examples open flames, fire places, welding, hot surfaces, barbeques, static electricity and devices that may cause an electrical arc for example open motors and switches.

10.3 Practical Limit for A2/A2L Refrigerants and Charge Limitations

The smallest unventilated enclosed space the system serves dictates the maximum refrigerant charge that can be safely installed.

For installation of split system air conditioners, refrigerant concentration levels are important, especially with ducted systems. Ducted indoor units pose an additional hazard because the indoor unit is generally in a confined space with only a small amount of room between the indoor unit and the rafters. If a gas leak occurs within the indoor unit the refrigerant can pool and become trapped, reaching flammable concentration levels.
Refer to the following sections:

- 5.14 Classifications
- 5.15 Limitations on the Charge of Class A2/A2L Refrigerants

Examples:

1. A RAC technician would like to install an R32 wall mounted air conditioner in a 49.5m^2 room. Determine the maximum refrigerant charge permitted for an Occupancy category “a” and a Location classification I

   Table A2 requirement: A4 and not more than m_2^a x 1.5

   A4 Formula: m_{max} = 2.5 x LFL$^{5/4}$ x ho x A$^{1/2}$
   = 2.5 x 0.307 $^{1.25}$ x 2.2 x 49.5 $^{0.5}$ = 8.84 kg

   Plus check this amount is not more than m_2^a x 1.5
   = 26m^3 x 0.307 LFL x 1.5 = 11.97 kg

   Therefore, the Maximum Charge = 8.84 kg

2. A coldroom (3.5m x 3m x 2.4m high) using R1234yf is located at ground level with a remote condensing unit located outside. Determine the maximum refrigerant charge permitted for an Occupancy category “b” and a Location classification II

   Table A2 requirement:
   - A4 and not more than 26kg or according to A.5 not more than m_3^b x 1.5

   Formula: m_{max} = 20% x LFL x m^3
   = 20% x 0.289 x 25.2 m^3 = 1.456kg
   Plus check this amount is not more than 25kg
   Plus check this amount is not more than m_3^b x 1.5
   = 130m^3 x 0.289 LFL x 1.5 = 56.355 kg
   Therefore, the Maximum Charge = 1.456kg

10.4 Installing Air Conditioning/Refrigeration Systems

Follow the manufacturers installation instructions to install the indoor unit, outdoor unit, refrigerant pipework, condensate drain and electrical wiring and adhere to relevant national and State/Territory Regulatory requirements, Australian Standards, Codes of Practice including:

- WHS Regulations
- Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, available at: https://www.environment.gov.au/protection/ozone/legislation
- AS/NZS 60335.2.40:2019, Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
- AS/NZS 3000:2018 Electrical installations "Wiring Rules"
- AS NZS 3500:2015 Plumbing and drainage
- AS/NZS 5149.1:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Definitions, classification and selection criteria
- AS/NZS 5149.2:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Design, construction, testing, marking and documentation
- AS/NZS 5149.3:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Installation site
- AS/NZS 5149.4:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Operation, maintenance, repair and recovery
- Refrigerant Handling Code of Practice 2007
- AIRAH Flammable Refrigerant Safety Guide

AS/NZS 60335.2.40 states that:

1. An instruction manual is required to be supplied with the air conditioning appliance which must include:
   - the WO21 warning symbol,
   - warnings that:
     - "The appliance shall be stored in a room without continuously operating ignition sources (for example open flames an operating gas appliance or an operating electric heater)
     - "Be aware that refrigerants may not contain an odour"

2. The appliance must be supplied with a manual:
   - outlining specific installation rules for pipe work installation
   - clearly indicate the minimum floor area of the room that can be served in the form of a table or single figure. Complicated refrigerant charge calculations should not be required as long as these minimum rules are observed.

The information that the instruction manual must contain is outlined in Annex DD of AS/NZS 60335.2.40 and includes details such as:

- Storage instructions and warnings
- The qualification and competency of installation and service personnel
- Information on appliance servicing

The servicing information provided in the instruction manual must cover securing the work area, checking for refrigerant, having a fire extinguisher if hot work is intended, controlling local ignition sources, ventilation of the work area, checks to the refrigeration equipment, checks to the electrical components and cabling, and instructions for repairs.

Refer to Appendix N: Manual for R32 Air Conditioner.

10.4.1 Flare connections

The refrigerant pipe wall thickness must be adequate for the pressures involved.

Where flammable refrigerants are used, no valves or detachable joints can be located in areas accessible to the general public. Soldered joints are preferred to flared joints to minimise the chances of refrigerant leakage. Flared joints are restricted to pipe sizes up to 20 mm OD on annealed pipe only. The flare nut should be tightened to the correct torque using a torque wrench. Correct torque values are provided by the manufacturer and also in AS/NZS 5149 for manually made flares.

For indoor flare connection requirements refer to Appendix K: HVAC&R Nation article "Where to Flare" from February 2018, which refers to the requirements for using flare joints and permanent connections such as a brazed joints or compression fittings under the following Standards:

- AS/NZS 60335.2.40:2019, Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
- AS/NZS 5149.2:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Design, construction, testing, marking and documentation

It concludes that Standard AS/NZS 5149.2:2016 Clause 5.2.3.7 which was modified by Appendix ZZ for Australia and New Zealand states:

> *"Specific requirements for the installation of piping for equipment intended to use A2, A3, B2 or B3 refrigerants: Piping and joints of a split system shall be made with permanent joints when inside an occupied space, except joints directly connecting the piping to indoor units"*

Any mechanical connections such as flare joints, used in the installation, must be accessible for maintenance and leak detection.

10.4.2 Using Oxygen Free Dry Nitrogen

Before brazing work is carried out, set up safety barriers/sign
Oxygen Free Dry Nitrogen should always be used when brazing to displace the oxygen and prevent oxidisation on the inside of the pipework. This procedure is important for A2/A2L systems as it is also required to displace any residual refrigerant and prevent concentration levels conducive to ignition.

10.5 Pressure Testing

As the indoor and outdoor units are factory pressure tested, the only components that need to be pressure tested are the field installed interconnecting pipework and their connections to the indoor and outdoor units. These must be pressure tested with Oxygen Free Dry Nitrogen (OFDN), in accordance with the Refrigerant Handling Code of Practice, to a safe test pressure recommended by the equipment manufacturer, and/or AS/NZS 5149.2 clause 5.2.2 Pressure Requirements, to ensure that there are no leaks.

The required test pressure for a reverse cycle spilt air conditioning system is that required for the high pressure side of the system, as the indoor unit is the condenser on the heating cycle. This test pressure can be determined using AS/NZS 5149.2 Table 2 Specified Design Temperature below.

Table 2 — Specified design temperatures

Ambient conditions	≤32 °C	≤38 °C	≤43 °C	≤55 °C
High-pressure side with air-cooled condenser	55 °C	59 °C	63 °C	67 °C
High-pressure side with water cooled condenser and water heat pump.	Maximum leaving temperature + 8 K			
High-pressure side with evaporative condenser	43 °C	43 °C	43 °C	55 °C
Low-pressure side with heat exchanger exposed to the outdoor ambient temperature	32 °C	38 °C	43 °C	55 °C
Low-pressure side with heat exchanger exposed to the indoor ambient temperature	27 °C	33 °C	38 °C	38 °C

NOTE 1 For the high-pressure side, the specified temperatures are considered the maximum that occur during operation. This temperature is higher than the temperature during compressor shutdown (standstill). For the low-pressure side and/or intermediate-pressure side, it is sufficient to base the calculation of pressure on the expected temperature during compressor standstill period. These temperatures are minimum temperatures and thus determine that the system is not designed for maximum allowable pressure lower than the saturated refrigerant pressure corresponding to these minimum temperatures.

NOTE 2 The use of specified temperatures does not always result in saturated refrigerant pressure within the system, e.g. a limited-charge system or a system working at or above critical temperature.

NOTE 3 For zeotropic blends, PS is the pressure at the bubble point.

NOTE 4 The system can be subdivided into several parts (e.g. low- and high-pressure sides) for each of which there could be a different maximum allowable pressure.

NOTE 5 The pressure at which the system (or part of the system) normally operates is lower than PS.

NOTE 6 Excessive stress can result from gas pulsations.

NOTE 7 For the determination of the ambient conditions, IEC 60721 can be used, as well as regional data.

For example, the Design Ambient Temperature in Summer for Adelaide is 37ºC (Melbourne 34ºC, Sydney 31ºC), per the table above, the required test pressure for the High pressure side with air cooled condenser is equivalent to 59ºC, which on R32 is 3,850 kPa.

10.6 Evacuation

Release the Oxygen Free Dry Nitrogen from the indoor unit and connecting pipework and evacuate them using an A2/A2L approved vacuum pump to at least 500 microns per equipment manufacturer instructions, AS/NZS 5149.2 and Refrigerant Handling Code of Practice requirements. Once 500 microns is achieved, the vacuum must be isolated from the system and for 60 minutes to ensure the vacuum is maintained to below 600 microns. If the vacuum above that, it indicates that there is moisture left inside the system or there is a leak.

10.7 Temporary Flammable Zone

It is generally recognized that the risk of fire or explosions is higher when a refrigerating and air conditioning system that contains flammable refrigerant is being worked on, compared to when it is operating normally. This is due to a higher likelihood of the possible release of refrigerant and the presence of potential sources of ignition during installation and repair activities, therefore a Temporary Flammable Zone must be created around the system/work area. It should be located around all points where at least some

emission of refrigerant is anticipated to occur during refrigerant charging or recovery. The areas around these points are classified as Zone 2 Hazardous Areas under AS/NZS 60079.10.1.

The size of the temporary flammable zone should be determined from the charge in the system being serviced, the density of the released refrigerant, and whether the system is indoors or in a well-ventilated area (e.g. outdoors). For example, for a domestic fridge or freezer it could be a minimum of two metres, for a small air conditioner or heat pump it could be three metres, for larger system with a larger charge, greater distances would be required.

10.8 Commissioning

- Most split air conditioning outdoor units and some refrigeration condensing units come pre-charged with sufficient refrigerant and additional refrigerant will only need to be added if the interconnecting pipework is over a certain distance prescribed by the manufacturer.
- Once the required vacuum has been confirmed, open both of the valves on the outdoor unit.
- Only add additional refrigerant charge if required, as per manufacturers requirements. Always check manufacturers nominated charging requirements (for example 20 grams of refrigerant per additional metre over 10 metres).

Note:

- Pure HFC refrigerants, for example R32 and Pure HFO refrigerants, for example R1234yf can be charged from either the liquid or vapour phase
- HFC blend refrigerants for example R410A and HFO blend refrigerants for example R454B, must be charged from the liquid phase to ensure accurate composition.

- Record commissioning results with the inverter compressor operating at 100% speed including those listed below, check that system operation is within manufacturer's system design conditions:
    - Indoor unit's Air-on and Air-off temperature
    - Outdoor unit's Air-on temperature
    - Suction pressure and Evaporation temperature
    - Discharge pressure and Condensing temperature
    - Evaporator and Condenser Td
- Operate system through control settings:
    - if an air conditioning unit, Cooling / Heating cycles and record results
    - If a refrigeration system, operate system, ensure space temperature is achieved and associated controls operate correctly.

The installation must be checked to ensure that services and equipment related to the refrigerating system are correctly installed and functioning prior to handover to the owner. AIRAH's Flammable Refrigerants Safety Guide contains a series of useful checklists for the installer. Refer to Appendix L High Wall Split System Checklist and M Coolroom Refrigeration System Checklist.

The Flammable Refrigerant Safety Guide (FRSG) recommends that the local fire station is notified of any system in their local area that is charged with 5 kg or more of a flammable refrigerant. This was a recommendation of the coroner following the Tamahere incident.

10.9 Leak Testing

When commissioning is completed, the system must be leak tested and all leaks must be repaired in accordance with Refrigerant Handling Code of Practice requirements.

- Always leak test using soapy water or approved electronic leak detector for use with A2/A2L refrigerants.
- Never use a halide leak lamp or other detector which uses a naked flame.

10.10 Refrigerant Detectors

Appropriate refrigerant detectors must be provided when the allowable charge specified in AS/NZS 5149.1 can be exceeded for the installation. This can commonly occur in plantrooms. Detectors must at least actuate an alarm and start the emergency mechanical ventilation of a machinery room.

A refrigerant detector for flammable refrigerant must activate at a concentration as low as practical and not exceeding 25 % of the LFL of the refrigerant and continue to activate at higher concentrations.

10.11 Labelling

AS/NZS 5149.2 clause 5.4.2.2 states the following details are required on refrigeration and air conditioning systems.

5.4.2.2 Refrigerating systems

A clearly readable identification plate shall be located near or on the refrigerating system.

The identification plate shall contain at least the following data:

a) the name or identification of the installer or manufacturer;

b) the model, serial number, or reference number;

c) the year of manufacture;

NOTE The year of manufacture can be part of the serial number, and all information can be part of the identification plate of the equipment and can be coded.

d) the number designation of the refrigerant in accordance with ISO 817 (see also Annex B of ISO 5149-1);

e) the refrigerant charge;

f) the maximum allowable pressure, high- and low-pressure sides;

g) when flammable refrigerants are used, the flame symbol according to W021 of ISO 7010:2011, shall be displayed with a minimum height of 10 mm, and the symbol need not be in colour.

Symbol ISO 7010- W021

10.12 Decommissioning

Refer to section 11.5 Refrigerant Recovery

10.13 Skill Practice
– Commission and Decommission R32 Split System Air Conditioner

Purpose:
This practical exercise requires the learner to apply the required knolwedge and skills to commission and decommission R32 split system air conditioner in accordance with relevant Regulations, Standards, Codes of Practice and manufacturers' requirements.

Equipment to be supplied by training facility / college:
An installed R32 split system air conditioner with:

- the outdoor unit pre-charged with R32,
- interconnecting pipework connected to it and the indoor unit which contain no refrigerant.

Refrigerant removal/recovery equipment, evacuation and charging equipment, measuring instruments, pressure testing equipment, leak testing equipment, refrigeration hand tools, dry nitrogen equipment tools, R32 refrigerant, lubricants and consumables.

Aids to be supplied by student
- Stationary, Calculator, Ruler, Pens
- Acceptable Personal Protective Equipment

Instructions to Learner
- Mobile phones are to be turned off and removed from your person.
- You may use any text or reference book or notes for this exercise.
- All sections must be attempted.
- You will not be permitted to carry out this exercise if you do not have the required Personal Protective Equipment (safety glasses, correct clothing, and correct footwear).

Activity 1 – Risk Assessment

Task
Carry out a Risk Assessment for a work area containing the R32 air conditioning system and refrigerant cylinder.

Procedure
1. Identify and record the details below of the R32 system and cylinder/s in the work area:

R32 refrigeration/air conditioning system		**R32 Refrigerant cylinder/s**	
System Type		Cylinder size	
System Make		Refrigerant weight in cylinder	
System Model Number		Recovery cylinder size	
Refrigerant Type		Refrigerant weight in cylinder	
Refrigerant Charge			

2. Inspect the work area and record on the following table:

   a) **Risks/hazards**, especially those associated with R32 system or cylinders including electrical, mechanical and ignition hazards, low spots and trench's, etc.
   b) Possible '**consequences of the hazards**' (how you or others may be injured).
   c) **Risk class** (A, B or C) using the table below.

Risk Classification		
A	High risk	Potential death or permanent disablement)
B	Medium risk	Potential serious injury/illness and temporary disablement)
C	Low risk	Potential minor injury, no lost time)

   d) **Control measures** required to minimise each of the risks.

Risk Assessment

a) Risk or Hazard	b) Consequence of the hazard	c) Risk Class	d) Control Measures

Activity Completed: YES/NO Teacher's Initials: …… Date: ……

Activity 2 - Access System

Task:
Connect service gauges to the outdoor unit.

You must:
- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Set up a temporary flammable zone
- ☐ Use appropriate tools and techniques to connect to access the system's refrigerant system.
- ☐ Correctly connect service gauges to outdoor unit service valves.

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 3 - Pressure Test and Repair Leaks

Task:
Pressure test and repair, if necessary any leaks found on the R32 system's interconnecting pipework and fittings.

You must:
- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Determine the test pressure value suitable for the application/system type.

Do not proceed any further.
Advice your teacher of the value/s you have chosen to use.

Pressure test level for the system you are working on:

High side_____kPa Low side_____kPa

- ☐ Connect Oxygen Free Dry Nitrogen cylinder and regulator are connected correctly.
- ☐ Safely introduce Oxygen Free Dry Nitrogen to the system to required pressure level.
- ☐ Check for leaks using an accepted method and any leaks found are rectified appropriately.
- ☐ Discharged Oxygen Free Dry Nitrogen from the system safely and in a controlled manner.

Activity Completed: YES/NO Teacher's Initials: ……Date:……

Activity 4 - Evacuate System

Task:
Evacuate the interconnecting pipework and indoor unit.

You must:

- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Re-fit the service gauges to the system correctly (after pressure testing) ready for evacuation.
- ☐ Check the vacuum pump for efficiency prior to starting evacuation.
- ☐ Fit a suitable device to measure the vacuum level achieved.
- ☐ Check gauge connections regularly for tightness, once evacuation has started
- ☐ Provide a description of 'Triple Evacuation'.

_____

_____

_____

Vacuum Required?_____

Vacuum Obtained?_____

- ☐ Provide a description of 'Deep Evacuation'.

_____

_____

_____

- ☐ Disconnect the vacuum pump ensuring that no loss of vacuum occurs.
- ☐ Prepare the system for charging with refrigerant.
- ☐ Ensure a vacuum pump retains efficient operation
- ☐ Describe the maintenance activity that should be carried out regularly on the vacuum pump?

_____

_____

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 5 – Open R32 Charge into Interconnecting Pipework

Task:
Release outdoor unit's R32 charge into interconnecting pipework and indoor unit.

You must:

- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Connect service gauges to the system correctly
- ☐ Open the outdoor unit's service valves to release the R32 charge into interconnecting pipework and indoor unit until pressure equalise.
- ☐ **Under the teacher's supervision turn on the system.**
- ☐ Measure and record system's operating pressures, temperatures and current on the table below.

Condition	Cooling Mode	Heating Mode
Ambient Temperature:		
Suction Pressure:		
Evaporation Temperature:		
Discharge Pressure:		
Condensing Temperature:		
Compressor Rated Full Load Current:		
Compressor Operating Current:		

- ☐ Confirm if the system is operating correctly per manufacturer's specifications and instructions: Yes/No
  Comments:
  _____
  _____
  _____
  _____

- ☐ Confirm if the system is operating with the correct refrigerant charge per manufacturer's specifications:
  Yes/No Refrigerant charge _____

- ☐ Disconnect service gauges from the system safely and with no loss of refrigerant charge.
- ☐ Seal access valves
- ☐ Carry out a final leak test.
- ☐ Leave the system as required – check with your assessor if it is to be left operating.

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 6 – Complete Documentation

Task:
Check operation and document relevant information of the R32 system as required by relevant regulations, codes, standards and the manufacturer.

You must:
- ☐ Pack away all tools & equipment correctly
- ☐ Remove any rubbish from work area
- ☐ Leave the work area safe for others.
- ☐ Complete the 'service tag' below, filling in the relevant information.

Refrigerant type used:_____

Refrigerant oil type used:_____

Ultraviolet dye added:_____

Service person name:_____

Service person ARC licence no:_____

Business name:_____

Date of service:_____

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Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 7 – Decommission the System.

Task:
Safely remove the R32 refrigerant charge from the system.

This shall be achieved by recovering the refrigerant into a suitable cylinder and applying approved techniques and in compliance with all applicable WH&S requirements and hazard control measures.

You must:
- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Connect service gauges to the system correctly
- ☐ **Isolate the electrical supply and tag it.**
- ☐ Connect the A2/A2L recover unit and A2/A2L recover cylinders
- ☐ Recover all of the refrigerant from the system.
- ☐ Record the quantity of refrigerant recovered_____kg
- ☐ Leak test recovery cylinder and repair any leak found.
- ☐ Attach De-Gassed sticker to units

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

10.14 Section Summary

- Pressure testing of a system should be conducted when a system is constructed or when a component is replaced.
- Oxygen Free 'high purity' Dry Nitrogen should be used for pressure testing refrigeration and air conditioning systems.
- Always use the manufacturers' recommended test pressure values if available.
- Liquid bubble detectors provide the best result when testing for leaks in a system or component.
- Some electronic leak detectors may provide a source of ignition if they employ a heated sensor tip operating at with a surface temperature above the ignition temperature of the flammable refrigerants.
- Always use electronic leak detectors that have been approved for use with A2/A2L refrigerants.
- The system must be evacuated to less than 500 microns
- The vacuum should not rise more than 100 microns in one hour
- Always use a vacuum pump designed for use with A2/A2L refrigerants. Check the manufacturers' specifications.
- Prior to charging a system with a A2/A2L refrigerant, survey the area for sources of ignition, set up a temporary flammable zone, inform relevant personnel and place a fire extinguisher nearby.
- Systems must be fitted with a label indicating refrigerant type and charge weight
- Electronic scales with a very low resolution (2g) is required when charging small appliances
- Use rules of thumb for liquid subcooling and suction superheating when the charge weight is not indicated - after checking with the manufacturer

10.15 Review Questions

Question 1
Explain why manufacturers have chosen to avoid the use of flare nuts on their self-contained appliances?

Question 2
State 2 occasions/situations that would create a need for the system to be pressure tested.

Question 3
Compressed air and oxygen must never be used to pressure test a system.
Explain why.

Question 4
What is the recommended test pressure for a split system air conditioner in Melbourne on R32?

Question 5
List 4 suitable methods for identifying the location of a leak in a system.

Question 6
Name the leak detection method that is considered by industry to be the most reliable and efficient.

Question 7
What depth of vacuum is recommended for a system in Microns?

Question 8
In what time period would this depth of vacuum be achieved?

Question 9
Once you have isolated the vacuum pump the vacuum is permitted to rise by a small amount in the next hour. State the allowable pressure increase.

Question 10
List 3 sources of ignition that must be considered and checked prior to working on a system charged with a A2/A2L refrigerant.

Question 11
When charging small domestic systems a charging scale with a low resolution will be required. What is the recommended resolution for these systems?

Question 12
Explain why a blended refrigerant must be charged into a system in the liquid form

10.16 Your Notes

11 Service requirements for A2/A2L Air Conditioning/ Refrigeration Systems

Purpose

In this section you will learn about the special requirements for servicing Class A2/A2L systems that are different to a typical Class A1 synthetic refrigerant systems.

Objectives

At the end of this topic you should be able to:

- Identify any potential hazards that may preclude the installation of a A2/A2L air conditioning or refrigeration systems
- Identify the relevant AS Standards applicable to servicing A2/A2L air conditioning or refrigeration systems
- Identify the manufacturers service requirements.

Content

- Manufacturers service instructions
- Ventilation requirements
- Refrigerant recovery
- Venting
- Flushing
- Changing an A2/A2L compressor

References

- AS/NZS 60079:2009 Explosive atmospheres
- AS/NZS 60335.2.40:2019, Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
- AS 2030.1 Gas cylinders - General Requirements
- AS 2381.1 Electrical equipment for explosive gas atmospheres
- AS/NZS 2430.3.1:2004 Classification of hazardous areas Examples of area classification - General.
- AS/NZS 3000:2018 Electrical installations “Wiring Rules”
- AS NZS 3500:2015 Plumbing and drainage
- AS 4332 The storage and handling of gases in cylinders
- AS 4484 Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding
- AS/NZS 5149.4:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Operation, maintenance, repair and recovery
- Refrigerant handling code of practice 2007
- "AIRAH Flammable refrigerant safety guide" and Fact Sheet on Installing systems with flammable refrigerants, freely available at: https://www.airah.org.au/Web/Resources/Technical_Resources/Other_Technical_Resources/AIRAH/Navigation/Resources/Other_Technical_Resources/Other_Technical_Resources.aspx?hkey=74c8e56d-58ba-4cc4-9069-ea4f03b49c4c#FRSG
- AIRAH’s Flammable Refrigerant Safety Guide – 2018 Update available at: https://www.airah.org.au/Content_Files/FRSG/FRSG-2018-Update.pdf?pdf=Flammable-Refrigerants-Update-One

11.1 Introduction

Due to the flammability of the refrigerant, different precautions equipment and procedures are required to service of Class A2/A2L refrigerant refrigeration and air conditioning systems than those use with typical Class A1 synthetic refrigerant systems to meet the relevant Regulations, Standards and manufacturers requirements, In particular:

- Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995
- AS/NZS 5149.4:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Operation, maintenance, repair and recovery
- AS/NZS 60335.2.40:2019, Household and similar electrical appliances — Safety, Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
- Refrigerant handling code of practice 2007

Note:
Under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, the RSS03 Restricted Split System Refrigerant Handling Licence issued by the Australian Refrigeration Council only permits the holder to handle a refrigerant for the installation and decommissioning of split systems less than 18kW. It does not permit them to handle a refrigerant for the servicing split systems, this requires the RAC01 Full Refrigeration and Air Conditioning Refrigerant Handling Licence.

External sources of ignition (naked flames, sparks from electrical equipment, etc.) must be isolated from the system (including any tools used). If it is absolutely necessary to have an electrical supply to equipment during servicing, then a constantly operating form of leak detection shall be located at the most critical point to warn of a potentially hazardous situation.

11.2 Manufacturers Service Instructions

AS/NZS 60335.2.40 states that an instruction manual is required to be supplied with the air conditioning appliance what it must contain is outlined in Annex DD of AS/NZS 60335.2.40 and includes details such as:

- Storage instructions and warnings
- The qualification and competency of installation and service personnel
- Information on appliance servicing

The servicing information provided in the instruction manual must cover securing the work area, checking for refrigerant, having a fire extinguisher if hot work is intended, controlling local ignition sources, ventilation of the work area, checks to the refrigeration equipment, checks to the electrical components and cabling, and instructions for repairs.
AS/NZS 5149.4 covers the operation, maintenance, repair and recovery of refrigerating systems and heat pumps and includes

- General requirements for operation instructions, instruction of operating personnel and documentation.
- Annex C Handling and storage of refrigerants
- Annex D In-service inspection

Refer to Appendix N: Manual for R32 Air Conditioner

11.3 Temporary Flammable Zone

Temporary Flammable Zone must be created around the system/work area where at least some emission of refrigerant is anticipated to occur during refrigerant charging or recovery. The size of the temporary flammable zone should be determined from the charge in the system being serviced, the density of the released refrigerant, and whether the system is indoors or in a well-ventilated area (e.g. outdoors). For example, for a domestic fridge or freezer it could be a minimum of two metres, for a small air conditioner or heat pump it could be three metres, for larger system with a larger charge, greater distances would be required***.***

11.4 Ventilation Requirements

The following precautions should be taken before working on the refrigerant circuit:

- obtain permit for hot work (if required)
- ensure that no inflammable materials are stored in the work area and that no ignition sources are present anywhere in the work area
- ensure that suitable fire extinguishing equipment is available
- ensure that the work area is properly ventilated before working on the refrigerant circuit or before welding and soldering work
- ensure that the leak detection equipment being used is non-sparking, adequately sealed or intrinsically safe (check with manufacturer for suitability of use with flammable gases)
- ensure that all maintenance staff have been instructed

11.5 Refrigerant Recovery

A2/A2L refrigerants which are HFCs, for example R32 are a controlled substance under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, which is administered by the Australian Refrigeration Council (ARC), therefore it is mandatory to recover this refrigerant from air conditioning and refrigeration systems during service work on the refrigeration circuit.

Other A2/A2L refrigerants which are HFOs, for example R1234yf are NOT a controlled substance under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, however is can still recommended to recover this refrigerant from air conditioning and refrigeration systems during service work on the refrigeration circuit as it is flammable and expensive.

11.5.1 Recovery Cylinder Safe Fill Capacity

This is the quantity of new liquid refrigerant that can be safely put to a cylinder which is determined using the following formula:

$$SFC = WC \times SFR$$

Where:

- SFC = Safe Fill Capacity in kilograms (kg's)
- WC = Water Capacity of the cylinder being filled in kilograms (kg's)
- SFR = Safe Fill Ratio for the refrigerant, based on its density compared to water and a factor to allow room for the liquid to expand due changes in the ambient temperature

All cylinders in Australia are stamped with their respective water capacity and this table lists of the common types.

Type	WC (kg)	Usual Tare Weight (kg)
M	4.5	4.5
NT	9	5.5
N	11	6.5
P	22	9.5
R	65	23

The Safe Fill Ratio number is based on the density of the refrigerant compared to water. Typical Safe Fill Ratios are listed on this table.

R32	0.78
R134a	1.05
R410A	0.81
R1234yf	0.79

Using the information in these two tables and applying the formula, an 'N' size cylinder can be safely filled with:

- 11 kg x 0.0.78 = 8.58 kg of new R32, and
- 11 kg x 1.05 = 11.55 kg of new R134a.

However, as recovered refrigerant may be contaminated and contain oil or water the safe filling capacity for Recovery Cylinders must be reduced by 80%.
Therefore, an 'N' size recovery cylinder can be safely filled with:

- 11 kg x 0.78x 80% = 6.86 kg of R32, and
- 11 kg x 1.05 x 80% = 9.24 kg of R134a.

11.5.2 Recovery units

The recovery pumps currently used with the Class A1 synthetic refrigerants are also materially compatible with the Class A2/A2L refrigerant range. The procedure for their use remains basically the same except for extra precautions due to the refrigerant flammability.

A new or existing recovery and reclaim unit needs to be assessed individually to ensure:

- It conforms with relevant International/ Australian Standards.
- The manufacturer's manual/specification states that it is designed for use with A2/A2L flammable refrigerants.
- All electrical components fitted to the device (including switches, pressure controls and motors) are sealed in a flameproof enclosure (i.e. are suitable for use in a flammable environment)
- Regular equipment maintenance is required to check for any possible new sources of electrical sparking.

11.6 Venting

This procedure involves the release to the atmosphere of HFO A2/A2L refrigerants, for example R1234yf which are NOT a controlled substance under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995.

Extreme care must be taken as they are flammable and the following outlines a typical procedure:

- The refrigerant should be vented into the outdoors
- Check for any sources of ignition
- Isolate any electrical devices in close proximity
- Isolate the appliance
- A flammable gas warning sign should be placed at the venting location if it is possible for untrained or unaware pedestrians to enter the site.

Appropriate signage

- Position a suitable fire extinguisher (Dry powder or CO_2) nearby
- Open the access valve
- The refrigerant flow rate should be kept low to ensure maximum dilution with air
- Allow the refrigerant to vent to the surrounding atmosphere
- Maintain constant lookout surrounding the venting point to ensure passing pedestrians/vehicles do not cause ignition or are placed in an unsafe situation
- Do not vent in a location that will allow the vapour (which is heavier than air), to collect in a drain system or recessed pit.

11.7 Flushing

When replacing or repairing any component that has anything to do with the refrigerant, the charge must be removed and the system flushed with Oxygen Free Dry Nitrogen. It will not react with any of the components within the system, prevents the entry of air and moisture and most importantly, will not burn.

Note:

Never use compressed air or oxygen as they become explosive when under pressure and in contact with oil.

Most forms of mechanical repair work on refrigeration and air conditioning systems operating on an A2/A2L refrigerant will require soldering or brazing work as they are usually a sealed hermetic system with a critical charge and all of the joints will be soldered or brazed. The following procedure should be carried out when preparing the system for hot work:

Dry Nitrogen Flushing:

- Obtain permit for hot work (as required)
- Set up a temporary flammable zone
- Remove the refrigerant charge using an appropriate method
- Charge the circuit with dry nitrogen to a suitable positive pressure equivalent to 25°C for the refrigerant used for example for R32, 1590 kPa.
- Allow the system to stand for a short period (3 to 5 minutes) then release the dry nitrogen to atmosphere
- Evacuate the system to a pressure of -70kPa gauge.
- Charge the circuit again with dry nitrogen to a pressure equivalent to 25°C
- Allow the system to stand then release the dry nitrogen to atmosphere

Continuous Dry Nitrogen Purging:

- Access the other side of the system (usually the high-pressure side)
- Allow the dry nitrogen to flow (at very low pressure) through the area being brazed
- Carry out the brazing work

Remember:

The compressor oil will have adsorbed a large quantity of the refrigerant and may continue to release refrigerant vapours while you are brazing. Purging the system with dry nitrogen while you braze will:

- Dilute the flammable vapour
- Prevent the formation of carbon/scale inside the pipework

11.8 Replacing A2/A2L Compressor - Sample procedure

- Isolate Power
- Review SDS and wear appropriate PPE
- Conduct a WHS Risk Assessment (JSA or SWMS)
- Obtain Hot Work permit if required to meet WHS requirements
- Always follow manufacturers requirements
- Set up a work area Temporary Flammable Zone with safety barrier/sign
- Make sure there is adequate ventilation and if necessary, set up extraction system using explosion proof fan motor to direct gases elsewhere
- Connect gauges
- Connect approved recovery unit and recover refrigerant into approved Flammable refrigerant reclaim bottle
- Open one side of system at flare nut if possible or use a tube cutter to cut the tubing
- Connect Oxygen Free Dry Nitrogen and bleed it through to displace the residual refrigerant and prevent concentration levels conducive to ignition.
- Manually cut pipes at compressor or if this cannot be done, cut pipes connecting compressor at another location
- Disconnect compressor electrically, and electrically isolate cable ends
- Remove compressor
- Replace compressor
- Re-braze existing pipework to new compressor, whilst bleeding dry nitrogen through system
- Pressure test system using Oxygen Free Dry Nitrogen.
- Evacuate system to 500 microns
- Re-connect electrical terminals to new compressor as per manufacturers requirements.
- Recharge system to manufacturers base refrigerant charge
- Re-engage power
- Operate system, test system and finalise refrigerant charge.
- Carry out a final leak test.

11.9 Skill Practice
- Service an A2/A2L air conditioning or refrigeration system

Purpose:
This practical exercise requires the learner to apply the required knolwedge and skills to service an A2/A2L air conditioning ot refrigeration system in accordance with relevant Regulations, Standards, Codes of Practice and manufacturers' requirements.

Note:
Under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995, the RSS03 Restricted Split System Refrigerant Handling Licence issued by the Australian Refrigeration Council only permits the holder to handle a refrigerant for the installation and decommissioning of split systems less than 18kW. It does not permit them to handle a refrigerant for the servicing split systems, this requires the RAC01 Full Refrigeration and Air Conditioning Refrigerant Handling Licence.

Therefore, this Skill Practice can NOT be carried out by those who hold the RSS03 Restricted Split System Refrigerant Handling Licence.

Equipment to be supplied by training facility / college:
An A2/A2L refrigeration or air conditioning system, refrigerant removal/recovery equipment, evacuation and charging equipment and tools, measuring instruments, pressure testing equipment, leak testing equipment, refrigeration copper tube and fittings; tube cutters; tube bending tools; flaring and swaging tools; soldering and brazing equipment tools and consumables; dry nitrogen equipment tools, A2/A2L refrigerant, lubricants and consumables.

Aids to be supplied by student
- Stationary, Calculator, Ruler, Pens
- Acceptable Personal Protective Equipment

Instructions to Learner
- Mobile phones are to be turned off and removed from your person.
- You may use any text or reference book or notes for this exercise.
- All sections must be attempted.
- You will not be permitted to carry out this exercise if you do not have the required Personal Protective Equipment (safety glasses, correct clothing, and correct footwear).

Activity 1 – Risk Assessment

Task
Carry out a Risk Assessment for a work area containing the A2/A2L refrigeration or air conditioning system and the refrigerant cylinder.

Procedure
Identify and record the details below of the A2/A2L system and cylinder/s in the work area:

A2/A2L refrigeration/air conditioning system		**A2/A2L refrigerant cylinder/s**	
System Type		Refrigerant type and size	
System Make		Refrigerant weight	
System Model Number		Recovery cylinder size	
Refrigerant Type		Refrigerant weight in cylinder	
Refrigerant Charge			

3. Inspect the work area and record on the following table:

   e) **Risks/hazards**, especially those associated with A2/A2L system or cylinders including electrical, mechanical and ignition hazards, low spots and trench's, etc.
   f) Possible '**consequences of the hazards**' (how you or others may be injured).
   g) **Risk class** (A, B or C) using the table below.

Risk Classification		
A	High risk	Potential death or permanent disablement)
B	Medium risk	Potential serious injury/illness and temporary disablement)
C	Low risk	Potential minor injury, no lost time)

   h) **Control measures** required to minimise each of the risks.

Risk Assessment

e) Risk or Hazard	f) Consequence of the hazard	g) Risk Class	h) Control Measures

Activity Completed: YES/NO Teacher's Initials: …… Date: ……

Activity 2 - Access System

Task:
Gain access to the refrigerant charge in an operating A2/A2L system.

This may be achieved with the aid of bullet piercing valves, tube piercing pliers or service valves, depending upon the system type.

You must:
- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Set up a temporary flammable zone
- ☐ Use appropriate tools and techniques to connect to access the system's refrigerant system.

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 3 - Remove/Recover Refrigerant

Task:
Safely remove the A2/A2L refrigerant charge from the system.

This may be achieved by recovering the refrigerant into a suitable cylinder by applying approved techniques and comply all applicable WH&S requirements and hazard control measures.

You must:
- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Connect the A2/A2L recover unit and A2/A2L recover cylinders
- ☐ Recover all of the refrigerant from the system.
- ☐ Record the quantity of refrigerant recovered_____kg

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 4 - Make System Safe for 'hot-work'

Task:
Prepare and make the system safe for hot-work.

This may be achieved by applying any one of the following acceptable techniques:
- ☐ Nitrogen flushing
- ☐ Continuous nitrogen purge

You must:
- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Apply an appropriate purging/flushing technique.

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 5 - Replace System Component/Pipework

Task:
Replace a soldered component or length of pipe on an A2/A2L system.

This may be achieved by applying any one of the following acceptable techniques:
- ☐ Oxy-acetylene and the correct grade of silver solder and/or flux
- ☐ Air-acetylene and the correct grade of silver solder and/or flux
- ☐ MAPP gas and the correct grade of silver solder and/or flux

You must:
- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Apply appropriate brazing/soldering techniques.

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 6 - Pressure Test and Repair Leaks

Task:
Pressure test and repair if necessary, any leaks found on an A2/A2L system.

You must:
- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Determine the test pressure value suitable for the application/system type.

Do not proceed any further.
Advice your teacher of the value/s you have chosen to use.

System refrigerant type _____

Pressure testing level for the system you are working on:

High side_____kPa Low side_____kPa

- ☐ Connect Oxygen Free Dry Nitrogen cylinder and regulator are connected correctly.
- ☐ Safely introduce Oxygen Free Dry Nitrogen to the system to required pressure level.
- ☐ Check for leaks using an accepted method and any leaks found are rectified appropriately.
- ☐ Repair any leaking joints or replace and leaking component
- ☐ Discharged Oxygen Free Dry Nitrogen from the system safely and in a controlled manner.

Activity Completed: YES/NO Teacher's Initials: ……Date:……

Activity 7 - Evacuate System

Task:
Evacuate the A2/A2L system.

You must:

- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Re-fit the service gauges to the system correctly (after pressure testing) ready for evacuation.
- ☐ Check the vacuum pump for efficiency prior to starting evacuation.
- ☐ Fit a suitable device to measure the vacuum level achieved.
- ☐ Check gauge connections are regularly for tightness, once evacuation has started
- ☐ Provide a description of 'Triple Evacuation'.

_____

_____

_____

Vacuum Required?_____

Vacuum Obtained?_____

- ☐ Provide a description of 'Deep Evacuation'.

_____

_____

_____

- ☐ Disconnect the vacuum pump ensuring that no loss of vacuum occurs.
- ☐ Prepare the system for re-charging with refrigerant.
- ☐ Ensure a vacuum pump retains efficient operation
- ☐ Describe the maintenance activity that should be carried out regularly on the vacuum pump?

_____

_____

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 8 - Charge System with Refrigerant and Check Operation

Task:
Charge an A2/A2L system with the correct quantity of refrigerant.

You must:

- ☐ Comply with all applicable WH&S requirements and hazard control measures.
- ☐ Obtain the correct refrigerant.
- ☐ Connect gauges to cylinder correctly.
- ☐ Correctly identify whether to liquid or vapour charge the system.
- ☐ Identify the correct charging point (dependent upon the charging style being used).
- ☐ Charge the correct amount into the system.
- ☐ Check system pressures and temperatures to confirm correct operation.
    - **(Check with your teacher for confirmation at this point)**.

- ☐ Record below the operating conditions of the system:

Ambient Temperature:_____
Suction Pressure:_____
Evaporation Temperature:_____
Discharge Pressure:_____
Condensing Temperature:_____
Compressor Rated Full Load Current:_____
Compressor Operating Current:_____

- ☐ Disconnect the refrigerant cylinder and service gauge from the system safely and with no loss of refrigerant charge.
- ☐ Remove and seal access valves
- ☐ Carry out a final leak test and repair any leaks found
- ☐ Leave the system as required – check with your assessor if to be left operating.

System refrigerant_____Quantity charged _____

Activity Completed: YES/NO Teacher's Initials: ……Date: ……

Activity 9 – Complete Documentation

Task:
Document relevant information/changes made to the A2/A2L system as required by relevant codes and standards.

You must:
- ☐ Pack away all tools & equipment correctly
- ☐ Remove any rubbish from work area
- ☐ Leave the work area safe for others.
- ☐ Complete the 'service tag' below, filling in the relevant information.

Refrigerant type used:_____

Refrigerant oil type used:_____

Ultraviolet dye added:_____

Service person name:_____

Service person ARC licence no:_____

Business name:_____

Date of service:_____

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Activity Completed: YES/NO Teacher's Initials: ……Date: ……

11.10 Section Summary

- A cylinder used to store recovered refrigerant may only filled to 80% if its' water capacity
- Recovery units must be checked to ensure they are approved for use with A2/A2L refrigerants,
- Always use Oxygen Free Dry Nitrogen (OFDN) as a flushing agent
- Always use the recommended flushing/purging procedure prior to opening up a circuit for replacement or repair work

11.11 Review Questions

Question 1

Calculate the safe fill capacity for an N type cylinder to be filled with new R410a.

Question 2

Calculate the safe fill capacity for an N type cylinder to be filled with new R32.

Question 3

Calculate the safe fill capacity for an N type cylinder to be filled with recovered R32.

Question 4

Identify at least 2 of the primary safety issues to be considered while performing the Venting procedure.

Question 5

What is the purpose of a Temporary Flammable Zone and when should it be used?

Question 6

What is the purpose of Flushing a system and when should it be used?

Question 7

Name the only safe Flushing agent to be used with all refrigeration systems.

11.12 Your Notes

Appendix

A. Glossary of useful terms

1. **Acute Toxicity.**
   Adverse health effect[s] from a single, short-term exposure.

2. **ADG Code.**
   Australian Code for the Transport of Dangerous Goods by Road and Rail. As a code, it provides a basis for State Governments to provide legislation for packaging, marking, transport and storage of dangerous goods.

3. **Asphyxiant.**
   A substance which, as a gas or vapour, can cause suffocation due to a lack of oxygen.

4. **Auto Ignition Temperature.**
   The lowest temperature at which a flammable gas or vapour in an air mixture will ignite from its own heat source without needing a spark or flame.

5. **Chronic Toxicity.**
   Adverse health effect[s] from long-term repeated exposures.

6. **Competent Person.**
   Defined by the Industrial Commission as a person suitably qualified (by qualification, experience and/or experience) to carry out the kind of work for which the person is required or engaged to perform the required task (to comply with the Standard/Code).

7. **Cylinder.**
   A container, which is designed to be refilled, with a capacity of more than 100mL and less than 500 litres (i.e. not a bulk container which are greater than 500 litres) for packing Class 2 goods.

8. **Dangerous Goods Class.**
   The Dangerous Goods class is a number assigned to a group of dangerous goods which exhibit a single or most significant risk by certain criteria. Occupiers are expected to know the difference between dangerous goods and hazardous substances, which are classified according to different criteria Dangerous goods have immediate effects and are explosive, flammable, corrosive, chemically reactive, highly combustible, acutely toxic, radioactive or infectious, that may affect life, health, property or the environment. Hazardous substances are classified only on the basis of immediate or long term health effects.
   Dangerous goods and hazardous substances are covered by separate regulations, standards and codes, each focusing on controlling the different risks described above. Since many hazardous substances are also classified as dangerous goods, both sets of requirements will apply in these cases.

9. Earth.

To reduce the potential of an item to that of the ground, normally by direct connection with a conductive cable or strap. It reduces the risk of static electricity discharges.

10. Exemption Limit.

Is the maximum quantity of a dangerous substance for which no placarding is required? It depends on the dangerous goods class and packaging group. The greater the hazard, the lower the Exemption Limit.

11. Exposure Standards.

Exposure standards detail levels of airborne concentrations of substances which, according to current knowledge, does not impair the health, or cause discomfort to the workers. Exposure standards are generally expressed as a time weighted average (TWA) concentration of a substance over an eight hour working shift, and applied to an eight hour day, for a five day week over an entire working lifetime. TWA permit exclusions above the limit provided that they are compensated by equivalent excursions below the limit during the workday.

12. Flammability Limits.

The concentration range of a flammable vapour in air at which a flame can be propagated will occur, with an ignition source under specific test conditions at $23^{O}C$ and 101.3 kPa absolute. There is always an upper limit (UFL) above which the mixture is too rich and will not burn and a lower limit (LFL) below which the mixture is too lean and will not burn. The wider the gap between the flammability limits, the more violent the explosion of a cloud of vapour when it reaches a source of ignition.

13. Flammable Liquid.

Any substance that will ignite when in a liquid form is considered to be a class 3 substance. Note that the vapour form of that substance may not necessarily be flammable. Gasoline (or petrol) is an example of a flammable liquid.

14. Flammable Vapour.

Any substance that will ignite when in a vapour form is considered to be a class 2.1 substance. Note that the liquid form of that substance will not necessarily flammable. The A2/A2Ls are all flammable vapours but are not flammable liquids.

15. Flashpoint.

The flashpoint is the lowest temperature at atmospheric pressure (101.3 kPa) at which a liquid gives off so much combustible vapour at the liquid surface that this vapour, when mixed intimately with air, can be ignited by a flame or spark. The lower the flashpoint value the higher the risk of ignition and fire.

16. Globally Harmonised System (GHS)

Under the Work Health and Safety Regulations, hazardous chemicals must be classified according to the globally harmonised system for the classification and labelling of chemicals (GHS).

17. Hazchem Code.

The Hazchem (emergency action) code provides information to emergency response services in terms of the type of extinguishing agent, protective equipment, spill containment, prospects for violent reaction and the need for evacuation.

The code consists of a number followed by a letter, and an optional third letter 'E', e.g... 3YE

18. Hazardous Atmosphere.

A hazardous atmosphere is one in which:

- There is not a safe oxygen level for breathing; or
- Concentrations of hazardous gases, vapours, mists, fumes and dusts are at or above relevant exposure standards: or
- The concentration of flammable gases, vapours, mists, fumes and dusts is at or above 5 per cent of the lower explosion limit.

19. Hydrocarbon.

A substance containing only hydrogen and carbon.

20. LC 50.

A concentration of a substance in air that produces death in 50 per cent of experimental animals on short term inhalation expressed in mass per unit volume of air.

21. LD 50.

The amount of substance that produces death in 50 per cent of a population of experimental animals. Normally expressed as milligrams per kilogram of body weight.

22. Safety Data Sheet (SDS)

A document describing the properties of a substance defined in the National Commission's National Code of Practice for Completion of Safety data Sheets.

23. Threshold Limit Value.

In three categories, these values are an exposure standard determined by the American Conference of Governmental Hygienists (ACGIH) It is the airborne concentration of substances at which persons may be exposed in the course of their daily work, on an indefinite basis without adverse effect.

24. Toxicity.

The potential ability of a substance to cause deleterious (toxic) effects.

Low: causes readily reversible changes which disappear after exposure stops. Causes some discomfort.

Moderate: May cause reversible or irreversible changes to exposed tissue but not permanent injury. Causes considerable discomfort.

High: capable of causing death or permanent injury in normal use.

25. Workplace.

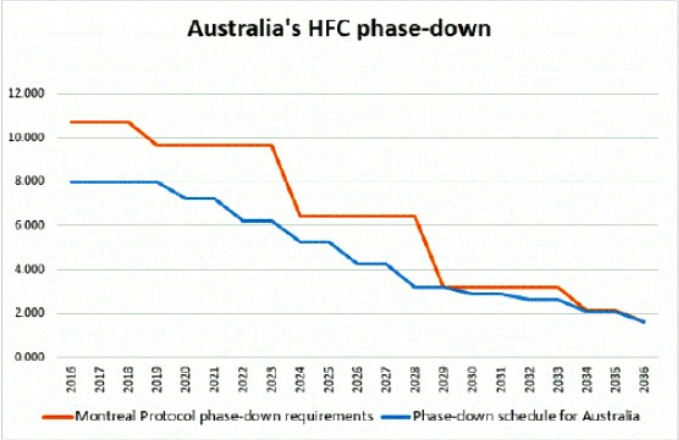
Any place, including aircraft, ship or vehicle, where a person works, is likely to work, or goes to while at work.

B. HFC Phase-down Fact Sheet

Australian Government
Department of the Environment and Energy

AUSTRALIA'S HFC PHASE-DOWN

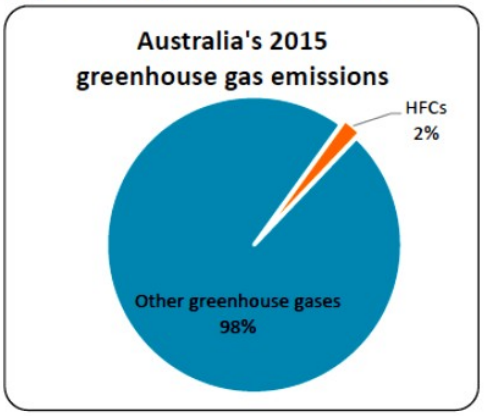
What is the HFC phase-down? An international phase-down of hydrofluorocarbons (HFC) was agreed under the Montreal Protocol on Substances that Deplete the Ozone Layer in 2016. Australia started a gradual phase-down of HFC imports from 1 January 2018. The HFC phase-down is contributing to Australia's 2030 greenhouse gas emissions reduction target and is encouraging industry to move to alternative technologies using lower or zero global warming potential gases. The phase-down is being managed through an annual import quota that will gradually reduce over 18 years. The end point of the phase-down, 15% of the baseline level, will be reached on 1 January 2036.



What are HFCs? HFCs are synthetic greenhouse gases, primarily used in refrigeration and air-conditioning equipment, but also in fire protection, foam blowing and aerosols and for medical and veterinary uses.

What effect do HFCs have on the environment? HFCs do not deplete the ozone layer, however they generally have a high global warming potential.

What does the HFC phase-down cover? The phase-down applies to all commonly used high global warming potential HFCs, either alone or contained in a blend with other chemicals. The phase-down only applies to bulk imports of HFCs such as in cylinders, and will not apply to gas imported in pre-charged equipment such as air-conditioners or refrigerators. Under the Montreal Protocol, HFCs contained in imported equipment are accounted for in the country of manufacture.



What alternative gases can replace HFCs? Several suitable alternatives with no or very low global warming potential are available in Australia, including ammonia, carbon dioxide, hydrocarbons and hydrofluoroolefins (HFOs). These gases are not regulated under the Ozone Protection and Synthetic Greenhouse Gas Management legislation unless they are in a blend containing an HFC.

Who will be immediately affected by the phase-down?

- Importers of bulk gas containing HFCs.

Who else will be affected by the phase-down?

- Technicians - Technicians will still be able to purchase HFCs to maintain equipment.
- HFC equipment importers and retailers - There will be no quota for HFCs in pre-charged equipment, such as air-conditioners and refrigerators. New equipment using alternatives to HFCs will be developed and enter the market over time.
- Other industries and applications that use HFCs, including foam blowing, aerosol propellants, fire protection and medical devices – the gradual phase-down and 15% residual will provide certainty in the transition to alternatives.
- Consumers - There is no requirement to replace the HFC in existing equipment. New equipment containing alternatives to HFCs will be developed and enter the market over time.

C. R32 Properties and Applications

Pack Sizes

9KG cylinder

A-GAS®

R32 Properties and Applications

R32 refers to Difluoromethane a flammable HFC refrigerant that has been used extensively as a component of 400 series blends but not on its own until recently. R32 is now being used by air conditioning OEMS as a low GWP HFC alternative to R410A.

Physical Properties

- ASHRAE A2L classification
- Mildly flammable
- Zero ODP
- Molecular weight is 52.02
- Boiling point at 1 ATM is –51.65 °C
- Critical Temperature is 78.4 °C
- GWP of 650 (IPCC assessment report 2)

PT Chart

Temp ⁰ C	Bubble Pressure KPa
-38	92.76
-34	129.79
-30	172.12
-26	220.24
-22	274.68
-18	335.96
-14	404.65
-10	481.31
-6	566.53
-2	660.94
0	711.78
2	765.15
6	879.8
10	1005.6
14	1143.2
18	1293.3
22	1456.6
26	1634
30	1826.2
34	2034

Applications

- Domestic and commercial air-conditioning

Usage Instructions

- R32 cannot be used as a 'drop-in' replacement for R410A in existing systems
- Charging can be done in liquid or vapour phase
- R32 cannot be discharged to atmosphere. Always recover R32 into a special R32 reclaim cylinder

Convenient • Simple • Transparent

A-Gas (Australia) Pty Ltd
9-11 Oxford Road
Laverton North, VIC 3026
Australia
T 1800 002 427
F [+61] (0) 3 9368 9233
info.au@agas.com
www.agas.com
A-Gas AU11734

A-GAS®

Storage & Handling of Gases in Cylinders

The purpose of this document is to provide the user with a brief overview of the key elements to review when considering storage & handling of gases in cylinders. There are many resources and regulations available, please visit AIRAH website for more information.

1. **Gas Classes**
   - Class 2.1 = Flammable gases (hydrogen, R32)
   - Class 2.2 = Non flammable, non toxic (most refrigerants)
   - Class 2.3 = Toxic Gases (ETO, Methyl Bromide)

2. **General Information**
   - All cylinders are treated as full (whether empty or connected to a system)
   - Cylinders should be restrained at all times.
   - All storage areas should be protected from unauthorised access (i.e. locked).
   - All storage areas should have natural ventilation (or calculate exposure levels for any gases if stored internally, refer AS1668.2 for mechanical ventilation).
   - All cylinders should be kept away from all heat sources, out of the sun, and free from sources of ignition (power points, lights, switches, etc)
   - The store should not be within 1 metre of any window, door, air vent or duct.
   - The storage area should have appropriate signage

3. **R32 Storage**
   - R32 is classified as a 2.1 Flammable Dangerous Good and should therefore be stored outside
   - All areas identified above in 'General Information' should be considered

Maximum quantity allowed for minor storage

Class of gas	Maximum water capacity, L
2.1	500
2.2	2000
2.2, subclass 5.1 Risk	1000
2.3	50

For further information on flammable refrigerants please refer to the AIRAH flammable refrigerant safety guide:

http://www.airah.org.au/iMIS15_Prod/AIRAH/Resources/Technical_Resources/AIRAH/Navigation/Resources/TechnicalResources/Technical_Resources.aspx

* Please update the relevant authority regarding the storage of dangerous goods by filling the *"Notification of Dangerous Goods Storage and Handling"* form

D. R32 - Safety Data Sheet

BOC
A Member of The Linde Group

SAFETY DATA SHEET

 # 009

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name	**R32**
Synonyms	009 - SDS NUMBER • GENETRON 32 • HFC32

1.2 Uses and uses advised against

Uses	REFRIGERANT

1.3 Details of the supplier of the product

Supplier name	**BOC LIMITED (AUSTRALIA)**
Address	10 Julius Avenue, North Ryde, NSW, 2113, AUSTRALIA
Telephone	131 262, (02) 8874 4400
Fax	132 427 (24 hours)
Website	http://www.boc.com.au

1.4 Emergency telephone numbers

Emergency	1800 653 572 (24/7) (Australia only)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

Physical Hazards

Flammable Gases: Category 1B
Gases Under Pressure: Liquefied gas

Health Hazards

Not classified as a Health Hazard

Environmental Hazards

Not classified as an Environmental Hazard

2.2 GHS Label elements

Signal word	**DANGER**

Pictograms

Hazard statements

H221	Flammable gas.
H280	Contains gas under pressure; may explode if heated.

Prevention statements

P210	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.

Response statements

P377	Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381	In case of leakage, eliminate all ignition sources.

Storage statements

P403 Store in a well-ventilated place.

Disposal statements

None allocated.

2.3 Other hazards

Asphyxiant. Effects are proportional to oxygen displacement.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
DIFLUOROMETHANE (HFC-32)	75-10-5	200-839-4	100%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye Cold burns: Immediately flush with tepid water or with sterile saline solution. Hold eyelids apart and irrigate for 15 minutes. Seek medical attention.

Inhalation If inhaled, remove from contaminated area. To protect rescuer, use an Air-line respirator or Self Contained Breathing Apparatus (SCBA). Be aware of possible explosive atmospheres. Apply artificial respiration if not breathing. Give oxygen if available. For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor.

Skin Cold burns: Remove contaminated clothing and gently flush affected areas with warm water (30°C) for 15 minutes. It is recommended that warm water is applied to clothing before removing it so as to prevent further skin damage. Apply sterile dressing and treat as for a thermal burn. For large burns, immerse in warm water for 15 minutes. DO NOT apply any form of direct heat. Seek immediate medical attention.

Ingestion Due to product form and application, ingestion is considered unlikely.

First aid facilities None allocated.

4.2 Most important symptoms and effects, both acute and delayed

In high concentrations may cause asphyxiation. Direct contact with the liquefied material or escaping compressed gas may cause frostbite injury.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Stop flow of gas if safe to do so, such as by slowly closing the cylinder valve.

5.2 Special hazards arising from the substance or mixture

Flammable. Eliminate all ignition sources including cigarettes, open flames, spark producing switches/tools, heaters, naked lights, pilot lights, mobile phones etc. when handling.

5.3 Advice for firefighters

Temperatures in a fire may cause cylinders to rupture and internal pressure relief devices to be activated. Cool cylinders or containers exposed to fire by applying water from a protected location. Do not approach cylinders or containers suspected of being hot. This material is capable of forming explosive mixtures in air.

5.4 Hazchem code

2SE

2 Fine Water Spray.

S Risk of violent reaction or explosion. Wear full fire kit and breathing apparatus. Dilute spill and run-off.

E Evacuation of people in and around the immediate vicinity of the incident should be considered.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

If the cylinder is leaking, evacuate area of personnel. Inform manufacturer/supplier of leak. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. Ensure adequate air ventilation. Eliminate all sources of ignition. Consider the risk of potentially explosive atmospheres.

6.2 Environmental precautions

Prevent from entering sewers, basements and workpits, or any place where its accumulation can be dangerous.

6.3 Methods of cleaning up

Carefully move material to a well ventilated remote area, then allow to discharge if safe to do so. Do not attempt to repair leaking valve or cylinder safety devices.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Do not drag, drop, slide or roll cylinders. The uncontrolled release of a gas under pressure may cause physical harm. Use a suitable hand truck for cylinder movement.

7.2 Conditions for safe storage, including any incompatibilities

Store cylinders securely, in separate area in an upright position in cool (<65°C), dry, well ventilated area, removed from incompatible substances, heat or ignition sources and foodstuffs. Ensure cylinders are labelled, protected from physical damage and valves closed when not in use. Make use of old stock first (using a "first in-first out" inventory system), and do not store empty and full cylinders together.

7.3 Specific end uses

No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Flammable/explosive vapours may accumulate in poorly ventilated areas. Maintain vapour levels below the recommended exposure standard.

PPE

Eye / Face	Wear safety glasses.
Hands	Wear leather gloves.
Body	Wear safety boots.
Respiratory	Where an inhalation risk exists, wear Self Contained Breathing Apparatus (SCBA) or an Air-line respirator.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	COLOURLESS LIQUID
Odour	SLIGHT SWEET AND ETHEREAL ODOUR
Flammability	FLAMMABLE
	NOT AVAILABLE

9.1 Information on basic physical and chemical properties

Flash point	
Boiling point	-43°C
Melting point	NOT AVAILABLE
Evaporation rate	NOT APPLICABLE
pH	NOT APPLICABLE
Vapour density	NOT AVAILABLE
Relative density	NOT APPLICABLE
Solubility (water)	NOT AVAILABLE
Vapour pressure	1,640 kPa @ 21°C
Upper explosion limit	33.4 %
Lower explosion limit	12.7 %
Partition coefficient	NOT AVAILABLE
Autoignition temperature	750°C
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

9.2 Other information

% Volatiles	100 %

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization will not occur.

10.4 Conditions to avoid

Avoid shock, friction, heavy impact, heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites), alkalis (e.g. sodium hydroxide) and alkaline earth metals (e.g. manganese).

10.6 Hazardous decomposition products

May evolve toxic gases if heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity Based on available data, the classification criteria are not met.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
DIFLUOROMETHANE (HFC-32)	--	--	1810 g/m³ (mouse)

Skin Not classified as a skin irritant. Contact with the liquefied material or escaping compressed gas may cause frostbite injury.

Eye Not classified as an eye irritant. Contact with the liquefied material or escaping compressed gas may cause frostbite injury.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Asphyxiant. Effects are proportional to oxygen displacement. Over exposure may result in dizziness, drowsiness, weakness, fatigue, breathing difficulties and unconsciousness.

STOT - repeated exposure	Not classified as causing organ damage from repeated exposure.
Aspiration	Not classified as causing aspiration.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
No information provided.

12.2 Persistence and degradability
No information provided.

12.3 Bioaccumulative potential
No information provided.

12.4 Mobility in soil
No information provided.

12.5 Other adverse effects
Global warming has been predicted as a potential consequence of the emission of this product.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal	Cylinders should be returned to the manufacturer or supplier for disposal of contents.
Legislation	Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	3252	3252	3252
14.2 Proper Shipping Name	DIFLUOROMETHANE (REFRIGERANT GAS R 32)	DIFLUOROMETHANE (REFRIGERANT GAS R 32)	DIFLUOROMETHANE (REFRIGERANT GAS R 32)
14.3 Transport hazard class	2.1	2.1	2.1
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards
No information provided.

14.6 Special precautions for user

Hazchem code	2SE
GTEPG	2A2
EmS	F-D, S-U
Other information	Ensure cylinder is separated from driver and that outlet of relief device is not obstructed.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule	A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safe Work Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals (GHS Revision 7).

Inventory listings **AUSTRALIA: AIIC (Australian Inventory of Industrial Chemicals)**
All components are listed on AIIC, or are exempt.

16. OTHER INFORMATION

Additional information

The storage of significant quantities of gas cylinders must comply with AS4332 The storage and handling of gases in cylinders.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m^3	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

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Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

E. R1234yf Pressure/Temperature Chart

F. R1234yf Safety Data Sheet

BOC
A Member of The Linde Group

SAFETY DATA SHEET

 # 2968

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name	**SOLSTICE® YF REFRIGERANT (R-1234YF)**
Synonyms	160HFO1234YFM - BOC PRODUCT CODE • 2968 - SDS NUMBER • R-1234YF

1.2 Uses and uses advised against

Uses	REFRIGERANT

1.3 Details of the supplier of the product

Supplier name	**BOC LIMITED (AUSTRALIA)**
Address	10 Julius Avenue, North Ryde, NSW, 2113, AUSTRALIA
Telephone	131 262, (02) 8874 4400
Fax	132 427 (24 hours)
Website	http://www.boc.com.au

1.4 Emergency telephone numbers

Emergency	1800 653 572 (24/7) (Australia only)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

Physical Hazards

Flammable Gases: Category 1B
Gases Under Pressure: Liquefied gas

Health Hazards

Not classified as a Health Hazard

Environmental Hazards

Not classified as an Environmental Hazard

2.2 GHS Label elements

Signal word	**DANGER**
Pictograms	

Hazard statements

H221	Flammable gas.
H280	Contains gas under pressure; may explode if heated.

Prevention statements

P210	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.

Response statements

P377	Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381	In case of leakage, eliminate all ignition sources.

Storage statements

P403 + P233 Store in a well-ventilated place. Keep container tightly closed.

Disposal statements

None allocated.

2.3 Other hazards

Asphyxiant. Effects are proportional to oxygen displacement. Contact with evaporating liquid may cause frostbite or freezing of skin.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content (v/v)
2,3,3,3-TETRAFLUOROPROP-1-ENE	754-12-1	616-220-0	100%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye Cold burns: Immediately flush with tepid water or with sterile saline solution. Hold eyelids apart and irrigate for 15 minutes. Seek medical attention.

Inhalation If inhaled, remove from contaminated area. To protect rescuer, use an Air-line respirator or Self Contained Breathing Apparatus (SCBA). Be aware of possible explosive atmospheres. Apply artificial respiration if not breathing. Give oxygen if available. For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor.

Skin Cold burns: Remove contaminated clothing and gently flush affected areas with warm water (30°C) for 15 minutes. It is recommended that warm water is applied to clothing before removing it so as to prevent further skin damage. Apply sterile dressing and treat as for a thermal burn. For large burns, immerse in warm water for 15 minutes. DO NOT apply any form of direct heat. Seek immediate medical attention.

Ingestion Due to product form and application, ingestion is considered unlikely.

First aid facilities None allocated.

4.2 Most important symptoms and effects, both acute and delayed

In high concentrations may cause asphyxiation. Direct contact with the liquefied material or escaping compressed gas may cause frostbite injury.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Stop flow of gas if safe to do so, such as by slowly closing the cylinder valve.

5.2 Special hazards arising from the substance or mixture

Flammable. Eliminate all ignition sources including cigarettes, open flames, spark producing switches/tools, heaters, naked lights, pilot lights, mobile phones etc. when handling. May evolve carbon oxides, hydrogen fluoride and carbonyl halides when heated to decomposition.

5.3 Advice for firefighters

Temperatures in a fire may cause cylinders to rupture and internal pressure relief devices to be activated. Cool cylinders or containers exposed to fire by applying water from a protected location. Do not approach cylinders or containers suspected of being hot. This material is capable of forming explosive mixtures in air.

5.4 Hazchem code

2YE

2 Fine Water Spray.

Y Risk of violent reaction or explosion. Wear full fire kit and breathing apparatus. Contain spill and run-off.

E Evacuation of people in and around the immediate vicinity of the incident should be considered.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

If the cylinder is leaking, evacuate area of personnel. Inform manufacturer/supplier of leak. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. Ensure adequate air ventilation. Eliminate all sources of ignition. Consider the risk of potentially explosive atmospheres.

6.2 Environmental precautions

Prevent from entering sewers, basements and workpits, or any place where its accumulation can be dangerous.

6.3 Methods of cleaning up

Carefully move material to a well ventilated remote area, then allow to discharge if safe to do so. Do not attempt to repair leaking valve or cylinder safety devices.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Do not drag, drop, slide or roll cylinders. The uncontrolled release of a gas under pressure may cause physical harm. Use a suitable hand truck for cylinder movement.

7.2 Conditions for safe storage, including any incompatibilities

Store cylinders securely, in separate area in an upright position in cool (<65°C), dry, well ventilated area, removed from incompatible substances, heat or ignition sources and foodstuffs. Ensure cylinders are labelled, protected from physical damage and valves closed when not in use. Make use of old stock first (using a "first in-first out" inventory system), and do not store empty and full cylinders together.

7.3 Specific end uses

No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Flammable/explosive vapours may accumulate in poorly ventilated areas. Maintain vapour levels below the recommended exposure standard.

PPE

Eye / Face	Wear safety glasses.
Hands	Wear leather gloves.
Body	Wear safety boots.
Respiratory	Where an inhalation risk exists, wear a Type A-Class P1 (Organic gases/vapours and Particulate) respirator. Where the boiling point is < 65°C, use an AX filter type.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	COLOURLESS LIQUEFIED GAS
Odour	SLIGHT ODOUR
Flammability	FLAMMABLE

9.1 Information on basic physical and chemical properties

Flash point	-104°C
Boiling point	-29.4°C
Melting point	NOT AVAILABLE
Evaporation rate	NOT AVAILABLE
pH	NOT AVAILABLE
Vapour density	4 (Air = 1)
Relative density	0.93 to 0.97
Solubility (water)	198.2 mg/L @ 24°C
Vapour pressure	6067 hPa @ 21.1°C
Upper explosion limit	12.3 to 13.3 (neat)
Lower explosion limit	6 % (Ethylene)
Partition coefficient	2.15 (n-Octanol/Water)
Autoignition temperature	405°C
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization will not occur.

10.4 Conditions to avoid

Avoid shock, friction, heavy impact, heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites), alkalis (e.g. sodium hydroxide) and alkaline earth metals (e.g. manganese). Incompatible with finely divided aluminium and magnesium.

10.6 Hazardous decomposition products

May evolve carbon oxides, hydrogen fluoride and carbonyl halides when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity Based on available data, the classification criteria are not met.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
2,3,3,3-TETRAFLUOROPROP-1-ENE	--	--	> 400000 ppm/4hrs (rat)

Skin Not classified as a skin irritant. Contact with the liquefied material or escaping compressed gas may cause frostbite injury.

Eye Not classified as an eye irritant. Contact with the liquefied material or escaping compressed gas may cause frostbite injury.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Asphyxiant. Effects are proportional to oxygen displacement. Over exposure may result in dizziness, drowsiness, weakness, fatigue, breathing difficulties and unconsciousness.

STOT - repeated Not classified as causing organ damage from repeated exposure.

exposure

Aspiration Not classified as causing aspiration.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

No ecological damage caused by this product. Toxicity to fish: LC50 > 197 mg/L/96hrs.

12.2 Persistence and degradability

This product is not readily biodegradable.

12.3 Bioaccumulative potential

This product is not expected to bioaccumulate.

12.4 Mobility in soil

Because of its high volatility, the product is unlikely to cause ground or water pollution.

12.5 Other adverse effects

Global warming has been predicted as a potential consequence of the emission of this product.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Cylinders should be returned to the manufacturer or supplier for disposal of contents.

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	3161	3161	3161
14.2 Proper Shipping Name	LIQUEFIED GAS, FLAMMABLE, N.O.S. (contains 2,3,3,3-tetrafluoropropene)	LIQUEFIED GAS, FLAMMABLE, N.O.S. (contains 2,3,3,3-tetrafluoropropene)	LIQUEFIED GAS, FLAMMABLE, N.O.S. (contains 2,3,3,3-tetrafluoropropene)
14.3 Transport hazard class	2.1	2.1	2.1
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

Not a Marine Pollutant.

14.6 Special precautions for user

Hazchem code 2YE

EmS F-D, S-U

Other information Ensure cylinder is separated from driver and that outlet of relief device is not obstructed. Refer to Commonwealth, State and Territory Dangerous Goods Legislation which contain requirements which affect gas storage and transport.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safe Work Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals (GHS Revision 7).

Inventory listings **AUSTRALIA: AIIC (Australian Inventory of Industrial Chemicals)**
All components are listed on AIIC, or are exempt.

16. OTHER INFORMATION

Additional information The storage of significant quantities of gas cylinders must comply with AS4332 The storage and handling of gases in cylinders.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m^3	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

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[End of SDS]

G. Refrigeration Oil - Safety Data Sheet

MATERIAL SAFETY DATA SHEET

Product Name: BSE POE Series Revision Date: March 2009

Not classified as hazardous according to criteria of NOHSC

Page 1 of 6

SECTION 1 PRODUCT/SUBSTANCE AND COMPANY IDENTIFICATION

Product Name: BITZER BSE POE Series

Product Description: Polyol Ester

Product Code: 11867339 Ester

Intended use: Synthetic refrigeration compressor oil

Company Name: CPI Corporation Pty Ltd

Address: 148 Old Pittwater Road, Brookvale NSW 2100, Australia

Emergency Tel: (02) 9939 9988

SECTION 2 HAZARDS IDENTIFICATION

Hazard Classification: Non hazardous substance. Non-dangerous good. No special warning labels are required. Does not contain any hazardous ingredients at or above regulated thresholds.

The product contains no known carcinogens. Classified in accordance with Approved Criteria for Classifying Hazardous Substances NOHSC:1008 and according to Australian Dangerous Goods Code.

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Composition: Polyol esters

Ingredients: No reportable hazardous material or substances up to 100%.

CAS#: Proprietary and not required.

SECTION 4 FIRST AID MEASURES

INHALATION Remove from further exposure and remove the source of contamination. Move the victim to fresh air and ensure airways are clear and use adequate respiratory protection or facemask if there is any breathing difficulty. If oil mist is inhaled, remove to fresh air and seek medical attention. If respiratory irritation, nausea, or unconsciousness occurs, seek immediate medical assistance.

SKIN CONTACT Prolonged exposure may irritate the skin. Remove any contaminated clothing. Wash exposed skin and contact areas with soap and water gently. If product gets under the skin seek immediate medical attention from a physician.

INGESTION Seek medical attention and do not induce vomiting. Immediately wash out mouth with clean water.

EYE CONTACT Wash thoroughly with clean water if contact with the eye occurs. If irritation and soreness develops or persists, seek medical attention.

Advice to Physician Treat symptomatically.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA DO NOT use water jet. Appropriate media includes carbon dioxide, foam, or dry chemical to extinguish flames. Water fog may be used to cool exposed containers.

FIRE FIGHTING TECHNIQUES Burning product or fluid may evolve irritating/noxious fumes. Evacuate area as soon as possible. Firefighters should use protective clothing / equipment and approved self-contained breathing apparatus (SCBA). Smoke, fumes, nitrogen and sulphur oxides, and carbon / inorganic products from incomplete combustion may be present. Water spray may be used to cool fire exposed surfaces and protect personnel.

FLAMMABILITY PROPERTIES

Flash Point (Open Cup): 230-300^{0} C

Flammability Limits: Not established

Autoignition Temperature: No data

SECTION 6 ACCIDENTAL RELEASE MEASURES

SPILL MANAGEMENT Wear suitable protective equipment, especially goggles. Stop source of leak or spill if you can do so without risk.

In the case of small spills, use inert absorbent material (eg. sand, sawdust or diatomaceous earth) to soak up the spilled product. Dispose of absorbent material in accordance with state or local regulations. Wash spill area with large amounts of water and detergent.

With larger spills, dike the spill area for containment and recovery if possible. Place inert absorbent material onto the spillage. Prevent spill entering drains, waterways, sewers, rivers, basements etc. If large quantities of this material enter the waterways contact the Environmental Protection Authority.

NOTIFICATION PROCEDURES In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable local, state and national regulations.

SECTION 7 HANDLING AND STORAGE

HANDLING Do not take internally. Avoid contact with skin, eyes and clothing. Upon contact with skin, wash with sufficient amounts of water and soap. Flush eyes with water for 15 minutes and seek medical attention. Wash contaminated clothing or dispose appropriately.

Repeated or prolonged contact with this material should be avoided in order to reduce the possibility of skin disorders. Observe good personal hygiene. Good ventilation is recommended and avoid build up of oil mist in the working area.

Misuse of empty containers can be hazardous. Do not cut, weld, heat or drill containers. Residue in the container may ignite if exposed to heat. Do not expose container to open flame or excess heat. Always keep container closed and caps in place.

STORAGE This product is hydroscopic and storage under dry nitrogen is recommended. Keep container tightly sealed when not in use. Store in a cool, dry, well-ventilated area, out of direct sunlight. Keep away from open flames and other ignition sources. For safe storage refer to Australian Standards AS1940.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMITS No value assigned for this specific material by the NOHSC. However, the threshold limit value (Exposure Standards) for oil mist is listed as 5mg/m

ENGINEERING CONTROLS Use in a well ventilated area. Where vapours or oil mists are generated and exposure standards are exceeded, the use of personal respiratory protection equipment or an adequate exhaust ventilation system is recommended.

RESPIRATORY PROTECTION If engineering controls are still inadequate, the use of an approved respirator with organic vapour / particulate filter complying with AS/NZS 1715 (Selection, Use and Maintenance of Respiratory Protective Devises) and AS/NZS 1716 (Respiratory Protective Devices) is recommended. The selection of type of breathing protection should be based on expert advice. Reference should be made to the relevant Australian Standards.

In the case of high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode.

HAND PROTECTION Protective gloves is normally not required, but impervious gloves such as nitrile, viton or neoprene is recommended if required. Contact the glove manufacturer for specific advice on glove selection. Inspect and replace worn or damaged gloves.

EYE PROTECTION Goggles or safety glasses with side shields are recommended.

BODY AND SKIN PROTECTION No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact. If required, use a chemical resistance apron to avoid contact of material with skin.

PERSONAL HYGIENE MEASURES Always observe good personal hygiene measures. Dispose contaminated clothing and footwear that cannot be cleaned. Always practise good housekeeping.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE Liquid

COLOUR Clear amber / light yellow tint

BOILING POINT >343^0 C

MELTING POINT N/A

ODOUR Mild, distinct

SOLUBILITY IN WATER Insoluble

pH VALUE Not applicable

SPECIFIC GRAVITY (WATER=1) 0.94-0.97

FLASH POINT (Open Cup) 230-300^0 C

FLAMMABLE LIMITS LEL / UEL Not Available

AUTOIGNITION TEMPERATURE No Data

FLAMMABILITY Combustible Class C2 liquid (AS 1940). Remove all sources of heat and ignition.

VAPOUR PRESSURE <0.01 mmHg @ 20^0 C

EVAPORATION RATE (butyl acetate=1) Nil

VOLATILES (percent by volume) 0%

SECTION 10 STABILITY AND REACTIVITY

STABILITY Stable under normal conditions of storage and handling

HAZARDOUS POLYMERIZATION Will not occur

MATERIALS TO AVOID Strong oxidizers

CONDITIONS TO AVOID Excessive heat or sources of ignition

HAZARDOUS DECOMPOSITION PRODUCTS Material does not decompose at ambient temperatures. Analogous compounds evolve carbon monoxide, carbon dioxide, and other unidentified products and fragments when burned.

SECTION 11 TOXICOLOGICAL INFORMATION

TOXICOLOGY INFORMATION This product contains synthetic base oils that through process conditions, chemical analysis and results of mutagenicity all support these oils should not cause skin cancer.

INHALATION May cause irritation to the mucous membrane and upper airways, especially if the material is heated or mists are generated and/or is used in poorly ventilated areas. Symptoms may include headache, dizziness and nausea.

INGESTION May cause irritation to the mouth, oesophagus and stomach. Symptoms may include nausea, vomiting and diarrhoea.

SKIN Unlikely to irritate on brief contact. Repeated or prolonged contact may dry and defat skin, resulting in skin irritation and possible dermatitis.

EYE May cause slight to moderate transplant eye irritation, resulting in redness, stinging and lachrymation.

CHRONIC EFFECTS Prolonged or repeated contact with this material may result in skin irritation leading to dermatitis.

SECTION 12 ECOLOGICAL INFORMATION

ENVIRONMENT PROTECTION This information is based on data available for the material, the components of the material, and similar materials. Prevent this material from entering the environment.

SECTION 13 DISPOSAL CONSIDERATIONS

WASTE DISPOSAL Disposal of waste must be in accordance with state, local, EPA and national current applicable laws and regulations.

DISPOSAL RECOMMENDATIONS Incinerate this material and all associated wastes in an enclosed burner in a licensed facility. Empty containers may contain residue and can be dangerous. Empty drums should be safely stored until taken for recycling, recovery, or disposal in accordance with government regulations. Do not pressurise, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. This may result in an explosion and cause injury or death.

SECTION 14 TRANSPORT INFORMATION

This material is not classified as a Dangerous Good according to the Australian Code for the Transport of Dangerous Goods by Road and Rail and IATA/ICAO, IMDG..

U.N. NUMBER None allocated

PROPER SHIPPING NAME None allocated

DG CLASS None allocated

HAZCHEM CODE None allocated

PACKING GROUP None allocated

SECTION 15 REGULATORY INFORMATION

Material is not hazardous as defined by the Approved Criteria for Classifying Hazardous Substances NOHSC:1008.

Product is not regulated according to Australian Dangerous Goods Code.

POISONS SCHEDULE No Poison Schedule number allocated by the Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP) established under the Therapeutic Goods Act.

Complies with the following national/regional chemical inventory requirements: AICS, IECSC, DSL, EINECS, ENCS, KECI, PICCS, TSCA. The product contains no known carcinogens.

SECTION 16 OTHER INFORMATION

The information and recommendations contained herein are, to the best of our knowledge and belief, accurate and reliable as of the date issued. The information and recommendations are offered for the user's consideration and examination. All reasonable care has been taken to ensure that the information and advice contained herein are accurate at the time of printing. However, CPI Corporation accepts no tortuous or contractual liability for any loss or damages suffered as a consequence of reliance on the information and advice contained herein. It is the user's responsibility to satisfy itself that the product is suitable for the intended use. If buyer repackages this product, it is the user's responsibility to insure proper health, safety and other necessary information is included with and/or on the container. Appropriate warnings and safe-handling procedure should be provided to handlers and users. Alteration of this document is strictly prohibited.

-------- END OF MSDS -------

H. Vacuum Pump Oil - Safety Data sheet

MATERIAL SAFETY DATA SHEET

BVA VAC 235

SECTION 1: CHEMICAL PRODUCT & COMPANY IDENTIFICATION			
Product Name	VAC 235	Date Prepared	October 24, 2001
Chemical Family	Petroleum Hydrocarbons	Prepared By	David J. Vincent
Manufacturer: BVA OILS P.O. 930301 Wixom, Mi. 48393		Phone	1-810-348-4920
		Emergency Phone	CHEMTRAC
			1-800-424-9300
Material Uses : All purpose vacuum pump oil			

SECTION II: Composition & Information on Ingredients					
		EXPOSURE LIMITS			
Chemical Name	CAS #	TWA (ppm)	STEL (ppm)	CEIL (ppm)	% by V/V
Severely Hydrotreated Paraffinic Oil	72623-84-8	5mg/m^3 (oil Mist)	NA	NA	100
Toxicological data on Ingredients	Acute oral toxicity : LD50 > 5000 mg/kg (rat)				

SECTION III: Hazard Identification	
Eye :	May cause eye irritation.
Inhalation :	If sprayed or misted may cause chemical pneumonitis.
Ingestion :	Low toxicity on ingestion, has laxative effect.
Skin :	Minimally irritating. Prolonged or repeated contact may cause dermatitis.

SECTION IV : First Aid Procedures	
Eye :	Copious warm water flush-15 minutes. Physician assessment if eyes inflamed.
Skin:	Remove contaminated clothing-Launder or dry clean clothes before reuse. Dispose of leather articles.
Inhalation :	Evacuate to a safe area with plenty of fresh air. Allow victim to rest in a well ventilated area then seek medical aid immediately.
Ingestion :	DO NOT induce vomiting. Consult a physician.

SECTION V : FIRE FIGHTING PROCEDURES	
Flammability of Product	Low Fire Hazard
Auto Ignition Temp.	235ÃC (435ÃF)
Flash Point COC	166ÃC (330ÃF)
Flammability Limits	Not Applicable
Products to avoid	Strong oxidizing agents, including peroxide, chlorine and strong acids.
Unusual Hazards :	Burning fluid may evolve irritating/noxious fumes.
Extinguishing Agents :	Dry chemical, CO_2 foam, water fog,
Protective Clothing :	Firefighters should use pressure demand NIOSH/MNSA approved self-contained breathing apparatus and full protective gear.
Firefighting Procedures :	SMALL FIRE : Use dry chemicals, CO_2 water spray or foam, SMALL OUT DOOR FIRE ; may extinguished with a portable fire extinguisher. LARGE FIRE : Use dry chemicals, CO_2 water spray or foam Do not use water jet. Respiratory and eye protection required for fire fighting personnel. A self contained breathing apparatus should be used for all indoor fires.

SECTION VI : ACCIDENTAL RELEASE MEASURES	
Personal Protection :	Wear protective clothing including splash proof goggles, rubber gloves and rubber overshoes. Remove all contaminated clothing promptly.
Procedures:	Floor may be slippery: use care to avoid falling. Contain spill immediately with inert material (e.g. sand, earth). Transfer liquids and solid diking material to separate suitable containers for recovery or disposal. CAUTION: Keep spills and cleaning runoff out of municipal sewers and open bodies of water.

SECTION VII : HANDLING AND STORAGE

Avoid contact with eyes, skin and clothing. WASH hands after handling and before eating.

Ensure that containers are properly secured before moving.

Keep container closed and keep away from oxidizing materials.

Store in a cool-well ventilated area.

"Empty" containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. "Empty" drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All other containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations. For work on tanks refer to Occupational Safety and Health Administration regulations, ANSI Z49.1, and other governmental and industrial references pertaining to cleaning, repairing, welding, or other contemplated operations.

SECTION VIII : EXPOSURE CONTROLS AND PERSONAL PROTECTION	
Eye	Safety glasses (ANSI Z87.1) or approved equivalent.
Skin	For direct contact of more than two hours Viton or Nitrile gloves are needed, otherwise PVC gloves may be used. Wear long sleeve clothing to minimize contact.
Inhalation	Use in well ventilated area. If mist is being generated and exceeds the TWA/TLV listed below than a respiratory program meeting OSHA 1910.134 and ANSI Z88.2 requirements must be followed.
Engineering Controls	General Ventilation
Exposure Limits	TWA 5mg/m^3: manufacturers recommendation based on ACGIH TLV for oil mist
Hazardous Decomposition:	Analogous compounds evolve carbon monoxide, carbon dioxide, and other unidentified fragments when burned.

SECTION IX : PHYSICAL & CHEMICAL PROPERTIES			
Appearance	Clear	Specific Gravity (WATER=1)	0.875
Physical State	LIQUID	pH (1%)	Not Applicable
Color	Colorless to light straw	Volatility	Non-Volatile
Odor	Hydrocarbon	Viscosity Sus	330
Vapor Pressure	0.0225mm of Hg@ 20C	Melting Point(Pour Point)	0°F (-17°C)
Vapor Density	Not Applicable	Solubility in Water	insoluble

SECTION X : STABILITY & REACTIVITY	
Stability:	Stable
Conditions to Avoid:	Excessive heat, formation of oil mist.
Material to Avoid:	Strong oxidants such as liquid chlorine, peroxides, concentrated oxygen, sodium hypochlorite, calcium hypochlorite
Hazardous Decomposition:	Analogous compounds evolve carbon monoxide, carbon dioxide, and other unidentified fragments when burned. See Section 5.
Hazardous Polymerization:	Will not occur.
Corrosivity	Not Applicable

SECTION X I: TOXICOLOGICAL INFORMATION	
Routes of Entry : Skin contact and Inhalation	
Dermal LD50 - Rabbit	> 5000 mg / kg
Toxicity to Animals	Oral LD50 > 5000 mg/ kg (rat)
Chronic Effects on Humans	If sprayed or mist may cause chemical pneumonitis. Prolonged exposure to skin may cause chapping, cracking or possible dermatitis.

SECTION XII : ECOLOGICAL INFORMATION	
Ecotoxicity	Not Determined
BOD5 and COD	Not Determined
Toxicity of Products of Biodegradation	Not Determined

SECTION XIII : WASTE DISPOSAL
Consult your local or regional authorities. Preferred waste management priorities are (1) recycle or reprocess. (2) incineration with energy recovery; (3) disposal at licensed waste facility. Ensure that disposal or reprocessing is in compliance with local, state and federal regulations.

SECTION XIV: TRANSPORT INFORMATION	
This product is non-hazardous. The product contains no known carcinogens. No special warning labels are required under OSHA 29 CFR 1910.1200. OSHA hazard warning are mot applicable for this product; Therefore no OSHA Warnings would appear on the label. No EPA hazard classification code.	
DOT Classification	Not DOT controlled
DOT (Pictograms)	None

SECTION XV : REGULATORY INFORMATION				
Degree of Hazard	NFPA	HMIS	HAZARD RATINGS	
Health	0	0	0	Insignificant
Fire	1	1	1	Moderate
Reactivity	0	0	2	High
Specific Hazards	None		3	Extreme
Personal Protection Index		a	4	Extreme
Other Regulations	All components of this formulation are listed in the Domestic Substances List (DBL.. Canadian) and in the Toxic substance Control Act Inventory (TSCA). The product contains no known carcinogens.			
WHMIS (Canada)	Not a WHMIS controlled material			
DSCL (EEC)	Not controlled under DSCL (Europe)			
CERCLA (40 CFR 302.40)	Not Listed, no reportable quantities			
EPCRA or SARA TITLE III Section 313 Toxic Chemicals	Not Listed			

Notice To reader

To the best of our knowledge the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

I. Flammable Refrigerant Gases Position Paper

SafeWork NSW

Flammable refrigerant gases position paper

This Position Paper was developed by the Heads of Workplace Safety Authorities (HWSA) and provides information on the obligations of work health and safety duty holders with respect to the use of flammable refrigerant gases at workplaces.

1. Scope

This paper concerns refrigerant gases classified as Division 2.1 flammable gases under the Australian Dangerous Goods Code or classified as Flammable Gas Category 1 using the Globally Harmonized System (GHS). It covers general work health and safety / occupational health and safety (WHS/OHS) duties, however, readers should check their legislative responsibilities at the state/territory and Commonwealth level in relation to working with refrigerants.

It includes information on:

- the use of flammable refrigerant gases in stationary and mobile (vehicle) workplace environments (including fixed or portable plant);
- how to manage the risk of fire and explosion from refrigeration and air-conditioning systems [1]containing flammable refrigerant gases and
- the storage and handling of flammable refrigerant gases.

This document does not address the transport of refrigerant gases. The application of WHS/OHS legislation in domestic environments is in scope only when work is being conducted; for example during installation or servicing of a domestic refrigeration system.

Whilst refrigerant gases may have one or more of a number of hazards (eg toxicity, irritant properties, flammability, environmental hazards) this paper focuses on the issue of flammability. The general duty of care provisions in the WHS/OHS legislation apply to all workplace hazards, including those not in the scope of this paper such as Flammable Gas Category 2 substances.

The term "**must**" is used where there is a WHS/OHS legislative duty. As this position paper applies broadly to various Australian jurisdictions, references to specific sections of the legislation are not provided and enquiries on this should be directed to the relevant regulator (Section 6).

2. Background

The use of flammable refrigerant gases, such as hydrocarbons, flammable hydrofluoroolefins (HFOs, eg R1234yf) and R32 has increased in recent years as organisations seek to minimise the use of ozone depleting gases and synthetic

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greenhouse gases with high global warming potential.

Ozone depleting substances and synthetic greenhouse gas refrigerant gases (fluorocarbons) are scheduled under the Commonwealth's Ozone Protection and Synthetic Greenhouse Gas Management Act 1989. All practitioners installing or working on systems that are designed to contain a fluorocarbon refrigerant **must** hold an appropriate licence granted under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995.

A licence under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 is not required for the use of HFOs. The use of refrigerant gases other than those in the scope of the Commonwealth legislation does not require a licence in most jurisdictions.

Queensland requires individuals or businesses to have a licence to handle hydrocarbon refrigerant gases, however there is not a mandatory national licence for working with flammable refrigerant gases. There is a voluntary national accreditation scheme available for key refrigerants not covered by a national licence, including hydrocarbons and HFO 1234yf (refer to the Australian Refrigeration Council item in Section 6 for more information).

3. Risks of flammable refrigerants

As the use of flammable refrigerants is increasing, there is a need to ensure duty holders have access to consistent information on how to manage WHS/OHS risks associated with these substances.

Some recent workplace fire incidents concerning flammable refrigerant gases have directly contributed to injuries, deaths and damage to property globally, including in Australia and New Zealand. Combustion products of some refrigerants and mixtures are toxic, for example halogenated refrigerants release hydrogen fluoride or carbonyl dichloride (phosgene) in a fire. It should be noted that lubricant/refrigerant mixtures may be flammable even if the refrigerant is non-flammable (SafeWork NSW, 2016) and that combustion products of non-flammable halogenated refrigerants are also toxic.

Some refrigerants are a blend of gases, and some blends (called zeotropic blends) change in composition if leaks occur (due to different boiling points), which can lead to unpredictable hazard properties.

The use of mercaptan or other odourants to add a warning property to hydrocarbon refrigerants is declining, however may be required in some jurisdictions. When an odourant is used, it may become ineffective over time, depending on the design of the equipment. People should be aware that flammable refrigerant leaks may be odourless.

The WHS/OHS legislation includes broad duties for risk management. The measures taken to manage risk should be proportionate and appropriate to the level of risk. The law uses the term "so far as reasonably practicable" to ensure the general duties are applied at a level proportionate to the risk.

4. Issues

a) Compatibility of refrigerant gases with the refrigeration system - Refrigerant gases **must** be compatible with the refrigeration system. This determination **must** be made by a competent person[2], 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.

b) Communication and provision of information - Refrigeration systems **must** be clearly labelled as to the refrigerant in use. Labelling may be supplemented by signage, placards and documentation. This is essential for the safety of refrigeration technicians as they may not have gas detection/identification equipment (however such equipment is strongly recommended).

There is a lack of information in relation to which workplaces use flammable refrigerants and the quantities used, placing reliance on duty holders to have effective communication systems (for example, systems to inform emergency services organisations).

c) Fire and explosion risks - There should be systems in place to reduce fire and explosion risks and manage potential hazardous atmospheres where flammable refrigerants are in use, appropriate to the risks.

d) Worker competency - All people with WHS/OHS duties in relation to flammable refrigerant gases **must** be competent to conduct that role safely. The required level of training, qualifications and/or experience to conduct a task will depend on the complexity of the task and the associated hazards. Duty holders should ensure that systems are in place to select workers, including contractors, with appropriate competencies, or to ensure appropriate training is provided to such workers.

e) Compliance concerns - Current levels of WHS/OHS compliance are inadequate in some cases, and this could lead to adverse outcomes such as fire, injuries or fatalities.

5. WHS/OHS Regulators' Position – Responsibilities of Duty Holders

5.1 Importers and manufacturers of flammable refrigerant gases

a) Importers and manufacturers of flammable refrigerant gases **must** classify the substance in accordance with the GHS[3]. For guidance, refer to the Safe Work Australia (SWA) publication *Guidance on the Classification of Hazardous Chemicals under the Work Health and Safety Regulations.*

b) Where a refrigerant gas is classified as a hazardous chemical (including a flammability hazard), the importer and manufacturer **must** prepare a compliant Safety Data Sheet (SDS) and label. Refer to the model SWA Codes of Practice Preparation of Safety Data Sheets for Hazardous Chemicals and Labelling of Workplace Hazardous Chemicals for detailed requirements.

c) Importers and manufacturers of refrigerant gases may also classify the products in terms of flammability and toxicity using *AS/NZS ISO 817:2016 Refrigerants – Designation and safety classification*. This is not mandatory under WHS/OHS legislation; however these classifications can be considered additional information and included on the SDS and label.

d) The importer and the manufacturer of a refrigerant gas that is a hazardous chemical **must** ensure that the product is correctly packed, which for flammable gases or gases under pressure, requires compliance with the Australian Dangerous Goods Code (ADG Code).

5.2 Designers of refrigeration systems

a) 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.

b) Designers of refrigeration systems should refer to the relevant Standards (see Section 6) for information on design measures to prevent the release of refrigerants and other controls.

c) 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

Designers of complex refrigeration systems may hold relevant tertiary qualifications.

d) Flammable refrigerants may be odourised to aid in their detection. **Note:** Odourants may fade with time in some circumstances.

e) The refrigerant gas quantity (charge size) **must** be appropriate to the room or enclosure size and use. Refrigerant gases and gas blends, which contain one or more flammable refrigerants, **must** have a charge limit equal to the lowest charge limit applicable to any constituent. See AS/NZS 5149.1 for more information on charge limits.

f) Gas detection equipment should be installed to detect leaks from larger stationary direct systems (where a rupture or leak would cause refrigerant release to an occupied space), eg machinery rooms or cold rooms. It is also recommended that where practicable, stationary air conditioning equipment using flammable refrigerants should use a flammable gas detector alarm system for the air leaving the cooling coil. Gas detection equipment should also be considered for smaller systems where a flammable refrigerant release could result in a flammable atmosphere, such as where the room is small. Such gas detection systems can be interlocked to shut down the system in the event of a leak if this is appropriate for the system. More information is available in AS/NZS 5149.

g) Designers of refrigeration systems should provide the following information to people who use, store, construct or maintain the system at a workplace:

- Specify one or more refrigerants which are compatible with the system;
- Any areas classified as hazardous areas in terms of fire risk as far as practicable (including documentation as per AS/NZS 60079 where the application is in the scope of that standard); and
- Instructions on the safe use and maintenance of the system.

h) 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.

5.3 Manufacturers, importers and suppliers of refrigeration equipment for use in workplaces

a) Manufacturers, importers and suppliers of refrigeration equipment **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, dispose of or use the system, and those in the vicinity of the system at a workplace.

b) Manufacturers, importers and suppliers of refrigeration systems **must** provide adequate information to clients in relation to the refrigeration system, its potential hazards, and instructions for safe installation and use. Details of the type of information to provide are available in AS/NZS 5149.2 (Section 5.4) and other applicable standards (eg the AS/NZS 60335 series covering vending machines, refrigerators, freezers, dryers, commercial refrigerating appliances, air conditioning and heat pumps).

c) Manufacturers, importers and suppliers of refrigeration systems for use in workplaces should have relevant experience and training, including completing relevant units of competency or equivalent, for example:

> UEENEEJ174A – Apply safety awareness and legal requirements for hydrocarbon refrigerants

5.4 Suppliers of refrigerant gases for use in workplaces

a) Suppliers of refrigerant gases **must** eliminate risks associated with the intended use, storage and disposal of the substance, so far as reasonably practicable. Where risks cannot be eliminated, they **must** be reduced as far as is reasonably practicable. This includes risks to people who use the gas, maintain the refrigeration system, or dispose of the gas, and those in the vicinity of the refrigeration system or gas storage area at a workplace.

b) Suppliers **must** provide adequate information to clients in relation to the refrigerant gas, covering potential hazards and instructions for safe use.

c) Suppliers of hazardous chemicals **must** provide compliant SDS and ensure the supplied product is correctly packed and labelled.

5.5 Refrigeration technicians, engineers and businesses that install or maintain workplace refrigeration systems

a) The installer of a stationary or mobile workplace refrigeration system **must** eliminate risks associated with the system, so far as 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, dispose of or use the system, and those in the vicinity of the system at a workplace.

b) Businesses that install or maintain refrigeration systems **must** ensure the refrigerant is compatible with the system, and that this compatibility is documented. For example, the specifications for the system should document the compatible refrigerant/s.

c) 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.

d) Where the system falls under the scope of AS/NZS 3000 (the "Wiring Rules") generally and specifically Clause 7.7 "Hazardous Areas (Explosive Gas or Combustible Dusts)" and compliance with AS/NZS 3000 is mandatory via the applicable jurisdiction's electrical regulations, the person in control of the installation **must** classify the hazardous areas in

accordance with Clause 7.7 (which invokes the hazardous area standard AN/NZS 60079.10.1). As a guide, most large fixed systems using flammable refrigerants in most jurisdictions **must** comply with these requirements.

e) If plant such as registerable pressure vessels is involved, re-registration by the WHS/OHS regulator may be required.

f) The business operating the workplace or vehicle should also be consulted prior to a refrigerant substitution and should approve the substitution prior to it proceeding. In the absence of written confirmation from a competent person on the suitability of an alternative refrigerant, the alternative refrigerant **must** not be used.

g) Systems for leak detection and emergency management **must** be suited to the refrigerant and proportionate to the risks. Further information is provided in AS/NZS 5149.

h) Technicians **must** be provided with information and training on the hazards and safe use of the specific refrigerants they use or are likely to encounter in their work. The employer of a refrigeration technician has a duty to ensure the technician has been informed and trained so far as practicable to manage risks to health and safety.

i) Refrigeration technicians **must** be competent to manage any foreseeable hazard (including a flammability hazard) during installation or maintenance work. They should have relevant experience and training, and where flammable refrigerants are or may be used, this should include relevant units of competency or equivalent, for example:

- UEENEEJ174A – Apply safety awareness and legal requirements for hydrocarbon refrigerants
- UEENEEJ175A – Service and repair self-contained hydrocarbon air conditioning and refrigeration systems
- UEENEEJ176A – Install and commission hydrocarbon refrigeration systems, components and associated equipment
- UEENEEJ177A – Design hydrocarbon refrigerated systems (where applicable).

Installers of complex refrigeration systems may hold relevant tertiary qualifications.

There is a voluntary national accreditation scheme available to assist refrigeration technicians to upskill in relation to key refrigerants not covered by a national licence, including hydrocarbons and HFO 1234yf (refer to the Australian Refrigeration Council item in Section 6 for more information).

Guidance in relation to vehicle air-conditioning is available in the Department of the Environment, Water, Heritage and the Arts (DEWHA) Code of Practice Control of refrigerant gases during manufacture, installation, servicing or de-commissioning of motor vehicle air-conditioners. The current edition does not cover flammable refrigerants. [**Note**: Any person who handles refrigerant gases containing scheduled ozone depleting substances or synthetic greenhouse gases, or carries out work on refrigeration and air

conditioning equipment containing these gases, **must** hold a national Refrigerant Handling Licence under the Ozone Protection and Synthetic Greenhouse Gas management Regulations 1995].

j) Businesses employing refrigeration technicians should develop safe work procedures for working with flammable refrigerants. For example, safe work procedures should include matters such as:

i. Confirming the type of refrigerant present.

ii. Do not top up a refrigeration system without first checking for and fixing any leaks.

iii. Only use electrical equipment that is rated for hazardous area use (eg flame-proof or intrinsically safe) near sources of flammable refrigerant (where there may be a leak or release). The hazardous area classification document (see also 5.5 d) developed in accordance with AS 60079.14 provides specific requirements, for example on the use of electrical equipment suitable for use in the hazardous area.

iv. Whenever a flammable refrigerant is placed in a vehicle air-conditioning system, affix a label in a prominent place in the engine bay to make it clear what refrigerant is used, and how much is used. It should incorporate a flammable gas (Division 2.1) class label or GHS pictogram. Refer also to the DEWHA Code of Practice *Control of refrigerant gases during manufacture, installation, servicing or de-commissioning of motor vehicle air-conditioners.*

v. Information **must** be provided whenever a flammable refrigerant is used in a stationary system, including appropriate labelling and/or signage. Placards may be required depending on quantities. The system owner **must** be provided with the SDS for the substance and provision should be made for leak detection and emergency management on a risk basis.

vi. For jurisdictions using WHS legislation, it should be noted that Regulation 51 of the model WHS regulations requires a person conducting a business or undertaking at a workplace to manage risks to health and safety from a hazardous atmosphere at the workplace, where a hazardous atmosphere includes atmospheres with flammable gases at more than 5% lower explosive limit (LEL). Management of such atmospheres and associated risk control measures may be achieved by following recognised industry standards, such as AS/NZS 5149 and AS/NZS 60079.10 within their scope of application.

k) Businesses installing or maintaining refrigeration systems should consider the purchase of portable gas detection and identification systems. **Note**: these systems rely on regular maintenance and calibration and operator training and results may be affected by environmental factors. Alternatively, portable gas detection and identification equipment may be hired, or safe work methods that minimise risks from all potential refrigerant hazards so far as is reasonably practicable may be developed and implemented.

l) Certification, inspection and maintenance records should be available for apparatus used in hazardous areas. These records should include the suitability of the equipment for hazardous areas, details of all inspection/maintenance and the details of the competent person who conducted the inspection/maintenance.

m) In Queensland, a licence is required for handling hydrocarbon refrigerant gases. Contact your regulator for more information.

5.6 People conducting a business or undertaking, employers and people with management or control of workplaces where flammable refrigerant gases are used in refrigeration or air-conditioning systems

a) The person conducting a business or undertaking (PCBU)[4] involved in the storage or handling of hazardous chemicals **must** eliminate risks associated with this storage or handling so far as 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, dispose of or use the system, and those in the vicinity of the system at a workplace. Minimising risks as far as is reasonably practicable means that more controls will be required for larger or higher risk refrigeration systems (eg commercial cool room) compared with small, low risk refrigeration systems (eg domestic type refrigerator).

b) PCBUs **must** ensure that only competent workers work on air-conditioners and other refrigeration systems, particularly those containing flammable refrigerants. Examples of suitable units of competency include:

- UEENEEJ174A – Apply safety awareness and legal requirements for hydrocarbon refrigerants
- UEENEEJ175A – Service and repair self-contained hydrocarbon air conditioning and refrigeration systems
- UEENEEJ176A – Install and commission hydrocarbon refrigeration systems, components and associated equipment
- UEENEEJ177A – Design hydrocarbon refrigerated systems.

[**Note**: Any person who handles prescribed refrigerant gases or carries out work on refrigeration and air conditioning equipment which may contain prescribed gases **must** hold a national Refrigerant Handling Licence under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995.]

Tertiary qualifications may be appropriate for persons conducting complex work with air conditioning and refrigeration systems.

c) Workers **must** be provided with information and training on the hazards and safe use of the specific refrigerants to which they could be exposed.

d) Gas detection equipment should be installed to manage the risk of leaks from larger systems.

e) Before using flammable refrigerants as a substitute to re-gas a refrigeration system designed for less flammable refrigerants, the PCBU **must** obtain written advice from a competent person (preferably the system's designer, manufacturer or supplier) on the suitability of the specific refrigerant for the system and the safety controls or system modifications required.

f) The PCBU should have systems in place to ensure that if a system needs additional refrigerant, the same type as is in the system should be used, to avoid creating a refrigerant mixture with unknown hazards.

g) The PCBU should implement a preventative maintenance program for the refrigeration system in accordance with the manufacturer's instructions or to an equivalent standard, and should ensure maintenance and inspection records are kept.

h) The PCBU **must** use information from the designer of the refrigeration system to identify hazardous areas, and ensure safe systems of work (eg hot work permits) are in place for hazardous areas.
4 Including an employer or a person with management or control of a workplace

i) If using a flammable refrigerant in a mobile system, the system should be labelled in a prominent place such as the engine bay to make it clear what refrigerant is used, and how much is used (charge size). The label should incorporate a flammable gas (Division 2.1) class label or GHS pictogram.

j) Adequate information **must** be provided whenever a flammable refrigerant is used in a stationary system, including appropriate labelling and signage. Placarding may be required depending upon quantities. The PCBU **must** obtain the SDS for the refrigerant, include it in the hazardous chemicals register and make it available to workers who may be exposed to the substance; and provision **must** be made for emergency management.

k) The PCBU may require placards and manifests and in some jurisdictions may need to notify the regulator of the use of the refrigerant, depending on the hazard classification and quantity of the refrigerant.

l) The PCBU should check conditions of equipment warranties and insurance policies prior to using alternative refrigerants, including whether the use of an alternative refrigerant should be disclosed to the insurer.

5.7 People conducting a business or undertaking (including employers) for the recovery, reclamation or disposal of refrigerant gases

a) PCBUs involved in the recovery, reclamation or disposal of hazardous chemicals **must** eliminate risks associated with this work so far as reasonably practicable. Where risks cannot be eliminated, they must be minimised as far as is reasonably practicable. This includes risks to people who conduct the work or others in the vicinity of the work.

b) PCBUs **must** ensure that only competent workers handle flammable refrigerants. Depending on the nature of the work and the specific refrigerants, examples of suitable units of competency include:

- UEENEEJ174A – Apply safety awareness and legal requirements for hydrocarbon refrigerants
- UEENEEJ175A – Service and repair self-contained hydrocarbon air conditioning and refrigeration systems

[**Note:** Any person who handles prescribed refrigerant gases or carries out work on refrigeration and air conditioning equipment which may contain these gases **must** hold a national Refrigerant Handling Licence under the Ozone protection and Synthetic Greenhouse Gas Management Regulations 1995.]

c) Workers undertaking recovery, reclamation or disposal activities **must** be provided with information and training on the hazards and safe handling of the specific refrigerants they handle.

d) Businesses reclaiming or disposing of refrigerants

should use appropriate gas detection and identification systems. **Note**: these systems rely on regular maintenance and calibration and on operator training and results may be affected by environmental factors.
e) PCBUs involved in the recovery, reclamation or disposal of refrigerant gases should ensure there is a procedure in place to identify the refrigerant, and a safe disposal procedure appropriate to each type of refrigerant.

f) It is an offence to discharge ozone depleting substances and synthetic greenhouse gases to the atmosphere whether in a mixture with other gases or not.

g) It is good practice to recover all synthetic refrigerants, including those for which recovery is not mandatory, for example R1234yf.

h) PCBUs should have recovery units and cylinders suitably rated and labelled for refrigerants likely to be encountered.

i) PCBUs involved in recovery, reclamation or disposal of refrigerant gases should refer to relevant standards and guides for information on requirements under other legislation.

5.8 Storage of flammable refrigerant gases

Flammable gases should be stored in accordance with relevant standards, including AS/NZS 4332 Storage of gases in cylinders and for LPG, AS/NZS 1596 The storage and handling of LP gas.

5.9 People transporting flammable refrigerant gases

This position paper does not address transport of refrigerant gases, which is covered by jurisdictional Dangerous Goods (Transport) legislation in most states and territories. In most jurisdictions, the requirements of the Australian Dangerous Goods (ADG) Code apply to the transport of flammable refrigerant gases.

5.10 Disposal of Refrigerants

Businesses have an obligation to send scheduled refrigerants for disposal to the holder of a refrigeration trading authorisation or to the operator of a refrigerant destruction facility. This includes mixtures of flammable and scheduled gases. Refer to the Ozone protection and Synthetic Greenhouse Gas management Regulations 1995 for further information.

6. Further information

- Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH). (2013). *Flammable Refrigerants Safety Guide* (Scope: applies to stationary applications)
- Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH). (2007). *Refrigerant handling code of practice 2007: Part 2 – Systems other than self-contained low charge systems*
- Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH). (2013) *Discussion paper – Transition to low-emissions HVAC&R: Issues and solutions*
- Australian Institute of Refrigeration, Air Conditioning and Heating training courses: www.airah.org.au
- Australian Refrigeration Council (ARC) *Accreditation Scheme for Technicians*
- COAG National Licencing Steering Committee. (2013). *Decision Regulatory Impact Statement*
- Department of Education and Training (2016). Courses and training providers. http://training.gov.au
- Department of the Environment, Water, Heritage and the Arts. (2008). Control of refrigerant gases during manufacture, installation, servicing or de-commissioning of motor vehicle air-conditioners.
- Department of Mines, Industry Regulation and Safety (WA) (2018). Safety Bulletin: Safety considerations when switching to flammable refrigerants
- Department of Mines and Petroleum (WA). (2012). *Safety Bulletin: Safe use of flammable refrigerants*
- Department of Natural Resources and Mines (Qld). (2013) *Illegal hydrocarbon refrigerant usage*
- Department of Natural Resources and Mines (Qld). (2015). *Hydrocarbon Refrigerants*
- Department of Sustainability, Environment, Water, Population and Communities. (2012). *Safety Considerations When Using Flammable Refrigerants*
- Department of the Environment. (2015). *Analysis of work health and safety data for the use of synthetic greenhouse gases and substitutes in the refrigeration and air-conditioning industry*
- New Zealand Fire Service. (2008). *Inquiry into the explosion and fire at Icepack Coolstores, Tamahere, on 5 April 2008*

- Safe Work Australia. (2018). *Guidance on the Classification of Hazardous Chemicals under the Work Health and Safety Regulations.*
- Safe Work Australia. (2015). *Model Code of Practice for Labelling of Workplace Hazardous Chemicals*
- Safe Work Australia. (2016). *Model Code of Practice for Preparation of Safety Data Sheets for Hazardous Chemicals*
- SafeWork NSW. (2016). Servicing of Refrigeration Systems
- SAI Global. AS/NZS 5149.1:2016 *Refrigerating systems and heat pumps – Safety and environmental requirements. Definitions, classification and selection criteria.* Available from https://www.saiglobal.com/online
- SAI Global. AS/NZS 5149.2:2016 *Refrigerating systems and heat pumps – Safety and environmental requirements. Design, construction, testing, marking and documentation.* Available from https://www.saiglobal.com/online
- SAI Global. AS/NZS 5149.3:2016 *Refrigerating systems and heat pumps – Safety and environmental requirements. Installation site.* Available from https://www.saiglobal.com/online
- SAI Global. AS/NZS 5149.4:2016 *Refrigerating systems and heat pumps – Safety and environmental requirements. Operation, maintenance, repair and recovery.* Available from https://www.saiglobal.com/online
- SAI Global. AS/NZS 1596:2014 *The storage and handling of LP Gas.* Available from https://www.saiglobal.com/online
- SAI Global. AS/NZS 60079.10.1:2009 *Explosive atmospheres - Classification of areas - Explosive gas atmospheres*
- SAI Global. AS/NZS 60079.14:2009 *Explosive atmospheres – Electrical installations design, selection and erection.* Available from https://www.saiglobal.com/online
- SAI Global. AS/NZS 60335 series – *Household and similar electrical appliances.* Available from https://www.saiglobal.com/online
- SAI Global. AS/NZS 4332:2004 *Storage of gases in cylinders.* Available from https://www.saiglobal.com/online
- SAI Global. AS/NZS ISO 817:2016 *Refrigerants – Designation and safety classification.* Available from https://www.saiglobal.com/online
- UNECE (2009). The Globally harmonized system of classification and labelling of chemicals (GHS)

Jurisdictional WHS/OHS regulators

- Australian Capital Territory: www.worksafe.act.gov.au
- Comcare: www.comcare.gov.au
- Northern Territory: www.worksafe.nt.gov.au
- New South Wales: www.safework.nsw.gov.au
- Queensland: www.worksafe.qld.gov.au ; www.dnrm.qld.gov.au
- South Australia: www.safework.sa.gov.au
- Tasmania: www.worksafe.tas.gov.au
- Victoria: www.worksafe.vic.gov.au
- Western Australia: www.dmirs.wa.gov.au

Footnotes

[1] The terms "refrigerant" and "refrigeration system" are used in a broad sense in this document and include air-conditioning applications.

[2] The term "competent person" is not used in Victorian OHS legislation; however the issue of competency, including relevant experience and training, is still pertinent.

[3] GHS classification became mandatory in most Australian jurisdictions from 01 January 2017 and is accepted in all Australian jurisdictions – contact your regulator for GHS implementation details.

[4] Including an employer or a person with management or control of a workplace.

https://www.safework.nsw.gov.au/resource-library/hazardous-chemicals/flammable-refrigerant-gases-position-paper 06-07-20

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J. IP65 Standard - International Protection ratings

PROTECTION AGAINST SOLIDS

	TEST	PROTECTION
x	No test applied	No specific protection
0	No test applied	Inherent degree of protection
1		Protected against solid objects equal to or greater than 50mm diameter. (eg. accidental contact with hand)
2		Protected against solid objects equal to or greater than 12.5mm diameter. (eg. contact with finger)
3		Protected against solid objects equal to or greater than 2.5mm diameter. (eg. tools and wires)
4		Protected against solid objects equal to or greater than 1mm diameter (eg. fine tools and wires)
5		Protected against quantities of dust that could intefere with satisfactory operation
6		Completely protected against dust.

Defined by IEC 60529
DIN 40050 CEI 70-1

PROTECTION AGAINST LIQUIDS

	TEST	PROTECTION
x	No test applied	No specific protection
0	No test applied	Inherent degree of protection
1		Protected against drops of water falling vertically.
2		Protected against drops of water falling at up to 15 degrees from the vertical
3		Protected against spraying water at up to 60 degrees from the vertical.
4		Protected against splashing water from all directions
5		Protected against jets of water from all directions.
6		Protected against jets of water of similar force to heavy seas
7		Protected against the effects of temporary immersion.
8		Protected against the effects of continuous immersion.

To Australian standards AS 60529-2004 Degrees of protection provided by enclosures. (IP Code)

Appendix K: HVAC&R Nation article “Where to Flare”

WHERE TO FLARE

The use of low-flammability refrigerants such as R32 in common air conditioning equipment is necessary if the HVAC&R industry is to successfully meet its obligations for the HFC phase-down under the Montreal Protocol. But there has been some confusion as to whether flare joints are allowed for connection indoors. HVAC&R Nation sets the record straight.

THE ISSUE

Some confusion exists as to whether flare joints are suitable for use indoors on wall-mounted split systems charged with R32 (classified as a Class 2L lower flammability refrigerant) or any other flammable refrigerant. The alternative, a permanent connection such as a brazed joint, can only be achieved with an open flame. This contradicts flammable refrigerant safety advice.

THE BACKGROUND

The standards that refer to the use of permanent joints indoors (between pipes, fittings and plant) for refrigeration and air conditioning systems that you should be familiar with are AS/NZS 60335.2.40 (2006 and 2015) and AS/NZS 5149.2:2016.

Then there is the international standard ISO 14903 *Refrigerating systems and heat pumps – Qualification of tightness of components and joints* (referred to in AS/NZS 60335.2.40:2015) and the advice of the *AIRAH Flammable Refrigerant Safety Guide* Clause 4.8.

Like other parts of the Australian standards, full comprehension of the entire standard and subsequent interpretation, is required.

WHAT DO THE STANDARDS SAY?

Here's an abbreviated version of the standards as they relate to connections, and our take on what they mean.

AS/NZS 60335.2.40:2006
Household and similar electrical appliances – Safety

Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

22.118 When a flammable refrigerant is used, all appliances shall be charged with refrigerant at the manufacturing location or charged on site as recommended by the manufacturer.

A part of an appliance that is charged on site, which requires brazing or welding in the installation, shall not be shipped with a flammable refrigerant charge. Joints made in the installation between parts of the refrigerating system, with at least one part charged, shall be made in accordance with the following.

- A brazed, welded or mechanical connection shall be made before opening the valves to permit refrigerant to flow between the refrigerating systems parts. A vacuum valve shall be provided to evacuate the interconnecting pipe and/or any uncharged refrigerating system part.

- Reusable mechanical connectors and flared joints are not allowed indoors.
- Refrigerant tubing shall be protected or enclosed to avoid damage.

Flexible refrigerant connectors (such as connecting lines between the indoor and outdoor unit) that may be displaced during normal operations shall be protected against mechanical damage.

Compliance is checked according to the manufacturer's installation instructions and a trial installation if necessary.

OUR VERDICT

Flare joint is allowed indoors.

Both the indoor unit and the interconnecting pipe of wall-mounted split systems are not charged with refrigerant.

AS/NZS 60335.2.40:2015

Household and similar electrical appliances – Safety

Part 2.40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

22.118 When a flammable refrigerant is used, all appliances shall be charged with refrigerant at the manufacturing location or charged on site as recommended by the manufacturer.

A part of an appliance that is charged on site, which requires brazing or welding in the installation, shall not be shipped with a flammable refrigerant charge. Joints made in the installation between parts of the refrigerating system, with at least one part charged, shall be made in accordance with the following.

- A brazed, welded or mechanical connection shall be made before opening the valves to permit refrigerant to flow between the refrigerating systems parts. A vacuum valve shall be provided to evacuate the interconnecting pipe and/or any uncharged refrigerating system part.
- Mechanical connectors used indoors shall comply with ISO 14903. When mechanical connectors are reused indoors, sealing parts shall be renewed. When flared joints are reused indoors, the flare part shall be re-fabricated.
- Refrigerant tubing shall be protected or enclosed to avoid damage.

Flexible refrigerant connectors (such as connecting lines between the indoor and outdoor unit) that may be displaced during normal operations shall be protected against mechanical damage.

Compliance is checked according to the manufacturer's installation instructions and a trial installation if necessary.

OUR VERDICT

Flare joint is allowed indoors.

AS/NZS 60335.2.40 was changed in 2015, with the addition of the reference to ISO 14903 compliance for mechanical connectors used indoors. The standard requires re-fabrication of a flare joint when reused indoors.

AS/NZS 5149.2:2016

Refrigerating systems and heat pumps – Safety and environmental requirements

Part 2: Design, construction, testing, marking and documentation

5.2.3.7 Specific requirements for the installation of piping for equipment intended to use A2, A3, B2 or B3 refrigerants.

Note: This clause is modified by Appendix ZZ.

Piping and joints of a split system shall be made with permanent joints when inside an occupied space, except joints directly connecting the piping to indoor units.

Components shall be shipped without refrigerant charge.

Refrigerant piping shall be protected to avoid damage.

OUR VERDICT

Flare joint is allowed indoors.

The standard says permanent joints are to be used inside an occupied space "except joints directly connecting the piping to indoor units."

AIRAH Flammable Refrigerant Safety Guide

Clause 4.8 System jointing and construction standards

The joining of refrigerant piping and components should, where possible, use permanent mechanical joints or be brazed. The use of serviceable-type joints such as flare nuts must not be used in the occupied space or in any area where leaked refrigerant could pool.

Note: Serviceable-type joints are permissible on the outside of outdoor units as long as they are in an area with good ventilation and no risk of leaked refrigerant pooling.

Refrigerant piping should be enclosed or protected to avoid mechanical damage during transport, installation and use.

OUR VERDICT

Flare joint is allowed indoors.

While this would appear to conflict with both of the above Australian Standards, the *AIRAH Flammable Refrigerant Safety Guide* was prepared in 2013, prior to the AS/NZS 60335.2.40:2015 update. Additionally, Australian standards take precedence over any industry Safety Guide.

THE MANUFACTURER'S TAKE ON THINGS

According to Daikin's engineering manager, Gary Knox, M.AIRAH, the misunderstanding around the use of flare joints with split systems charged with R32 relates to the complicated phrasing of international standards (which has been adopted into Australian standards).

FREQUENTLY ASKED QUESTIONS

Q: What is the main difference between R32 and R410A?

A: R32 is a Class 2L (lower flammability) refrigerant and R410A is a Class 1 (no flame propagation) refrigerant. (Reference AS/NZS/ISO 817-2016)

Q: How easy is R32 to ignite?

A: R32 is difficult to ignite. For ignition to occur its concentration in air must be between 14% (300g/m^3) and 29%, the concentration must be relatively still and there must be a sufficient energy source present at the same time to cause ignition. Sparks generated by relays or switches in household appliances as well as common static electricity do not have sufficient energy to ignite R32.

Q: Why use a flare connection indoors?

A: There is no requirement to use a special mechanical connector indoors when the piping and indoor unit is not pre-charged with refrigerant. Installers already have the appropriate tools and are skilled in making flare connections, so … this will produce the most reliable connection.

Source: Daikin R32 Pocket Guide.

"For flammable refrigerants, Clause 22.118 of AS/NZS 60335.2.40:2006 includes the sentence 'Reusable mechanical connectors and flared joints are not allowed indoors'," says Knox.

But he points to a sentence immediately preceding this, which states that "Joints made in the installation between parts of the refrigerating system, with at least one part charged, shall be made in accordance."

"Wall-mounted split systems comprise of three parts – the indoor unit, interconnecting piping and the outdoor unit," says Knox.

"The indoor joining parts are the indoor unit and the interconnecting piping. Neither part is pre-charged with refrigerant, so it follows that indoor flared joints are permitted. This was later confirmed when the 2015 edition of AS/NZS 60335.2.40 was revised, and states that 'When flared joints are reused indoors, the flare part shall be re-fabricated'".

Knox says that when installers are in doubt, the best source of information is usually the manufacturers' installation instructions. Beyond that, installers should ask the manufacturer for help.

"Brazing is not required to install our R32 wall-mounted split systems, and our recommended installation method is the flare joint," Knox says.

Daikin considers the flare joint to be the best method of installation for wall-mounted split systems, giving consideration to industry practice, cost and reliability.

"Our recommended installation for wall-mounted split systems fully conforms to AS/NZS 60335.2.40:2015."

ONE LAST PIECE OF ADVICE

We can't say it enough – good practice is required when replacing refrigeration parts. Remove the part by a pipe cutter and never by a brazing torch.

Please refer to SafeWork NSW Safety Alert | 07/11/2016 – Servicing Refrigerant Systems at www.safework.nsw.gov.au/news/safety-alert/servicing-of-refrigerant-systems for more information. ■

Appendix L:

A1 High wall split system check list (updated 2018)

The following is a check list of issues that need to be addressed by the installer to install or convert a typical high wall split system air conditioner using a flammable A2L, A2 or A3 refrigerant in a domestic dwelling or in light commercial application such as a restaurant, café or small office:

High wall split system check list	Yes? No? or N/A
1. Have you received the appropriate training and are you **competent** to install or convert a high wall split system? – Refer Section 10.	
2. Conduct a **Risk Assessment** – Refer Clause 5.2: a. If the installation is to be a 'conversion' is the current system in good condition and leak tight? b. Is the owner of the system aware that it will be charged with flammable refrigerant and has the owner given permission to convert? – Refer Clause 1.3.	
3. Have you prepared an **Emergency Plan** for the work area? – Refer Section 7.	
4. Determine the **refrigerant charge limit (RCL)**: a. Refer to the appliance instruction manual which will list the <u>minimum</u> floor area of the room that can be served by the unit. The area of the smallest room served is used. b. Alternatively calculate the maximum mass of refrigerant charge limit in accordance with Annex GG of AS/NZS 60335.2.40 based on i. the amount of refrigerant used in the appliance, ii. the installation location, and iii. the type of ventilation of the location or of the appliance. c. Calculate m_1, m_2 and m_3 and compare these quantities with the maximum mass of refrigerant M as per Table GG.1. d. Is the system located above ground or below ground? If below ground special consideration must be given to the risk of pooling of leaked refrigerant. e. Measure the smallest room that is to be air conditioned by the system. Calculate the allowable charge (maximum mass of refrigerant) using the formula in Annex GG.	

www.airah.org.au Update 1 2018

5. Identify **potential sources of ignition** (SOI) -– Refer Clause 4.7: a. Is the split system designed and approved for flammable refrigerants? b. If the system is to be converted from non-flammable to a flammable refrigerant, can all of the SOI within the system be eliminated? c. Check for SOI in the location the system is to be installed. Do not locate the system near open fire places, gas heaters or other SOI.	
6. Does the system have any **serviceable joints** within the occupied space, excepting the final connection to the unit? These must be removed and replaced by brazed or permanent mechanical joints.	
7. Does the system have the appropriate pressure equipment **ratings and approvals** for flammable refrigerants? – Refer Clause 4.9. a. If the system is to be converted, does it have a pressure relief valve? Refer Clause 4.10.	
8. Installation of a **new** system or conversion of an **existing** system: a. Check the work area is safe and setup a **'temporary flammable zone'**, refer Clauses 6.3 and 6.4. b. Ensure you have the appropriate tools and equipment, refer Clause 6.8. c. Do you have the appropriate Personal Protective Equipment? Refer Section 8. d. If the system is a conversion, recover controlled CFC, HCFC and HFC refrigerant. Note: An ARCtick licence is required for this work. e. Apart from final connections to the unit, remove all serviceable type joints (e.g. flare joints) from the occupied space and replace with either a permanent mechanical joint or braze – refer AS/NZS 60335.2.40. f. Eliminate all potential SOI – refer Clause 4.7. g. Pressure and leak test the system. h. Commission the system and provide written operating and maintenance instructions – refer AS/NZS 60335.2.40. i. Instruct the operator on the correct operation and maintenance of the system.	
9. Marking and labelling of the system: a. Ensure that both the indoor and outdoor units are labelled with an **ISO 7010 W021 flame symbol**, refer Section 9. b. The Name Plate or Serial Plate must also be appropriately marked, refer AS/NZS 60355.2.40. c. Interconnecting pipework should also be labelled with the **GHS Flammable Gas symbol**, near valves and where walls are penetrated, refer Clause 9.3.	

Appendix M:

A2 Coolroom refrigeration system check list (updated 2018)

The following is a check list of issues that need to be addressed by the installer, to install or convert a typical coolroom refrigeration system using a flammable A2L, A2 or A3 refrigerant, with a condensing unit mounted inside the occupied space of the building and a ceiling mounted evaporator, in a light commercial application such as a restaurant, fast food outlet, butchers shop or convenience store:

Coolroom refrigeration system check list	Yes? No? or N/A
1. Have you received the appropriate training and are you **competent** to install or convert a commercial refrigeration system with this refrigerant? – Refer Section 10.	
2. Conduct a **Risk Assessment** – Refer Clause 5.2: a. If the installation is to be a 'conversion' is the current system in good condition and leak tight? b. Is the owner of the system aware that it will be charged with flammable refrigerant and has the owner given permission to convert? – Refer Clause 1.3. c. Conduct a hazardous area assessment in accordance with AS/NZS 60079.10.1.	
3. Have you prepared an **Emergency Plan** for the work area as the contractor working on a flammable system? The 'sites emergency plan' will have to also be updated if it does not account for a refrigeration system that has flammable refrigerant – Refer Section 7.	
4. Determine the **refrigerant charge limit (RCL)**: a. Refer Clause 4.5, the allowable charge limit is calculated by the RCL limit for the refrigerant multiplied by the room net volume, where RCL is 20% of the LFL. This is then compared to the maximum charge limit restrictions of Table A.2 which are capped based on the LFL of refrigerant. b. Identify the 'occupancy category' a or b or c; see AS/NZS 5149.1. In this example it will be '*General Occupancy a*', (note the inside of the coolroom is not considered as occupied space if only used for storage). c. Identify where the refrigerant containing parts will be located and determine the 'Location Classification'; I, II, III, or IV; see AS/NZS 5149.1. In this example the system is Class I: *Refrigerant containing parts located in occupied space*. d. Determine charge cap factors m_1, m_2 and m_3 and the appropriate multiplier for the refrigerant class in use (e.g. 1.5 for 2L refrigerants). e. Determine charge limits from AS/NZS 5149.1 Table A.2 using the flammability class A2L, A2 or A3 as appropriate, the occupancy category a, and the location classification I. f. For A2L there are no room volume restrictions for refrigerant charges below or equal to m_1 x 1.5, for A2 and A3 refrigerants there are no restrictions for refrigerant charges below m_1. g. If the system is using A3 refrigerant, is it located above ground or below ground? If above ground the maximum charge is 1.5 kg for 'Other applications' in General Occupancy a. If below ground, the maximum charge is 1kg and special consideration must be given to the risk of pooling of leaked refrigerant. h. Measure smallest room that has refrigerant containing parts of the system. Calculate the allowable charge using the formula – 20% x LFL x room net volume. The 'allowable' charge must not exceed the charge limits calculated above. Note: the smallest room with refrigerant containing parts may not be the coolroom. Check the volume of the space that the condensing unit is located in, unless it is mounted outdoors.	

5. Identify potential **sources of ignition** (SOI) – Refer Clause 4.7: a. Is the refrigeration system designed and approved for flammable refrigerants? b. If the system is to be converted from non-flammable to a flammable refrigerant, can all of the SOI within the system be eliminated? c. Check the location the system is to be installed in for SOI. Do not locate the system near open fire places, gas heaters or other SOI.	
6. Does the system have any **serviceable joints** within the occupied space (apart from final connections to the units) – both inside the coolroom and the condensing unit if it is located indoors? These must be removed and replaced by brazed or permanent mechanical joints – Refer Clause 4.8.	
7. Does the system have the appropriate pressure equipment **ratings and approvals** for flammable refrigerants? – Refer Clause 4.9: a. If the system is to be converted, does it have a pressure relief valve? Refer Clause 4.10.	
8. Installation of a **new** system or conversion of an **existing** system: a. Check the work area is safe and setup a '**temporary flammable zone**', refer Clauses 6.3 and 6.4. b. Ensure you have the appropriate tools and equipment, refer Clause 6.8. c. Do you have the appropriate Personal Protective Equipment? Refer Section 8. d. If the system is a conversion, recover controlled CFC, HCFC and HFC refrigerant. • Note: An ARCtick licence is required for this work. e. Remove all serviceable type joints (e.g.: flare joints) from the occupied space (excluding final connections) and replace with either a permanent mechanical joint or braze, refer AS/NZS 5149.2. f. Eliminate all potential SOI – refer Clause 4.7. g. Pressure and leak test the system. h. Commission the system and provide written operating and maintenance instructions – refer AS/NZS 5149.4 i. Instruct the operator on the correct operation and maintenance of the system.	
9. Marking and labelling of the system: a. Ensure that both the condensing unit, the evaporator and all service access points are labelled with a '**ISO 7010:2011, W021 flame symbol**. b. The Identification Plate must also be appropriately marked, refer AS/NZS 5149.2. c. Interconnecting pipework should also be labelled with the '**GHS Flammable Gas symbol'**, near valves and where walls are penetrated, refer Clause 9.3.	

Appendix N: Manual for R32 Refrigerant Air Conditioner

HITACHI

Additional manual for R32 refrigerant air conditioner

Explanation of symbols displayed on the indoor unit or outdoor unit.

	WARNING	This symbol shows that this equipment uses a flammable refrigerant. If the refrigerant is leaked, together with an external ignition source, there is a possibility of ignition.
	CAUTION	This symbol shows that the Operation Manual should be read carefully
	CAUTION	This symbol shows that a service personnel should be handling this equipment with reference to the Installation Manual.
	CAUTION	This symbol shows that there is information included in the Operation Manual and/or Installation Manual.

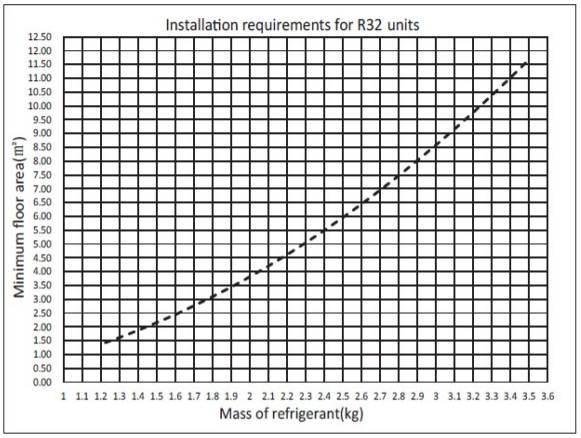
⚠ WARNING

- Do not use means to accelerate the defrosting process or to clean, other than those recommended by the manufacturer.
- The appliance shall be stored in a room without continuously operating ignition sources (for example: open flames, an operating gas appliance or an operating electric heater).
- Do not pierce or burn.
- Be aware that the R32 refrigerant does not contain an odour.
- Do not disconnect the pipe connection after checking the leak otherwise it may cause refrigerant leakage.

⚠ CAUTION

1.Installation (Space)

- That the installation of pipe-work shall be kept to a minimum.
- That pipe-work shall be protected from physical damage and shall not be installed in an unventilated space.
- That compliance with national gas regulations shall be observed.
- That mechanical connections shall be accessible for maintenance purposes.
- In cases that require mechanical ventilation, ventilation openings shall be kept clear of obstruction.
- When disposing of the product is used, be based on national regulations, properly processed.
- The minimum floor area [m2] is determined based on the installation height of 1.8mfor wall-mounted units is secified in the graph and table on the right side.
- An unventilated area where the appliance using flammable refrigerants is installed shall be so constructed that should any refrigerant leak, it will not stagnate so as to create a fire or explosion hazard
  - The appliance shall be stored in a well-ventilated area where the room size corresponds to the room area as specified for operation;
  - The appliance shall be stored in a room without continuously operating open flames (for example an operating gas appliance) and ignition sources (for example an operating electric heater).
- Other potential continuously operating sources known to cause ignition of the refrigerant used.
- The appliance shall be stored so as to prevent mechanical damage from occurring.



Minimum floor area for equipment installed inside			
m(kg)	A_{min}(m²)	m(kg)	A_{min}(m²)
1.224	-	2.4	5.49
1.225	1.43	2.5	5.96
1.3	1.61	2.6	6.44
1.4	1.87	2.7	6.95
1.5	2.15	2.8	7.47
1.6	2.44	2.9	8.02
1.7	2.76	3.0	8.58
1.8	3.09	3.1	9.16
1.9	3.44	3.2	9.76
2.0	3.81	3.3	10.38
2.1	4.20	3.4	11.02
2.2	4.61	3.5	11.68
2.3	5.04	3.6	12.36

⚠ CAUTION

2.Servicing

2-1.Service personnel

- Any person who is involved with working on or breaking into a refrigerant circuit should hold a current valid certificate from an industry-accredited assessment authority, which authorizes their competence to handle refrigerants safely in accord-ance with an industry recognised assessment specification.
- Servicing shall only be performed as recommended by the equipment manufacturer. Maintenance and repair requiring the assistance of other skilled personnel shall be carried out under the supervision of the person competent in the use of flammable refrigerants.
- Servicing shall be performed only as recommended by the manufacturer.

2-2. Checks to the area

- Prior to beginning work on systems containing flammable refrigerants, safety checks are necessary to ensure that the risk of ignition is minimised. For repair to the refrigerating system, the precautions in 2-2 to 2-10 shall be complied with prior to conducting work on the system.

2-3. Work procedure

- Work shall be undertaken under a controlled procedure so as to minimize the risk of a flammable gas or vapour being present while the work is being performed.

2-4. General work area

- All maintenance staff and others working in the local area shall be instructed on the nature of work being carried out. Work in confined spaces shall be avoided. The area around the workspace shall be sectioned off. Ensure that the conditions within the area have been made safe by control of flammable material.

2-5.Checking for presence of refrigerant

- The area shall be checked with an appropriate refrigerant detector prior to and dur-ing work, to ensure the technician is aware of potentially flammable atmospheres.
- Ensure that the leak detection equipment being used is suitable for use with flam-mable refrigerants, i.e. non sparking, adequately sealed or intrinsically safe.

2-6.Presence of fire extinguisher

- If any hot work is to be conducted on the refrigeration equipment or any associated parts, appropriate fire extinguishing equipment shall be available to hand.
- Have a dry powder or CO_2 fire extinguisher adjacent to the charging area.

2-7.No ignition sources

- No person carrying out work in relation to a refrigeration system which involves exposing any pipe work that contains or has contained flammable refrigerant shall use any sources of ignition in such a manner that it may lead to the risk of fire or explosion.
- All possible ignition sources, including cigarette smoking, should be kept sufficiently far away from the site of installation, repairing, removing and disposal, during which flammable refrigerant can possibly be released to the surrounding space.
- Prior to work taking place, the area around the equipment is to be surveyed to make sure that there are no flammable hazards or ignition risks. “No Smoking” signs shall be displayed.

2-8. Ventilated area

- Ensure that the area is in the open or that it is adequately ventilated before breaking into the system or conducting any hot work.
- A degree of ventilation shall continue during the period that the work is carried out.
- The ventilation should safely disperse any released refrigerant and preferably expel it externally into the atmosphere.

2-9. Checks to the refrigeration equipment

- Where electrical components are being changed, they shall be fit for the purpose and to the correct specification.
- At all times the manufacturer’s maintenance and service guidelines shall be followed.
- If in doubt consult the manufacturer’s technical department for assistance.
- The following checks shall be applied to installations using flammable refrigerants.
  - The charge size is in accordance with the room size within which the refrigerant containing parts are installed.
  - The ventilation machinery and outlets are operating adequately and are notobstructed.
  - If an indirect refrigerating circuit is being used, the secondary circuit shall bechecked for the presence of refrigerant.

2-9. Checks to the refrigeration equipment

- Marking to the equipment continues to be visible and legible. Markings and signsthat are illegible shall be corrected.
- Refrigeration pipe or components are installed in a position where they are unlikely to be exposed to any substance which may corrode refrigerant containing components, unless the components are constructed of materials which are inherently resistant to being corroded or are suitably protected against being so corroded.

2-10. Checks to electrical devices

- Repair and maintenance to electrical components shall include initial safety checks and component inspection procedures.
- If a fault exists that could compromise safety, then no electrical supply shall be connected to the circuit until it is satisfactorily dealt with.
- If the fault cannot be corrected immediately but it is necessary to continue operation, an adequate temporary solution shall be used.
- This shall be reported to the owner of the equipment so all parties are advised.
- Initial safety checks shall include.
  - That capacitors are discharged: this shall be done in a safe manner to avoid possibility of sparking.
  - That there no live electrical components and wiring are exposed while charging, recovering or purging the system.
  - That there is continuity of earth bonding.

3.Repairs to sealed components

- During repairs to sealed components, all electrical supplies shall be disconnected from the equipment being worked upon prior to any removal of sealed covers, etc.
- If it is absolutely necessary to have an electrical supply to equipment during servicing, then a permanently operating form of leak detection shall be located at the most critical point to warn of a potentially hazardous situation.
- Particular attention shall be paid to the following to ensure that by working on electrical components, the casing is not altered in such a way that the level of protection is affected.
- This shall include damage to cables, excessive number of connections, terminals not made to original specification, damage to seals, incorrect fitting of glands, etc.
- Ensure that apparatus is mounted securely.
- Ensure that seals or sealing materials have not degraded such that they no longer serve the purpose of preventing the ingress of flammable atmospheres.
- Replacement parts shall be in accordance with the manufacturer’s specifications.

NOTE: The use of silicon sealant may inhibit the effectiveness of some types of leak detection equipment.
Intrinsically safe components do not have to be isolated prior to working on them.

4.Repair to intrinsically safe components

- Do not apply any permanent inductive or capacitance loads to the circuit without ensuring that this will not exceed the permissible voltage and current permitted for the equipment in use.
- Intrinsically safe components are the only types that can be worked on while live in the presence of a flammable atmosphere.
- The test apparatus shall be at the correct rating.
- Replace components only with parts specified by the manufacturer.
- Other parts may result in the ignition of refrigerant in the atmosphere from a leak.

5.Cabling

- Check that cabling will not be subject to wear, corrosion, excessive pressure, vibra tion, sharp edges or any other adverse environmental effects.
- The check shall also take into account the effects of aging or continual vibration from sources such as compressors or fans.

6.Detection of flammable refrigerants

- Under no circumstances shall potential sources of ignition be used in the searching for or detection of refrigerant leaks.
- A halide torch (or any other detector using a naked flame) shall not be used.

7.Leak detection methods

- Electronic leak detectors shall be used to detect flammable refrigerants, but the sensitivity may not be adequate, or may need re-calibration. (Detection equipment shall be calibrated in a refrigerant-free area.)
- Ensure that the detector is not a potential source of ignition and is suitable for the refrigerant used.
- Leak detection equipment shall be set at a percentage of the LFL of the refrigerant and shall be calibrated to the refrigerant employed and the appropriate percentage of gas (25 % maximum) is confirmed.
- Leak detection fluids are suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine may react with the refrigerant and corrode the copper pipe-work.
- If a leak is suspected, all naked flames shall be removed/ extinguished.
- If a leakage of refrigerant is found which requires brazing, all of the refrigerant shall be recovered from the system, or isolated (by means of shut off valves) in a part of the system remote from the leak.
- Oxygen free nitrogen (OFN) shall then be purged through the system both before and during the brazing process.

8.Removal and evacuation

- When breaking into the refrigerant circuit to make repairs – or for any other purpose –conventional procedures shall be used. However, it is important that best practice is followed since flammability is a consid eration.
  The following procedure shall be adhered to:
  - remove refrigerant
  - purge the circuit with inert gas
  - evacuate
  - purge again with inert gas
  - open the circuit by cutting or brazing
- The refrigerant charge shall be recovered into the correct recovery cylinders.
- The system shall be "flushed" with OFN to render the unit safe.
- This process may need to be repeated several times.
- Compressed air or oxygen shall not be used for this task.
- Flushing shall be achieved by breaking the vacuum in the system with OFN and continuing to fill until the working pressure is achieved, then venting to atmosphere, and finally pulling down to a vacuum.
- This process shall be repeated until no refrigerant is within the system.
- When the final OFN charge is used, the system shall be vented down to atmos pheric pressure to enable work to take place.
- This operation is absolutely vital if brazing operations on the pipe work are to take place.
- Ensure that the outlet for the vacuum pump is not close to any ignition sources and there is ventilation available.

9.Charging procedures

- In addition to conventional charging procedures, the following requirements shall be followed.
  - Ensure that contamination of different refrigerants does not occur when using charging equipment.
  - Hoses or lines shall be as short as possible to minimize the amount of refrigerant contained in them.
  - Cylinders shall be kept upright.
  - Ensure that the refrigeration system is earthed prior to charging the system with refrigerant.
  - Label the system when charging is complete (if not already).
  - Extreme care shall be taken not to overfill the refrigeration system.
- Prior to recharging the system it shall be pressure tested with OFN.
- The system shall be leak tested on completion of charging but prior to commissioning.
- A follow up leak test shall be carried out prior to leaving the site.

10.Decommissioning

- Before carrying out this procedure, it is essential that the technician is completely familiar with the equipment and all its details.
- It is recommended good practice that all refrigerants are recovered safely.
- Prior to the task being carried out, an oil and refrigerant sample shall be taken in case analysis is required prior to re-use of reclaimed refrigerant.
- It is essential that electrical power is available before the task is commenced.
  a) Become familiar with the equipment and its operation.
  b) Isolate system electrically.
  c) Before attempting the procedure ensure that:
- mechanical handling equipment is available, if required, for handling refrigerant cylinders;
  - all personal protective equipment is available and being used correctly;
  - the recovery process is supervised at all times by a competent person;
  - recovery equipment and cylinders conform to the appropriate standards.

  d) Pump down refrigerant system, if possible.
  e) If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.
  f) Make sure that cylinder is situated on the scales before recovery takes place.
  g) Start the recovery machine and operate in accordance with manufacturer's instructions.
  h) Do not overfill cylinders. (No more than 80 % volume liquid charge).
  i) Do not exceed the maximum working pressure of the cylinder, even temporarily.
  j) When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.
  k) Recovered refrigerant shall not be charged into another refrigeration system unless it has been cleaned and checked.

11.Labelling

- Equipment shall be labelled stating that it has been de-commissioned and emptied of refrigerant.
- The label shall be dated and signed.
- Ensure that there are labels on the equipment stating the equipment contains flam mable refrigerant.

12.Recovery

- When removing refrigerant from a system, either for servicing or decommissioning, it is recommended good practice that all refrigerants are removed safely.
- When transferring refrigerant into cylinders, ensure that only appropriate refrigerant recovery cylinders are employed.
- Ensure that the correct number of cylinders for holding the total system charge are available.
- All cylinders to be used are designated for the recovered refrigerant and labelled for that refrigerant (i.e. special cylinders for the recovery of refrigerant).
- Cylinders shall be complete with pressure relief valve and associated shut-off valves in good working order.
- Empty recovery cylinders are evacuated and, if possible, cooled before recovery occurs.
- The recovery equipment shall be in good working order with a set of instructions concerning the equipment that is at hand and shall be suitable for the recovery of flammable refrigerants.
- In addition, a set of calibrated weighing scales shall be available and in good working order.
- Hoses shall be complete with leak-free disconnect couplings and in good condition.
- Before using the recovery machine, check that it is in satisfactory working order, has been properly maintained and that any associated electrical components are sealed to prevent ignition in the event of a refrigerant release. Consult manufacturer if in doubt.
- The recovered refrigerant shall be returned to the refrigerant supplier in the correct recovery cylinder, and the relevant Waste Transfer Note arranged.
- Do not mix refrigerants in recovery units and especially not in cylinders.
- If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that flammable refrigerant does not remain within the lubricant.
- The evacuation process shall be carried out prior to returning the compressor to the suppliers.
- Only electric heating to the compressor body shall be employed to accelerate this process.
- When oil is drained from a system, it shall be carried out safely.

