AUSTRALIA AND NEW ZEALAND

REFRIGERANT HANDLING CODE OF PRACTICE

PART 2

SYSTEMS OTHER THAN SELF-CONTAINED LOW CHARGE SYSTEMS

2025 EDITION

PREFACE

The first edition of this Code of Practice was originally developed in 1990 by the Association of Fluorocarbon Consumers and Manufacturers (AFCAM). This code has been periodically revised over time with assistance from the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH), Standards Australia, the Institute of Refrigeration Heating and Air Conditioning Engineers of New Zealand (IRHACE) and other institutions.

This 2025 edition of the code has been updated from the 2007 version to reflect changes in the Standards and Regulations the industry currently works with:

- Requirements and recommendations on design, manufacture and maintenance, have been updated based on the applicable Australian and New Zealand standards and industry guidelines.
- Procedures have been outlined for (on-site) evacuation, charging, inspection and repair.
- More focus and clarity are provided around leak inspection, leak detection and leak testing.

Sections on refrigerant recovery, recycling, reclamation, handling and storage and Appendices A and B on refrigerants are identical in both Part 1 and Part 2 of this code.

This code only applies to activities involving, and equipment containing, scheduled refrigerants. It does not apply to activities involving non-scheduled refrigerants such as hydrocarbons, ammonia, carbon dioxide, water and non-scheduled fluorinated refrigerants.

While they have a lower global warming potential, some non-scheduled refrigerants present additional safety risks, including toxicity (e.g. ammonia), higher flammability (e.g. hydrocarbons), and higher pressure (e.g. carbon dioxide). As the Australian Government phases down hydrofluorocarbons and these are replaced by more environmentally friendly alternatives, technicians are increasingly likely to come across non-scheduled refrigerants in their work.

Technicians who may be working with these non-scheduled refrigerants will require knowledge and skills outside the scope of this code. This code contains references to standards, codes and guides that may apply or be relevant to working with non-scheduled refrigerants. For instance, information on flammable scheduled refrigerants may also be relevant to non-scheduled flammable refrigerants.

There are a range of resources available regarding the use of flammable refrigerants, including but not limited to:

- Heads of Workplace Safety Authorities' (HWSA) Flammable Refrigerant Gases Position Paper as published by the relevant state or territory WHS authority
- Australian Institute of Refrigeration, Air Conditioning and Heating's (AIRAH) Flammable Refrigerants Safety Guide
- Australian Refrigeration Council's (ARC) Handle Class A2/A2L Flammable Refrigerants

and a range of fact sheets produced in Australia by Refrigerants Australia and in New Zealand by CCCANZ.

Anyone working with scheduled or non-scheduled refrigerants that present safety risks, should be competent to do so. Some jurisdictions may also have additional safety or licencing requirements for certain types of non-scheduled refrigerants.

Scope

This code provides mandatory requirements, best practice recommendations and information concerning the proper handling of scheduled refrigerants (see shortlist in Appendix A), and any equipment containing them. The practices are intended to reduce emissions of scheduled refrigerants to the environment, providing both environmental benefits and cost savings.

Part 1 of the code covers self-contained equipment which contains a refrigerant charge of 2kg or less, and where no work on the refrigerating system is required at the time of installation. Self-contained systems can include refrigerating appliances such as fridges and freezers, ice and ice-cream makers, window/wall and portable room air conditioners, standalone dehumidifiers, commercial dispensing appliances, vending machines, and heating appliances such as tumble dryers and some hot water heat pumps.

This Part 2 of the code applies to all other systems which use scheduled refrigerants, including heat pumps and air conditioning systems, commercial and industrial refrigeration, and transport refrigeration, collectively referred to as RAC equipment. A separate code, the Australian automotive code of practice, covers motor vehicle air conditioning (MVAC) systems.

In Australia, this code is referenced in a Determination under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 (the Regulations). The mandatory requirements in this code are mandated through the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (the Australian Act), the Regulations, permit conditions on licence holders, and the standards referred in the Determination. Some requirements originate from other applicable legislation including electrical safety, work health and safety, consumer protection and building regulations.

In New Zealand, ozone depleting substances, hydrofluorocarbons, and perfluorocarbons are subject to controls under the *Ozone Layer Protection Act 1996* and the *Climate Change Response Act 2002*. This Code does not have mandatory legislative status in New Zealand.

This code only applies to activities involving scheduled refrigerants and equipment containing them. Other refrigerants such as hydrocarbons, ammonia, carbon dioxide, water and non-scheduled fluorinated refrigerants are outside the scope of this code unless used in a blend with a scheduled refrigerant.

Acknowledgments

This is the fourth edition of this code and AIRAH, the ARC and the Department of Climate Change, Energy, the Environment and Water (DCCEEW) acknowledge and thank all contributors to the previous editions of this document.

This edition was facilitated by AIRAH, the ARC and DCCEEW, with assistance from a review committee, and was subject to public review prior to publication. The Air Conditioning and Refrigeration Permit Scheme Industry Advisory Group (ACRPSIAG) also provided valuable feedback as part of the consultation. AIRAH, the ARC and DCCEEW thank all those who contributed to the review and we acknowledge and thank representatives of AIRAH, ARC and DCCEEW who worked to prepare the 2025 edition of this document.

How to read this code

Text containing the term **'must'** underlined in bold font indicates compliance is mandatory under applicable legislation. Sections containing the terms **'should'** or **'recommended'** are not mandatory but are recommended as best practice. Other sections are explanatory notes for informative purposes only.

Definitions for some of the terms used are provided in Appendix C. Standards are referred to by their numerical code, and a complete list of their titles and the other documents referred to can be found in Appendix D.

Any provisions contained in the applicable legislation take precedence over the provisions contained in this code. The provisions in this code, however, take precedence over any original equipment manufacturer instructions (except where specified otherwise herein).

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Australia and New Zealand Refrigerant Handling Code of Practice
Part 2 — Systems other than self-contained low charge systems

CONTENTS

1. GENERAL

1.1 Personnel

1.1.1 Australian licensing

In Australia, any person who carries out work that involves handling a scheduled refrigerant, or a component of refrigeration and air conditioning (RAC) equipment with a risk of scheduled refrigerant being emitted, **must** ensure that they and/or any of their employees who handle scheduled refrigerant are appropriately licensed under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 (the Regulations).

Such work activities include decanting of scheduled refrigerant, and manufacturing, installing, commissioning, servicing and modifying RAC equipment that contains, will be charged with, or will be manufactured incorporating any scheduled refrigerant, whether or not refrigerant is present. It also includes decommissioning RAC equipment in which scheduled refrigerant is present.

Apprentices and other trainees working with refrigerant and RAC equipment **must** hold a trainee licence and work under the supervision of a fully qualified licence holder.

A person or company **must** also be appropriately authorised to acquire, possess, or dispose of bulk scheduled refrigerant.

Refrigerant Trading Authorisation holders and some Refrigerant Handling Licence holders **must** include their permit number on advertising, invoices, receipts and quotes, as detailed in their permit conditions.

Other relevant national licensing scheme conditions are referred to in the relevant section of this code. Permit holders **must** comply with the conditions of their permit. Conditions may be added or changed as outlined in the Regulations. For further details on the Australian licensing system, see www.dcceew.gov.au or www.arctick.org.

1.1.2 New Zealand certification

In New Zealand, any person who carries out work including the manufacturing, installation, servicing, modifying, or dismantling of any RAC equipment which contains, will be charged with, or will be manufactured incorporating any refrigerant, **must** ensure that they and/or any of their employees who carry out refrigerant charging or recovery, possess a refrigerant filler and handler training and certification.

In New Zealand, it is a legal requirement that any person who fills gas containers with gases under pressure, **must** be trained and hold a current, approved filler compliance certificate. This applies to all gases under pressure, including air. The Refrigerant License Trust Board operates under the name Refrigerant License New Zealand (RLNZ) and provides refrigerant filler and handler training and certification for HVAC&R practitioners in New Zealand.

For more details on filler certification see
www.irhace.org.nz and www.rlnz.org.nz.

1.1.3 Standard of work

Any person who carries out work including the manufacturing, installation, servicing, modifying, or dismantling of any RAC equipment which contains, will be charged with, or will be manufactured incorporating, any scheduled refrigerant, **must** ensure that they and/or any of their employees who handle scheduled refrigerant are provided with a copy of this code and work to the standards set out herein.

1.2 Refrigerant

1.2.1 Refrigerant discharge

The *Australian Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* prohibits conduct that results in (or is likely to result in) the discharge of a scheduled substance to the atmosphere. See section 45B of the Australian Act for more details.

Examples of such discharges may include:

- venting refrigerant directly or indirectly to atmosphere
- charging refrigerant into equipment with known or suspected leaks
- using refrigerant to flush refrigerant pipework clean internally
- using refrigerant as the pressure medium during leak tightness testing
- using refrigerant to clean heat exchanger fins or coils.

1.2.2 Prohibited refrigerant charging

Systems **must not** be charged with a higher global warming potential (GWP) refrigerant than the refrigerant the equipment was designed to use (the design refrigerant), unless the design refrigerant was an ozone-depleting hydrochlorofluorocarbon (HCFC). To do so is an offence under the Australian Regulations.

Systems that were not designed to operate with scheduled refrigerants **must not** be charged with a scheduled refrigerant.

See Australian regulations 2AAA, 111A, 135 and 141, including for information on when this prohibition does not apply.

1.2.3 Refrigerant classification

All refrigerants used in RAC equipment **must** have been classified according to AS/NZS ISO 817 (See Appendix B).

1.2.4 Flammable scheduled refrigerant

Under AS/NZS ISO 817 refrigerants are assigned to one of four flammability classes: 1, 2L, 2 or 3. Flammable refrigerants include Class A2L, A2, A3 and B2L refrigerants (see Appendix B).

Flammable scheduled refrigerants are currently either Class A2L (common) or Class A2 (uncommon).

It **should** be noted that lubricant/refrigerant mixtures may be flammable even if the refrigerant is classified as non-flammable.

Manufacturers and suppliers include additional safety information in the installation and service manuals for equipment using a flammable scheduled refrigerant.

Technicians **should** follow these instructions.

For more information on the duties associated with flammable refrigerants refer to the Heads of Workplace Safety Authorities (HWSA) Flammable Refrigerant Gases Position Paper and the AIRAH *Flammable Refrigerants Safety Guide*.

This section deals with the design considerations of new RAC systems and components as well as modifications to existing systems. It also identifies potential sources of refrigerant losses to the atmosphere. Details on the installation of systems can be found in Section 4 of this code.

2. DESIGN CONSIDERATIONS

2.1 Design of mass-manufactured systems

All systems **must** be designed so that they are able to be:

- manufactured
- installed
- operated
- maintained
- decommissioned,

without the loss of refrigerant.

The system design **must** comply with Clauses 2.2 to 2.12 of this code.

As an alternative to the prescriptive requirements in this code, a performance-based approach may be used for the design and be deemed compliant provided all of the following requirements are met:

1. Technical assessment **must** demonstrate that the system is an equivalent or better standard than a comparable system that is designed in compliance with the relevant prescriptive requirements of this code.
2. The assessment **must** be verified by a suitably trained, qualified and, where required, licensed person, who is independent of the design process.
3. The assessment and verification **must** be documented and retained in a technical file.

Where the designer can provide evidence that a system has been designed to an equivalent or better standard than is set out in this section, and complies with this clause, the design may be considered exempt from Clauses 2.3 to 2.12 inclusive.

2.2 Design compliance standards

Good system design is necessary for the prevention of refrigerant leakage.

All refrigerating systems **must** be designed in accordance with the applicable Australian and New Zealand standards. These standards set minimum compliance requirements to ensure all potential hazards are eliminated or reduced to an acceptable level.

The applicable compliance standards include AS/NZS 60335.2.40 for electrical heat pumps, air conditioners, and dehumidifiers, and AS/NZS 5149 parts 1 to 4 for all other refrigerating systems.

Refrigerating appliances or systems **must** also adhere to the following product standards:

- AS/NZS 60335.2.24, for refrigerating appliances, ice-cream appliances and ice-makers
- AS/NZS 60335.2.40, for electrical heat pumps, air conditioners and dehumidifiers
- AS/NZS 60335.2.89, for commercial refrigerating appliances with an incorporated or remote refrigerant unit or compressor.

Appliances that meet these standards are considered to comply with AS/NZS 5149.2, with the exception of electrical heat pumps, air conditioners, and dehumidifiers. For these appliances, AS/NZS 60335.2.40 mandates that they also adhere to the mechanical strength requirements outlined in AS/NZS 5149.2.

In addition to meeting the required compliance standards, designers should facilitate maintenance by providing safe access to the entire plant, including distribution pipework.

2.3 Working fluids

2.3.1 Refrigerant charge

Systems **should** be designed to optimise the amount of refrigerant required. The designer **should** always aim to minimise the specific refrigerant charge, i.e. the ratio of design refrigerant charge mass to system design heating or cooling capacity (kg/kW).

Design parameters that affect refrigerant charge include:

- system architecture
- selection of refrigerant type
- diameters and lengths of pipes
- sizing of receivers
- the technology of the expansion device
- the technology of the heat exchangers employed.

2.3.2 Maximum refrigerant charge – standards

The maximum refrigerant charge limits of design standards **<u>must</u>** be complied with.

Refrigerant charge limit (RCL) is the maximum amount of refrigerant allowed in a product or system to reduce the risks of toxicity, asphyxiation and flammability hazards.

AS/NZS 60335 standards contain RCLs for particular products, and AS/NZS 5149.1 Tables A.1 and A.2 contain RCLs for systems.

Refrigerant charges are restricted according to the level of risk posed based on the toxicity/flammability class, the occupancy category, the application (human comfort or other) and whether the system is above or below ground.

Practical limits, used for simple calculations for non-toxic and non-flammable refrigerants, are based on the RCL or historically established charge limitations.

Alternative provisions such as system valving, ventilation, detection and alarm can be used in accordance with the design standards to modify the RCL allowed in some circumstances.

2.3.3 Maximum charge – air conditioners

There are applicable refrigerant charge limits specified for all refrigerants and, for air conditioners that use flammable refrigerants, corresponding minimum room sizes specified. Manufacturers and suppliers include additional safety information in the installation instructions for air conditioners using a flammable refrigerant. Technicians **should** follow these instructions.

Considering the number of variables and the complexity of the required calculations for air conditioners that use flammable refrigerants, AS/NZS 60335.2.40 mandates that the manufacturer performs the calculations and that the installation instructions clearly show the resulting minimum floor area into which the air conditioner can be installed. Air conditioning installations **<u>must</u>** conform to those application limits.

For residential or light commercial air conditioning using a flammable refrigerant, the RCL is specified in AS/NZS 60335.2.40. The common rule of thumb calculation of 20 per cent room volume, previously used for A1 refrigerants, is not applicable for systems using a flammable refrigerant. The allowable charge of flammable refrigerant 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, for example detectors, sensors, alarms, etc.

For installation of split system ducted air conditioners, the maximum refrigerant charge limits are particularly important. The smallest room the system serves dictates the maximum refrigerant charge in the system that can be safely installed. Ducted indoor units pose an additional hazard if the indoor unit is located in a confined space where, if a refrigerant leak occurs, the refrigerant could pool or become trapped, exceeding RCL levels.

For air conditioners using a non-flammable A1 refrigerant, the maximum refrigerant charge or minimum room volume is calculated using AS/NZS 5149.1.

2.3.4 Lubricants

All lubricants used **should** be compatible with the refrigerant and equipment, as indicated by the refrigerant/equipment manufacturer's specifications.

Designers **should** ensure manufacturers' specifications for refrigerants and lubricants are complied with.

2.3.5 Filters and dryers

To ensure all the refrigerant and oil circulated within the system stays clean and moisture-free, provisions **should** be made for removing moisture, solids, and oil from the refrigerant using sufficiently sized strainers, filters, and dryers.

Refrigerant dryers <u>**must**</u> be compatible with the refrigerant and lubricant used in the system.

Replaceable dryers **should** be used on all systems. For larger systems these should be replaceable core dryers. A moisture-indicating liquid line sight glass installed with the dryer is **recommended**. Full flow filter dryers **should** be used in preference to bypass dryers.

2.4 Compressors

Leaks associated with compressors usually, but don't always, occur at either:

- the shaft seals, in the case of open drive compressors
- the cylinder head seals and motor terminal block seals, in the case of semi-hermetic compressors, particularly when overheated
- in the case of all compressors, the ancillary equipment such as gauge and control connections, oil return, oil drain, oil sight glass, service valves, relief valve and connecting pipework.

Seal compatibility with both oil and refrigerant is important. If contaminated oil reaches the seal it can cause damage. Oil can become contaminated in many ways, the most common being foreign matter such as minute copper particles or other metal dust mixing with the oil.

Moisture also creates problems. Excess moisture in the system can combine with the refrigerant to form an acid solution leading to oil breakdown, component corrosion, and the formation of sludge. Therefore, a clean and dry system is essential for prolonged seal effectiveness.

2.4.1 Shaft seals in open compressors

The shaft seals in open compressors **must** be:

- compatible with the compressor, oil and refrigerant used in the system
- capable of containing any pressure or vacuum that may be attained during both operation and any shut down periods.

Lack of lubrication can cause seal mating surfaces to dry out and adhere. Subsequently, dry starting can cause damage to the seal faces. To avoid this, large systems **must** have a separate oil pump to lubricate the compressor bearings and shaft before start-up.

Superior shaft seals that do not rely on carbon faces **should** be used to prevent leakage of refrigerant. The provision of double shaft seals is advantageous.

Where a carbon seal is used, soft versus hard face combinations **should** be used, where the soft face material is mechanical carbon, while the hard face can be a ceramic or other non-wearing material.

2.4.2 Vibration isolation

The compressor **must** be mounted on a solid foundation, and/or anti-vibration mountings to avoid leaks caused by vibration.

Pipeline connections to the compressor **must** be supported in accordance with AS 4041 and AS/NZS 5149.2 to avoid unacceptable stresses that could lead to fracture and leakage.

The inclusion of a gas muffler or equivalent to reduce gas pulsation is **recommended**, especially on large capacity systems.

Eliminating vibration in the suction and delivery refrigerant pipelines connected to the compressor will also minimise the potential for leaks.

2.4.3 Compressor valving

Service valves **should** be fitted to both the suction and discharge sides of the compressor to minimise refrigerant discharge during service work, in all systems except those that are hermetically sealed.

Where compressor service valves are not installed, pump out capability with isolating valves **must** be provided for system servicing.

Multiple compressors **should** be fitted with independent isolation valves where practical.

Oil equalising lines between compressors **should** be fitted with isolation valves that allow for the removal of individual compressors without the loss of refrigerant.

Consideration **should** be given to potential over-pressurisation and component failure resulting in refrigerant loss from inadequate pressure relief methods and location of service/isolation valves, especially on systems with external refrigerant oil cooling.

2.5 Refrigerant condensers and evaporators

2.5.1 Corrosion

All systems **should** be designed with materials selected to minimise the risk of corrosion.

Sacrificial anodes, cathodic protection systems or other anti-corrosion measures **should** be provided where it is necessary to reduce corrosion and protect against electrolytic action.

2.5.2 Erosion

The system **should** be designed to avoid excessive fluid velocity through the heat exchangers, which can cause vibration and erosion failures.

2.5.3 Vibration isolation

Anti-vibration mountings, vibration eliminating pipework connections and mufflers are **recommended**, as vibration transferred from compressors or other equipment can cause heat exchanger tubing failure.

2.5.4 Poor water quality

Where cooling water quality is poor, for example with sea water or bore water:

- The tube plate and tube materials appropriate to the type of water **should** be selected to minimise corrosion.
- Facilities for flushing and/or drainage **<u>must</u>** be fitted, since reduced or inactive water flow may lead to serious corrosion problems.
- Treatment and filtration methods **should** be designed to avoid corrosion or erosion failure. and
- Galvanised surfaces **should** be passivated before use (with no system load) to prevent premature corrosion.

2.6 Refrigerant pipelines and fittings

2.6.1 General

All pipelines **<u>must</u>** be designed so that the number of joints is kept to the practical minimum.

Provision **<u>must</u>** be made for thermal movements in the pipework, and loops/anchors incorporated to account for expansion and contraction of long runs of piping.

Trombone bends or spring hangers **should** be specified for large pipelines (75mm diameter or above).

Piping in refrigerating systems **<u>must</u>** be designed to minimise the likelihood of liquid hammer (hydraulic shock) damaging the system.

2.6.2 Pipelines

Refrigerant pipelines **<u>must</u>** be designed in accordance AS 4041 and AS/NZS 5149.2.

Refer to AS 4041 to determine the class of piping and the requirements associated with that class. Scheduled refrigerant pipelines are generally characterised as Class 3 pipelines under AS 4041.

Pipework **<u>must</u>** have sufficient flexibility to accept structural movement during earthquakes, in accordance with AS 4041.

Pipe sizing (particularly for liquid services and larger plant) **should** minimise the potential for liquid hammer, which can result in component and pipework failure.

Piping material **should** be assessed for compatibility with the refrigerant being used, and preference **should** be given to materials that have a higher resistance to corrosion/environmental effects.

The fixings of plant, pipework and fittings **should** be designed to resist wind, seismic vibration and other loads that may be imposed on them during their life.

2.6.3 Joining

Welding, brazing or another permanent hermetic sealing method is **recommended** for joining refrigerant pipelines, since these methods offer increased resistance to pressure, temperature and vibration stresses.

Flared, screwed, or flanged connections **should** be avoided.

Pipelines **must** be welded or brazed to flanges wherever possible.

Where flanged joints are used, attention **must** be given to the selection of gaskets, joining materials and joint design to withstand the pressures and temperatures involved and the effects of exposure to the refrigerant/oil mixtures.

Mechanical crimped connections **should** only be used with solutions designed specifically for RAC equipment and rated to appropriate pressures in accordance with AS/NZS 5149.2.

2.6.4 Vibration

Vibration is a major source of fatigue on piping systems and is the cause of many leaks.

Pipelines **must** be designed to minimise breakage due to vibration.

Pipe penetrations through structures **should** be designed to prevent rubbing on pipelines due to vibration.

Lines to fitted gauges, high-pressure and low-pressure cut-outs and oil safety switches etc., **must** be designed to minimise breakage due to vibration.

Care **should** be taken where vibration loops are created on small lines to prevent pipes rubbing through, and to support the weight and forces developed in the vibration loop.

Liquid line solenoids fitted for the purpose of system control **should** be sited as close to the evaporator as practical to reduce the effect of liquid hammer.

2.6.5 Flexible hose

The use of flexible refrigerant hose **should** be kept to the practical minimum.

Refrigerant flexible hose **should** comply with ISO 13971.

Flexible hose connections **should** incorporate 'O' ring seals or flared fittings to ensure minimum leakage of refrigerants.

Flexible hoses **should** only be used for instrument and oil connections, with preference for stainless instrument lines on larger systems.

Consideration **should** be given to maximum working pressure of flexible lines for high-pressure refrigerants.

2.7 Valves

2.7.1 General

Valves with welded or brazed connections **must** be used where the valve size exceeds 18mm outside diameter.

2.7.2 Isolation valves

Isolation/service valves **must** be fitted to all systems to:

- minimise the danger and loss of refrigerant
- enable the pump down and isolation of major components and equipment
- assist in the servicing and maintenance of plant.

Refrigeration pipework systems **must** be designed so that liquid refrigerant cannot be trapped between isolation valves without pressure relief.

Where gauges are fitted, isolation valves **must** be installed to minimise the chance of refrigerant loss during servicing or replacement.

2.7.3 Valves with removable packing

Where valves with removable packing are used, they **must** have retained or captive spindles, and facilities for tightening or replacement of the gland packing under line pressure.

The system **must** be designed to enable valves that use packing (e.g. expansion valves, service valves and packed line valves) to retain leakage from the spindle gland and to remain capped at all times, unless being opened or closed.

2.7.4 Schrader valves

The use of Schrader valves **should** be kept to the practical minimum.

Schrader valves fitted to the system **must** be sealed with a cap when not in use to prevent loss of refrigerant.

The specification **should** include a requirement for all valves to be capped. The valve cap should be attached to the valve to prevent its loss when uncapped.

2.8 Pressure relief

Pressure relief arrangements in refrigerating systems **must** be designed in accordance with AS/NZS 5149.2 and AS/NZS 1200, which specify the type and size of pressure relieving device permitted for different system types.

2.8.1 Pressure relief device

Systems must have relief devices selected for the refrigerant and the operating conditions of the system. Relief devices **must** be of the type that automatically reset after activation.

Safety cut-out devices or switches **must not** be capable of being isolated from the system in normal operation.

Relief devices for liquid services **must not** discharge directly into the atmosphere.

Safety componentry/solutions **should** be assessed for integrity of operation in accordance with AS/NZS 4024 to mitigate risk of safety system failure.

2.8.2 Pressure settings

Fail-safe electrical and/or mechanical protection and isolation **must** occur before any critical or maximum allowable pressure can be exceeded.

Unnecessary operation of the pressure relief device **must** be avoided, by providing an adequate safety margin between the normal high-pressure cut-out setting of the system and the relief device setting.

2.8.3 Discharge

It is **recommended** that where relief devices are activated, they will not result in release of the total refrigerant charge.

Relieving the high-pressure side into the low-pressure side involves several risks.

High side pressure relief devices **must not** discharge into the low-pressure side of the system unless provisions are made so that the system is not affected by increased downstream back pressure. The designer **should** ensure that this pressure does not exceed the vessel's maximum allowable pressure.

Alternatively, the low-pressure side **must** have a pressure relief valve with sufficient capacity to protect all connected vessels, compressors and pumps simultaneously subjected to excess pressure.

Refer to AS/NZS 5149.2 for guidelines on pressure relief to atmosphere from the low-pressure side.

2.8.4 Indication device

For systems with a refrigerant charge greater than 300kg, an indicating device **must** be provided to indicate when the pressure relief device has discharged.

Installing a rupture disc between the equipment and the relief valve will protect the valve from corrosion and resetting problems. Where a rupture disc is utilised in this manner, an indicator system **must** be installed to indicate whenever the disc has ruptured and permitted refrigerant to contact the relief valve.

2.9 Air purgers (negative pressure systems)

For negative pressure systems, a non-condensable gas purge unit that recovers refrigerant **should** be fitted to all new commercial and industrial equipment and retrofitted to existing systems.

The refrigerant loss due to non-condensable purging **must not** exceed 0.5kg of refrigerant per 1kg of air. A purge monitor that indicates actual purging time **must** be fitted in all cases. The performance of all air purgers **must** comply with ANSI/AHRI 580.

2.10 Refrigerant pump down capability

2.10.1 Systems with receivers

All refrigeration systems that have a liquid receiver or condenser/receiver combination **should** have at least the capacity to hold the refrigerant charge of the largest group of evaporators to be pumped out for service at any one time.

The system **should** be designed so that the entire charge can be contained in the high-pressure receiver when the receiver is no more than 80% full, by volume.

The receiver vessels **must** be designed to contain the pressure at ambient conditions at pump down without the relief valve discharging (see AS 1210).

Auxiliary receivers **must** be installed to accommodate system expansion for safety and operational requirements.

Refrigerant receivers in systems containing more than 100kg of group A1 refrigerant, or 25kg of group A2 refrigerant, and which can be isolated, **must** be provided with a liquid level indicator to show at least the maximum refrigerant level.

2.10.2 Combined condenser/receiver

Systems containing a one-piece condenser/receiver need not contain a separate receiver if the condenser shell is:

- large enough to contain the pumped down refrigerant charge
- fully isolated by shut off valves
- protected by a pressure relief valve in accordance with AS/NZS 5149.2.

2.10.3 Systems without receivers

All refrigeration systems that do not have a liquid receiver as part of their design **must** be fitted with permanently installed access valves for pumping out the system (i.e. capillary expansion or other critical charge designs).

2.10.4 Flooded and pump-recirculated systems

Flooded and pump-recirculated systems **must** be fully isolatable with shut off valves and protected by a pressure relief facility in accordance with AS/NZS 5149.2.

Systems may be exempted from having a receiver, provided the evaporator or liquid accumulator/separator (or both) can contain the entire refrigerant charge.

Flooded systems **must** have service valves to allow the transfer of the entire refrigerant charge to approved storage vessels without the loss of refrigerant. See AS 1210 for approved storage vessels and refrigerants.

Service valves **must** be fitted to compressors and major items of equipment to allow the connection of a pump down unit for the removal of refrigerant before service or repair operations.

2.11 Transport refrigeration systems

Vibration absorbing mountings, flexible refrigerant hosing and/or vibration eliminators **should** be incorporated into the system design as appropriate, to minimise the effect of vibration.

Service access ports **must** be provided on all transport refrigeration systems.

Systems **must** have service valves located at the compressor and other locations (in accordance with AS/NZS 5149.2) to allow refrigerant removal and charging.

Note: A separate code, the Australian automotive code of practice, covers motor vehicle air conditioning (MVAC) systems.

2.12 Leak detection systems

Leak detection systems **must** be provided where required by AS/NZS 5149.

For applications not required by AS/NZS 5149, a refrigerant charge monitoring or leak detection system **should** be used on all new installations, where practical, to alert RAC equipment operators to a refrigerant leak.

Two different types of leak detection system can be applied:

1. A direct system, which uses fixed electronic sensors to detect the presence of leaked refrigerant in areas adjacent to the refrigeration plant.
2. An indirect system, which interprets appropriate measurements within the refrigeration plant to indicate a leak.

There are advantages and disadvantages to both types of systems and it is necessary to take the specific circumstances of a refrigeration installation into account to select the best approach.

2.12.1 Required direct detection systems

AS/NZS 5149.3 requires that detectors **must** be installed where the RCL of the refrigerant can be exceeded in the occupied space if a leak occurs. Detectors **must** be refrigerant specific and located where a refrigerant leak will concentrate. Triggers to actuate alarms, shut-off valves and emergency ventilation systems in machinery rooms are specified, including:

- 19.5% oxygen content (for human respiration)
- 25% of the lower flammability limit (LFL) of the refrigerant
- Half or less of the AS/NZS ISO 817 RCL concentration of the refrigerant.

Leak detection systems can also be required by design standard AS/NZS 5149.1 as part of the appropriate measures that **must** be applied if the quantity limit with minimum ventilation (QLMV) value is exceeded.

The appropriate measures that **must** be provided include:

- ventilation (natural or mechanical)
- safety shut-off valves
- safety alarms

and these measures **must** be initiated by a refrigerant gas detection device.

2.12.2 Indirect leak detection

Indirect leak detection involves observation of parameters such as temperatures and pressures in the refrigerating system to ascertain whether there is a shortage of refrigerant. This can be especially useful if parts of the plant are inaccessible or located outdoors (where a hand-held leak detector may not function well).

Indirect detection can detect slow leaks over time and leaks where the RAC equipment is placed in a well-ventilated environment. If a leak is detected indirectly, it will often be necessary to use direct measurement methods to identify the exact location.

3. MANUFACTURE AND ASSEMBLY

3.1 General

This section covers systems, equipment, major components and sub-assemblies, that are manufactured, assembled and tested prior to being delivered to site.

3.2 Personnel

All supervisory personnel involved in the manufacturing process **must** be conversant with refrigerant technology and familiar with all aspects of the manufacturing process.

3.3 Complete systems

Complete RAC systems **must** be supplied clean, dry, leak tightness tested, evacuated, pressurised, sealed and labelled with the refrigerant type before delivery.

If the system is pressurised with a substance other than the specified refrigerant, this substance **must** be identified on the system label.

3.4 System components

RAC system components **must** be supplied clean, dry, leak tightness tested, capped and labelled so that the appropriate refrigerants and lubricants can be identified.

3.5 Strength/tightness testing

Under AS/NZS 5149 all manufactured systems and components, except piping consisting of type-tested components, **must** undergo the following tests:

1. strength-pressure test (see AS/NZS 5149.2)
2. tightness test (see AS/NZS 5149.2)
3. functional test (see AS/NZS 5149.2).

Alternatively, systems and components **must** be factory tested in accordance with the applicable manufacturing standard, see Clause 2.2.

All refrigerant-containing parts, units or systems **must** be tested and proved tight by the manufacturer at not less than the design pressure for which they are rated.

Systems and components that are not factory tested **must** be included in the system leak tightness tests (refer to Clause 4.9). Where no tightness criteria are specified by the manufacturer, the components should be tested with detection equipment with a capability of 3g/yr of refrigerant or better, under a pressure of at least 0.25 × maximum allowable pressure (PS).

3.6 Evacuation

Manufacturers' recommendations for required evacuation levels **should** be followed. All systems **should** be evacuated to less than 500 microns/67Pa absolute pressure before charging with refrigerant.

3.7 Charging of refrigerant

All charging **must** be carried out in accordance AS/NZS 5149.4, with the exception that manufacturers are not required to charge only into the low-pressure side of the system.

3.8 Installation, operation and maintenance instructions

3.8.1 Instructions

Installation, operation and maintenance instructions **must** be provided with each new system, component, or sub-assembly, detailing the correct methods and recommended procedures for installation, operation, and maintenance that:

- prevent the deliberate emission of scheduled refrigerant
- minimise the potential for accidental emission of scheduled refrigerant.

3.8.2 Standards

Installation, operation and maintenance instructions **must** be provided in accordance with the applicable standard:

- AS/NZS 5149.2 – Clause 5.4 Marking and Documentation
- AS/NZS 60335.2.24, AS/NZS 60335.2.40, AS/NZS 60335.2.89 – Section 7 Marking and instructions
- AS/NZS 60335.2.40 – Annex DD Requirements for installation, service, maintenance and repair, and decommissioning manuals of appliances using flammable refrigerants.

3.8.3 Installation

The installer **must** follow the installation instructions and provide the operation and maintenance instructions with the completed system.

3.8.4 Operation and maintenance instructions

Instructions **must** encourage the owner to pass on operation and maintenance procedures for the system to the purchaser if the system is sold and is to be reinstalled.

4. SYSTEM INSTALLATION PROCEDURES

Details on the design of pipework systems and on the methods of connection can be found in Section 2 of this code.

4.1 Self-contained systems

Some self-contained products with a refrigerant charge of greater than 2kg are manufactured and sold as a complete package. Where connection of refrigerant piping is not required, installation is normally the responsibility of the purchaser. The manufacturer's installation instructions **should** be followed.

4.2 Manufacturer's installation instructions

Manufacturer's instructions **must not** specify a practice that will result in emission of scheduled refrigerant.

4.2.1 Factory matched systems

The manufacturer's instructions for installation **should** be followed if the system is factory matched and the manufacturer has supplied instructions with the system.

If the manufacturer's instructions are followed, the installation is exempt from the requirements of this section.

The relevant parts of this section of this code **must** be complied with if there are any installation procedures not covered by the manufacturer's instructions.

4.2.2 Other systems

Installation of all other systems, or systems where the manufacturer's instructions are not supplied, **must** comply with this section of this code in its entirety.

4.3 Pre-installation

The installer **must** ensure that all tools and equipment used during the installation process (including, but not limited to, vacuum pumps, tools and gauges) are appropriately rated for the refrigerant being used in the installation and are in serviceable condition.

For flammable scheduled refrigerants, tools and equipment **must** be rated for use with the appropriate flammability grade (2 or 2L).

4.4 System cleanliness

Dry, clean and descaled tubing with no sign of corrosion or powder **must** be used in the piping layout.

Prior to assembling, all pipework and fittings **must** be thoroughly examined for cleanliness and suitability for the system and refrigerant type.

Where any copper residue or any dirt, scale or metal particles are found, pipework and fittings **must** be thoroughly cleaned to remove them prior to assembly.

During construction, all pipework, fittings and components **must** be protected from dirt and moisture.

4.5 Installation procedures

Installation procedures **must** comply with AS/NZS 5149.2 and AS/NZS 5149.3.

Installation work **must** only be undertaken by competent personnel, or trainee personnel working under appropriate supervision.

Equipment **should** be sourced from manufacturers capable of providing spare parts and technical backup.

4.6 Installation of piping

The installer **must** ensure that all piping used is selected and applied in accordance with AS/NZS 1571 and AS 4041 as applicable and is delivered clean and sealed from the ingress of foreign matter.

Copper pipe may be hard-drawn or soft-drawn.

Pipes **must** be clean, burr free and not out-of-round, before assembly.

Refrigerant pipelines **should** be as short and direct as possible. Joints should be carefully made.

Where it is not possible to install copper pipework in a location where it will not be exposed to potential mechanical damage, the copper pipework **must** be enclosed within a protective covering or otherwise protected against mechanical damage.

Flexible pipe elements **must** be protected against mechanical damage.

All mechanical joints **must** be double-checked for tightness.

All pipe insulation **must** conform to the requirements of the Australian National Construction Code/ Building Code of New Zealand, where applicable.

4.6.1 Piping location

Refrigerant pipe **must not** be exposed to external sources of excessive heat such as furnace rooms or boilers.

The exposure of refrigerant pipe or insulation to direct sunlight **should** be minimised.

Refrigerant pipe **must not** be installed where it can be walked on or mechanically damaged, unless protected from mechanical damage.

Piping with detachable joints not protected against disconnection **must not** be located in public hallways, lobbies, stairways, stairway landings, entrances, exits, or in any duct or shaft that has unprotected openings to these locations.

4.6.2 Pipe penetrations

The position of any equipment, cables or piping that may already be in place **must** be ascertained before any holes are drilled or penetrations made in the building to avoid possible damage and leakage of refrigerant.

All penetrations **must** conform to the requirements of the Australian National Construction Code/Building Code of New Zealand, where applicable.

4.6.3 Pipe cutting

Pipe **should** be cut with a pipe cutter and de-burred using the correct tool. When cutting pipe, the opening **should** be facing down.

Metal filings **must not** be left in pipework after cutting, as they can cause damage to shaft seals, compressor bearings and windings in hermetic and semi-hermetic compressors.

4.6.4 Pipe bending

All copper pipes **must** be bent with the correct-sized pipe bender or bending spring.

When pre-insulated pipe is bent (e.g. pair coil pipes) the following procedure **must** be used:

1. Split the insulation and cut away from around the pipe.
2. Bend the pipe using the correct-sized bender or insert a copper bend using brazed connections.
3. Replace the insulation, or insulate the bend, and seal the joins using adhesive and tape.

4.6.5 Brazing and soldering

After pipework has been fixed in position, oxygen-free nitrogen (OFN) **must** be passed through the system to remove any oxygen before brazing or silver soldering joints.

OFN **must** be purged continuously through the system during the operation to eliminate oxidation (scaling), a common cause of choked dryers, blocked expansion valve strainers, dirty oil and compressor failure.

The OFN pressure **must** be at minimal gauge pressure during brazing, to eliminate the possibility of pin hole leaks forming in the solder.

4.6.6 Flare connections

The use of flare connections **must** be kept to the practical minimum. Their use is restricted by AS/NZS 5149.2 for some refrigerant/system types.

Flared joints **must** only be used with annealed pipe and on pipe sizes not exceeding 20mm outside diameter. Care **should** be taken not to flare piping that has been work hardened.

Flaring of joints is not a simple task and the correct tool, suitable for the refrigerant type and pipe wall thickness being applied, **must** be used.

Pipe **must** be cut with a pipe cutter and de-burred using the correct tool.

A suitable refrigerant-compatible lubricant **must** be used on the flare threads, flare sealing surfaces and between the back of the flare and the nut to avoid tearing the flare when tightening the nut.

For single-flare connections of copper tubes, the torque and conditions outlined in AS/NZS 5149.2 **must** be applied, see Table 4, or the manufacturer's instructions used.

AS/NZS 5149.2 Table 4 - Standard tightening torque

Nominal outside diameter			Minimum wall thickness	Tightening torque
Metric series	Millimetre/Inch series			
mm	mm	In	mm	Nm
6			0.80	14 - 18
	6.35	1/4	0.80	14 - 18
	7.94	5/16	0.80	33 - 42
8			0.80	33 - 42
	9.52	3/8	0.80	33 - 42
10			0.80	33 - 42
12			0.80	50 - 62
	12.7	1/2	0.80	50 - 62
15			0.80	63 - 77
	15.88	5/8	0.95	63 - 77
18			1.00	90 - 110
	19.06	3/4	1.00	90 - 110

The flare nut **must** be tightened with the designated torque by means of an appropriate torque wrench and spanner.

The torque used to tighten the nut **must not** exceed the manufacturer's instructions.

4.6.7 Welded connections

Stainless welds for refrigerant lines **must** be purged with an appropriate inert gas (nitrogen or argon) during the process to prevent internal contamination.

Any welded pipework connections **should** be completed in accordance with AS 4041 and AS 3992.

4.6.8 Flanged connections

The use of flanged connections **must** be kept to the practical minimum.

The correct type and grade of gasket material **must** be used, that is:

- suitable for the operating temperatures and pressures in the relevant part of the system
- compatible with the relevant refrigerant and oil.

Flanged connections **must** be arranged so that the connected parts can be dismantled with minimum distortion stress of the piping.

Flanges **should** be evenly tightened, applying the 'opposites' rule in three or more gradual passes until the flange is seated correctly.

4.6.9 Compression/crimped fittings

Compression/crimped fittings **must** be installed following the manufacturer's preparation and fitting instructions.

All burrs **must** be removed from pipe ends before connecting.

4.6.10 Schrader valves

Valve cores **must** be tightened to the manufacturer-recommended torque using a purpose designed tool.

Valve cores **should** be removed when brazing the fitting.

4.6.11 Piping supports

Pipework and fittings **must** be adequately supported according to their size and service weight, to prevent movement and failure.

The selection of pipework support materials **should** take into account surrounding atmospheric conditions to prevent premature wear and corrosion.

Where galvanised clamps are used, copper pipe **must** be protected from chafing and corrosion.

Pipework **must** be fixed at regular intervals according to the outside diameter.

The maximum spacing for supports **should not** exceed the recommendations of AS/NZS 5149.2 (see Table 5 and 6).

AS/NZS 5149.2 Table 5 - Recommended maximum spacing for copper pipe supports

Outside diameter (mm)	Support spacing (m)
15 to 22	2
> 22 to < 54	3
> 54 to 67	4

AS/NZS 5149.2 Table 6 - Recommended maximum spacing for steel pipe supports

Nominal bore (DN)	Support spacing (m)
15 to 25	2
32 to 50	3
65 to 80	4.5
100 to 175	5
200 to 350	6
400 to 450	7

These are recommended maximum spacings and additional support may be needed to account for components, vibration and thermal expansion, as specified by the designer or manufacturer.

Good support throughout the system means not only fewer leakage problems, but better operation and offers the following additional advantages:

- no pipework sagging and eventual cracking
- good oil-handling characteristics
- no bad effects from vibration
- longer service life for the piping
- less chance of liquid hammer damage.

4.6.12 Piping clearance

The clearance around the piping **must** be sufficient to allow:

- routine maintenance of insulation, vapour barrier, and components
- checking of pipe joints
- repairing of leaks.

4.6.13 Pipework testing

Pipework **should** undergo visual and non-destructive testing post installation in accordance with AS 4041 to verify its integrity.

4.7 Compressor installation

4.7.1 Cleanliness

Compressors **must** be in a clean, dry and serviceable condition when installed.

The technician **must** ensure that no foreign matter enters the suction side of the compressor during the initial run-in period.

4.7.2 Shafts and drives

Shaft alignment **must** be within the compressor manufacturer's specifications.

Compressor drive belts, when fitted, **must not** be over tensioned, as this can lead to premature bearing wear and shaft seal failure.

4.7.3 Condensing units

Condensing units **must** be secured in accordance with the manufacturer's instructions to prevent any movement.

4.8 System testing

Before putting any refrigerating system into service, all the individual components, or the whole refrigerating system, **must** undergo the following tests:

1. Strength-pressure test, in accordance with AS/NZS 5149.2
2. Leak tightness test, in accordance with Clause 4.9
3. Functional test of safety switching devices for limiting the pressure, in accordance with AS/NZS 5149.2
4. Conformity test of the complete installation, in accordance with Clause 8.3.

Joints **must** be accessible for inspection while the strength-pressure testing and tightness testing are in progress.

After strength-pressure testing and leak tightness testing, the functional testing of all the electrical safety circuits is carried out.

All tests **must** be documented, see Section 8.

4.9 Leak tightness testing

Scheduled refrigerant **must not** be put into a system for the purposes of pressure leak tightness testing.

All sections of the system constructed on the installation site **must** be leak tightness-tested before the plant is charged with refrigerant.

4.9.1 General

This test applies to site assembled systems and not to manufactured systems or components.

Warning: When pressure testing at high pressures with oxygen-free nitrogen (OFN), the pressures are high enough to cause serious injury or death. Nitrogen is an asphyxiant.

4.9.2 When to test

Systems or parts of systems **must** be leak tightness tested to ensure that they are leak free before being charged with refrigerant.

The leak tightness test **must** be completed:

- at initial system commissioning
- after the system is moved, altered, or a change in use has occurred
- after the system is repaired
- after a change in refrigerant type
- when a refrigerant leak or low refrigerant charge is known or suspected
- after system standstill for longer than two years.

4.9.3 Test equipment

OFN (Oxygen-free nitrogen) – high purity <10ppm moisture content.

Note: The use of standard grade nitrogen is unsafe because of the possibility of sufficient oxygen to cause an explosion at high pressure.

Tracer gas – OFN with a small percentage of <5% hydrogen (tracer) or 10–30% helium (tracer) gas added, to improve the sensitivity of detection. Specific detectors for hydrogen or helium are used to pinpoint the leak.

Warning: For safety reasons 5% hydrogen **must not** be exceeded.

Note: With the use of a suitable electronic leak detector, using tracer gas (H_2/N_2) offers far more sensitive and accurate leak detection than when using pure OFN.

Leak detectors – A variety of technology is available for leak detection:

- Electronic leak detector – gas detector designed and calibrated for the gas being detected (**recommended**).
- Ultrasonic leak detector – electronic detectors designed to detect the sound of leaking gas.
- UV additives – fluorescent additives that can reveal the location of leaks using a UV light.
- Proprietary leak detection spray – commercial non-corrosive spray purpose-designed for leak testing.

All equipment **should** be used in accordance with the manufacturer's instructions. The use of an electronic leak detector is **recommended**, with leak detection spray limited to point source leak verification.

Systems containing flammable refrigerants require the use of a leak detector designed specifically for combustible gases. Traditional halide leak detectors can create a spark and **must not** be used for flammable refrigerants.

The detection equipment **should** be calibrated periodically. The sensitivity of portable gas detection devices should be at least 5g per year.

4.9.4 Test pressure

For initial system commissioning the test pressure **must** be at the maximum system operating pressure and:

- lower than any pressure limiting device setting and any pressure relief device setting
- never greater than the maximum allowable pressure (PS).

When testing a repair or component replacement the test pressure **must** be:

- above 25% and below 90% of the maximum system allowable pressure (PS)
- lower than any pressure limiting device setting and any pressure relief device setting.

4.9.5 Test procedure

The leak-detection procedure **must** take into account the response time of the equipment and the maximum distance between the leak and the leak-testing equipment. The following steps are **recommended**:

1. Evacuate the system, recovering any refrigerant where applicable.
2. Connect the OFN cylinder to the system or isolated section under test.
3. Pressurise the system in stages.
4. Check for leakage and pressure loss at every pressure increment increase.

5. When the maximum system allowable pressure has been reached, isolate the system from the nitrogen cylinder and record the system pressure and ambient temperature.
6. Monitor the system pressure for the required test duration, 1 hour or 24 hours.
7. If there is any drop in pressure (pressure adjusted for changes to ambient conditions in accordance with the ideal gas laws) then all leaks **must** be identified.
8. While the system is holding the test pressure all potential leakage points **must** be tested with a leak detector. Check the whole system. The first leak found may not be the only leak.
9. If a leak is identified, the OFN **must** be vented, the leak repaired and the leak tightness test procedure repeated.

The detection equipment **should** be used in accordance with the manufacturer's instructions.

It is best practice to use a combination of techniques e.g. an electronic detector to test an area and leak detection spray to identify and verify the exact location of the leak.

When the system has met the acceptance criteria the OFN **must** be evacuated and the system charged with refrigerant in accordance with Section 6.

When the system has not met the acceptance criteria, and a leak has not been found, the test **must** be repeated using more sensitive leak detection, e.g. using a tracer gas to improve detection or a specialised UV leak detection dye.

4.9.6 Test duration

Leak tightness test pressure **must** be held for:

- 24 hours for initial system commissioning tests, and
- 1 hour when testing a repair or component replacement.

4.9.7 Acceptance criteria

The system **must** be observed over a period of time, relative to the size of the system, to ensure that no pressure drop occurs, having due regard to temperature variation throughout the system.

For joints, equipment and components assembled at the installation site, all potential leakage points **must** be tested with detection equipment with a capability of 5g per year of refrigerant or better, with the equipment in standstill and under operation or under a pressure of at least the standstill or operational conditions.

For refrigerants with global warming potential (GWP) > 150, the AS/NZS 5149 acceptance criterion for this test is that no leaks are detected when using detection equipment with a capability of 10^{-6} Pa·m^3/s or better, for example, a helium sniffer.

For refrigerants with GWP < 150, the AS/NZS 5149 acceptance criterion for this test is that no leaks are detected when using detection equipment with a capability of 10^{-3}Pa·m^3/s or better, for example, application of a leak detection spray to the outer surface.

Any leak detected at this level of sensitivity **must** be repaired and retested.

4.9.8 Leak repairs

Repairs **must** be carried out and verified before the system is charged with refrigerant.

Repairs **must not** be made with the system pressurised.

Repairs **must** be carried out in accordance with Clause 9.9.

After the repairs have been completed, the system or affected parts of the system **must** be leak tightness tested to ensure that the repair is leak free.

4.10 Charging procedure

All charging **must** be carried out in accordance with Section 6.

All systems **must** be evacuated prior to charging with refrigerant.

4.11 System documentation

It is a requirement of AS/NZS 5149 to provide the RAC equipment owner with certain documentation.

The installer **must** provide the following documentation with the completed system:

- Operating and maintenance instructions, including logbook – in accordance with Section 7
- Commissioning data – in accordance with Section 8
- Test certificates.

Training of the system operator is **recommended**.

4.12 Installer warranty service

The customer **should** be reminded when a routine maintenance service is required for a period of at least two years after installation.

A maintenance service checklist (such as provided in AIRAH DA19) **should** be utilised and a copy **should** be given to the customer after each service.

5. EVACUATION PROCEDURES

5.1 General

Evacuation is the final step before charging a system and is critical for the removal of air and moisture from the system. It also serves as a final verification of system tightness.

This section refers to evacuation in the field only – not evacuation during the manufacturing process. Systems **must** be evacuated prior to system charging:

- at initial commissioning
- every time the refrigerant is removed from the system, e.g. during repair or replacement.

5.2 Manufacturer's evacuation instructions

Manufacturer's evacuation instructions **must not** specify a practice that will result in emission of scheduled refrigerant.

5.2.1 Factory matched systems

The manufacturer's instructions for evacuation **should** be followed if the system is factory matched and the manufacturer has supplied instructions with the system.

If the manufacturer's instructions are followed then the evacuation procedure is exempt from the requirements of this section.

The relevant parts of this section of this code **must** be complied with if there are any evacuation procedures not covered by the manufacturer's instructions.

5.2.2 Other systems

Evacuation of all other systems, or systems where manufacturer's instructions are not supplied, **must** comply with this section of this code in its entirety.

5.3 Equipment

Evacuation **should** be carried out with dedicated evacuation hoses (large diameter/as short as practical) and vacuum gauges and not service manifolds/gauges.

Depth of vacuums **must** be measured using accurate measuring equipment selected for the specific application i.e. a dedicated vacuum gauge, not a standard manifold pressure gauge.

5.4 Procedures

Scheduled refrigerants **must** be recovered from the system prior to evacuation. Before beginning the evacuation process the system **must** be completely depressurised ensuring that air is not introduced into the pipework.

Procedures **must** be planned so that breaking the vacuum with refrigerant does not introduce contaminants into the system.

Evacuation **must** be either the deep evacuation method or the triple evacuation method using oxygen-free nitrogen (OFN).

The deep evacuation method is suitable for small simple systems where internal contamination is unlikely or low. The triple evacuation method is suitable for all systems, and particularly large or complex systems where internal contamination is likely. Where the pipework has been exposed to atmosphere for any extended period of time, the triple evacuation method **should** be used.

Note: When evacuating a wet system in ambient temperatures below 0°C, it will take a lot longer for the system dehydration to be achieved. If a wet system has a vacuum pulled to below 4,500 microns, some of the internal moisture can change to solid ice. Where possible, warm the equipment up. Do not use flame-based methods.

After the system has been evacuated, the vacuum pump **must** be isolated from the system to check if the system vacuum pressure rises. This is known as the 'drop test'.

As a guide, with constant ambient conditions, the vacuum **should not** rise more than 100 microns (13.33Pa absolute) in one hour. A greater rate of rise during the drop test may indicate a leak or the presence of moisture, and the system **must** be leak tightness tested and all leaks repaired.

5.4.1 Deep evacuation method

1. Evacuate the system to at least 500 microns/67Pa absolute.
2. Isolate the vacuum pump from the system.
3. Allow the system to stand for 60 minutes. Ensure that vacuum is maintained below 600 microns/80Pa absolute.
4. If the gauge rises by 100 microns or more, then there is a leak or moisture in the system.
5. Test for leaks if the vacuum is not maintained.

5.4.2 Triple evacuation method

1. Evacuate the system to at least 4,500 microns/600Pa absolute.
2. Break vacuum with oxygen-free nitrogen (OFN).
3. Allow the system to stand.
4. Purge OFN through the pipework.
5. Re-evacuate the system, pulling the second vacuum to at least 4,500 microns/600Pa absolute and repeat the process using OFN to break the vacuum.
6. Re-evacuate the system for a third time, pulling the third vacuum to 500 microns/67Pa absolute.
7. On the third re-evacuation, isolate the vacuum pump from the system.
8. Allow the system to stand for 60 minutes to ensure the vacuum is maintained below 600 microns/80Pa absolute.
9. If the gauge rises by 100 microns or more, then there is a leak or moisture in the system.
10. Test for leaks if the vacuum is not maintained.

6. REFRIGERANT CHARGING PROCEDURE

Charging to a known mass is the most accurate method of achieving the correct refrigerant charge – use this when possible.

6.1 General

All refrigerant pipework, components and systems **must** be evacuated before refrigerant charging.

6.2 Charging procedure

The system refrigerant charge limits **must not** be exceeded, see Clause 2.3.

All charging **must** be carried out in accordance with AS/NZS 5149.4, Section C.2 Handling. Note that pure refrigerants can be charged as a vapour or liquid but refrigerant blends can only be charged as a liquid.

Hoses, fittings and procedures used during charging **must** be those which minimise the loss of refrigerant.

6.3 Verify hose connections

Except where charging is being carried out by the manufacturer on an assembly line, the hoses connecting a cylinder to a refrigerating system **must** be leak-tested before the cylinder valve is fully opened. This can be done by partially opening and then closing the cylinder valve to pressurise the connecting hoses and testing for a leak.

6.4 Refrigerant mass

Refrigerant **must** be weighed into and weighed out of the system.

Refrigerant being transferred **must** be accurately measured into the system with due reference to temperature in accordance with AS 4211.3.

The refrigerating system **must not** be over filled.

6.5 Charging precautions

Charging lines should be as short as possible and have suitable fittings to minimise losses during disconnection at the end of the transfer.

Care should be taken to avoid refrigerant liquid being trapped between closed valves as high pressures may develop.

Refrigerant cylinders **must not** be connected to a system at a higher pressure, or to a hydraulic leg, where the pressure is sufficient to cause a back flow of refrigerant into the cylinder.

Refrigerant cylinders **must not** be connected to systems or other cylinders at a higher temperature for similar reasons.

Back flow of refrigerant can result in cylinders being contaminated or overfilled, resulting in the subsequent danger from the development of a pressure high enough to burst the cylinder.

6.6 Flammable scheduled refrigerant

Before charging a refrigerating system with a flammable refrigerant, it is essential to ensure that the immediate area (deemed a temporary flammable zone) is suitable for working safely and the appropriate precautions are in place. This **should** include an assessment of the area for ventilation, sources of ignition, fire hazards, fire safety equipment and include the use of detection equipment and personal protective equipment (PPE).

Refer to the AIRAH *Flammable Refrigerants Safety Guide* for further details on temporary flammable zones.

The refrigerating system **must** be earthed prior to charging with flammable refrigerant.

6.7 Records

All refrigerant added to the system **must** be recorded in the logbook in accordance with AS/NZS 5149.4.

7. LABELLING AND DOCUMENTATION

7.1 System documentation and marking

Manufactured systems, equipment, major components and sub-assemblies, that are manufactured, assembled and tested before being delivered to site **must** be provided with installation, operation and maintenance instructions in accordance with Section 3.

For systems assembled on site, the system marking and documentation **must** comply with AS/NZS 5149.2 and this section.

7.2 Labelling

7.2.1 Identification plate

At installation, a clearly readable identification plate **must** be located near or on the refrigerating system. The identification plate **must** contain at least the following data:

- the name or identification of the installer or manufacturer
- the model, serial number, or reference number
- 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.

- the number designation of the installed refrigerant type, in accordance with AS/NZS ISO 817
- the refrigerant charge
- the maximum allowable pressure, high- and low-pressure sides
- when flammable refrigerants are used, the flame symbol (ISO 7010 W021).

7.2.2 Change of refrigerant or lubricant

Whenever the type of refrigerant and/or lubricant in a system is changed, see Section 11, the technician **must** clearly label the system with:

- the number designation of the new replacement refrigerant, in accordance with AS/NZS ISO 817
- the refrigerant charge
- the maximum allowable pressure, high- and low-pressure sides
- when flammable refrigerants are used, the flame symbol (ISO 7010 W021)
- name of technician, licence number (Australia only) and service organisation
- date of service
- whether any ultraviolet dye has been added.

Whenever the type of lubricant in a system is changed (other than when it has been pre-charged into a replacement compressor by its manufacturer), the technician **must** also clearly label the system with:

- the lubricant type.

7.2.3 Pipe marking

Pipe markers **should** also be utilised in accordance with AS 1345, accurately indicating refrigerant, especially for plants with lines external to plantroom.

7.3 Operation and maintenance information

The manufacturer or installer **must** supply an adequate number of instruction manuals and provide safety instructions.

The instruction manual **should** at least contain the following information (where relevant), in accordance with AS/NZS 5149.2, if applicable.

7.3.4 General

The manual **should** include:

- the purpose of the system and a description of the machinery and equipment
- a refrigerating system schematic diagram and electrical circuit diagram
- instructions concerning the starting, stopping, and standstill of the system
- instructions concerning the disposal of operating fluid and equipment
- precautions to be taken to prevent freezing at low ambient temperatures or by normal reduction in the system pressure/temperature
- precautions to be taken when lifting or transporting the systems or parts of the systems
- information displayed on the documentation at the operating site, if necessary, in its entirety.

7.3.5 Safety

The manual **must** include:

- a reference to protective measures, first aid provisions, and procedures to be followed in the event of emergencies, e.g. leakage, fire, explosion
- the instructions concerning the handling of refrigerant and the hazards associated with it
- the instructions concerning the function and maintenance of safety, protective, and first aid equipment, alarm devices, and pilot lamps.

7.3.6 Maintenance and refrigerant leakage

The manual **must** include:

- the causes of the most common defects and measures to be taken, e.g. instructions concerning leakage detection by authorised personnel and the need to contact competent technicians in the event of leakage or breakdown
- the maintenance instructions for the entire system with a time schedule for preventive maintenance with respect to leakage
- the instructions concerning the charging and discharging of refrigerant
- the logbook and guidance for the use of the logbook, where applicable.

7.4 Logbook

For all systems with a refrigerant charge over 3kg, AS/NZS 5149.2 requires that the manufacturer or installer **must** supply a logbook with the system documentation.

The following information **must** be able to be recorded in the logbook:

- the details of maintenance and repair works carried out
- the quantities and kind of (new, reused, recycled) refrigerant that have been charged or transferred from the system on each occasion
- the source and the results of any analysis of any reused refrigerant
- all changes and replacements of components of the system
- the results of all periodic routine tests
- significant periods of non-use.

8. COMMISSIONING

8.1 Manufacturer's commissioning instructions

Manufacturer's instructions **must not** specify a practice that will result in emission of scheduled refrigerant.

8.1.1 Factory matched systems

The manufacturer's instructions for commissioning **should** be followed if the system is factory matched and the manufacturer has supplied instructions with the system.

If the manufacturer's instructions are followed then the commissioning is exempt from the requirements of this section.

The relevant parts of this section of this code **must** be complied with if there are any commissioning procedures not covered by the manufacturer's instructions.

8.1.2 Other systems

Commissioning of all other systems, or systems where manufacturer's instructions are not supplied, **must** comply with this section of this code in its entirety.

8.2 Commissioning tests

Commissioning of the installed refrigerating system **must** include or validate at least the following tests:

1. strength-pressure test, in accordance with AS/NZS 5149.2
2. leak tightness test, in accordance with Clause 4.9
3. functional test of safety switching devices for limiting the pressure, in accordance with AS/NZS 5149.2
4. conformity test of the complete installation, in accordance with Clause 8.3.

8.3 Conformity test of the complete installation

Before the refrigerating system is put into operation, the complete installation **must** be checked against the specification and installation drawings, flow diagrams, pipe and instrumentation diagrams and the electrical diagrams of the system.

The inspection of a refrigerating system **must** include the following items:

- checking of documentation relating to pressure equipment
- checking of safety devices
- checking that permanent joints on piping are in accordance with the design documentation
- checking of piping against the design
- checking and documenting the alignment of the drive couplings of open compressors, pumps, fans, etc. with their drives
- checking the record of the leak tightness test of the refrigerating system
- visual inspection of the refrigerating system, see AS/NZS 5149.2.

Visual checks of the system in accordance with AS/NZS 5149.2 **should** include:

- vibrations and movements caused by temperature and pressure under operational conditions
- installation of fittings
- supports and fixing (materials, routing, connection)
- quality of welding and other joints
- protection against mechanical damage and heat
- protection of moving parts
- accessibility for maintenance or repair and for inspection of piping
- valve arrangement
- quality of thermal insulation and vapour barriers
- fouling of heat exchange surfaces.

This conformity test inspection **must** be documented.

8.4 Start up

Starting up the new plant is a critical period in which it is necessary to avoid damage.

When starting up the new plant, the following minimum procedures **should** be followed:

1. Gauges **should** be fitted to high-pressure and low-pressure sides of the compressor.
2. Pressures **should** be compared with the pressure for the prevailing ambient pressure for that refrigerant (higher pressure indicates non-condensable gases or poorer than expected condenser performance).
3. High-pressure/low-pressure safety cut-outs **should** be set.
4. The compressor oil level **should** be checked, even if this is normally carried out in the factory.
5. The system refrigerant charge **should** be checked.
6. Operation **should** be observed for at least two cycles (a cycle is from when the unit is turned on, to when the thermostat turns it off), and fine adjustments made if necessary.

7. The compressor oil level **should** be re-checked and topped up, if necessary, after first ensuring there are no other circumstances contributing to low oil level.
8. Gauges **should** be removed, re-tests should be carried out for leaks, and drives should be adjusted if necessary.

8.5 Variable speed technologies

When utilising variable speed technologies with compressors, the compressor **should** be run and monitored for excessive vibration during ramp up to maximum speed.

8.6 Strainers and dryers

After the initial running in period (100 hours) it is **recommended** that strainers and dryers be changed and examined for signs of abnormalities.

8.7 Commissioning procedures

RAC systems and components **should** be commissioned with calibrated instruments and established checklists and procedures, such as those outlined in:

- ASHRAE Refrigeration Commissioning Guide for Commercial and Industrial Systems
- AIRAH DA27 Building Commissioning
- CIBSE Commissioning Code R (Refrigeration) and Code M (Management)
- ASHRAE Guideline 1-1 *The HVAC Commissioning Process*.

A copy of the completed commissioning checklist **should** be provided to the owner.

8.8 Commissioning data

Commissioning data **should** represent the best operational settings of the system achievable by the commissioning specialist. For this reason, commissioning records are important in performance monitoring of the plant.

Commissioning data recorded **should** include:

- the refrigerant and lubricant type used and the mass of the refrigerant charge
- safety device settings such as pressure relief valves, high- and low-pressure cut-outs and any temperature-based protective arrangements
- full load running currents and supply voltages for compressor drive motor(s), where applicable, and for other drive motors on the plant
- design and actual operating pressures and temperatures
- details of the strength-pressure test, leak tightness test, functional test and conformity test of the complete installation, in accordance with AS/NZS 5149.2
- any other relevant information.

Commissioning data **should** be provided to the owner.

9. MAINTENANCE, REPAIR AND DECOMMISSIONING

Technicians have the opportunity to reduce leakage when servicing or maintaining systems. Conversely, poor service and maintenance will increase the risk of leakage occurring.

9.1 General

Technicians handling equipment containing a scheduled refrigerant **must** be competent (i.e. suitably qualified and holding a relevant national licence where required, see definition in Appendix C).

Scheduled refrigerant **must not** be discharged to atmosphere. All scheduled refrigerants **must** be recovered and either recycled, reclaimed, or held for destruction in an approved manner.

If the technician doubts the integrity of the system due to leakage rate and charging history, it **must not** be recharged until appropriate repairs and leak testing have been undertaken.

Having identified and located a leak, that part of the system **must** be isolated to minimise the loss of refrigerant. All remaining refrigerant **must** be pumped back into the system receiver or recovered to a separate cylinder if isolation is impractical, after which the repair can be undertaken.

The cylinders designated for the recovery of scheduled refrigerants **should not** be used for recovery of any other refrigerants.

Technicians **should** always read and understand the instructions and advice of the manufacturers and suppliers of all equipment, and apply as relevant and appropriate.

9.2 Refrigerant type

A technician **should** be aware of the possibility that the system may have been incorrectly charged or incorrectly labelled.

Before working on an unfamiliar system the technician **should** first establish the type of refrigerant contained in the system, by checking the pressure/temperature relationship or by using a refrigerant analyser or other methods, and verify that the labelling is correct.

Any refrigerant that cannot be identified **must not** be vented from the system.

If identification of the refrigerant is not possible it **should** be treated as a flammable refrigerant.

9.3 Flammable scheduled refrigerant

When working on appliances containing flammable scheduled refrigerant, instructions conforming to the requirements of AS/NZS 60335.2.40: Annex DD **must** be adhered to.

Manufacturers and suppliers include additional safety information in the operation and maintenance manuals for RAC equipment using a flammable refrigerant. Technicians **should** always read and understand the instructions and advice of the manufacturers and suppliers of all equipment, and apply as relevant and appropriate. Tools and equipment **must** be rated for use with the appropriate flammability grade (2 or 2L).

For flammable refrigerants, if a leak is suspected, all sources of ignition and naked flames **must** be removed/extinguished.

Before beginning work on systems containing flammable refrigerants, safety checks are necessary to ensure that the risk of ignition is minimised. Ensure that the area is in the open air or that it is adequately ventilated before breaking into the system or conducting any hot work. Any mechanical ventilation utilised **should** be suitable for use in a potentially hazardous environment. Electrical devices, leads or ignition sources in the vicinity **should not** be energised, unless rated for hazardous environments.

For more information, refer to the flammable refrigerant resources mentioned in the Preface of this code.

9.4 Maintenance

9.4.1 Preventative maintenance

Regular leak tests, inspections and checking of the safety equipment **should** be carried out.

The system instruction manual (see AS/NZS 5149.2) **must** include the maintenance instructions for the entire system with a time schedule for preventive maintenance with respect to leakage.

AS/NZS 5149.4 requires that preventive maintenance be carried out in accordance with the system instruction manual.

9.4.2 Inspection

All systems **should** be regularly inspected in accordance with AS/NZS 5149.4, *Section 5.2 Maintenance* and AIRAH I DA19 – *HVAC&R maintenance* – Compliance level maintenance.

The general operating conditions **should** be checked once a week, including system pressures where readings are displayed, refrigerant sight glass, etc. The condition of condensing equipment **should** be checked once a week. For air cooled equipment, the condition of the condenser coil **should** be observed.

A regular inspection program **should** ensure that the protection offered by the sacrificial anode or other protection where fitted is maintained and that the heat exchangers stay clean and scale-free.

9.5 In-service leakage inspection

Including in-service leak inspections as part of a preventative maintenance program allows the technician to find and fix small leaks before they lead to complete loss of refrigerant charge.

The in-service leak inspection is carried out with the refrigerant in place and the system operating as normal.

'Inspected for leakage' means that the equipment or system is examined primarily for leakage using direct or indirect measuring methods, focusing on those parts of the equipment or system most likely to leak.

For an in-service leakage inspection, the technician **should** complete:

1. a visual inspection of the system
2. a diagnostic analysis of the system operating parameters
3. a leak inspection of the system, including common leakage points.

9.5.1 Visual inspection

The technician **should** review the maintenance records to check where leaks have been found previously. The technician **should** complete a visual inspection of the operating system including, but not limited to, identifying any:

- visible oil or dust stains on joints, components or insulation

- movement or stresses due to vibration or thermal expansion
- signs of corrosion, thermal stress, wear or metal to metal contact points
- unusual level of noise or vibration from the system.

9.5.2 Diagnostic analysis

The technician **should** assess the system/refrigerant operating temperatures and pressures and compare against the manufacturer's data and operation instructions to determine whether the refrigerant charge is low.

For systems with fixed-speed compressors, measuring pressure readings coupled with air and refrigerant temperatures allows technicians to assess charge levels against manufacturer data.

For systems with variable speed compressors, diagnostic analysis can involve running the system at maximum output and measuring temperature difference (ΔT) across the heat exchanger at steady state or measuring delivered capacity, which requires measuring ΔT (heating), ΔH (cooling) and airflow.

Some systems have on-board diagnostics for automatic leak detection.

Where diagnostic analysis indicates a low refrigerant charge, a leak tightness test **must** be performed.

9.5.3 Leak inspection

Various methods may be used for leak inspection, e.g. electronic leak detectors, ultrasonic leak detectors, proprietary leak detection spray, or ultraviolet fluorescent additives. Electronic leak detectors **must** be specific to the refrigerant type, see Clause 4.9.3.

- Using a leak detector, assess all joints and components on the system for leakage, with a focus on common leakage points and any areas identified in the visual survey.
- Follow the leak detector manufacturer's instruction for leak detection.
- The results of the in-service inspection **should** be recorded.

Where a leak is detected, all refrigerant **must** be removed from the system or affected section, and the leak repaired.

Where a leak is suspected but not detected, all refrigerant **must** be removed, and the system (or affected section) **must** be leak tightness tested.

9.5.4 Common leakage points

The following areas **should** be individually assessed with a leak detector:

- joints – flare joints, mechanical joints and flanges, brazed joints, catalyst cured joints
- valves – Schrader valves, service valves, manual valves, pressure relief valves/devices, expansion valves, line tap valves
- evaporators and condensers – corroded areas, return bends, valves and joints
- seals – shaft seals (open compressor), compressor gaskets, seals on replaceable driers and filters, seals on gauge points, seals on caps
- other – capillary tubes, control bellows, O rings and pressure switches.

Access valves **should** have their caps refitted.

9.5.5 Testing the low-pressure side

The low-pressure side of a system **must** be placed under a positive pressure before leak testing the evaporator, heat exchanger, expansion valve, solenoid valve, and other components.

Pressure build up in the low-pressure side of the system **must not** exceed the maximum design conditions during testing.

9.5.6 Testing negative pressure systems

Negative pressure systems can, if not controlled correctly during testing, burst the rupture disc.

The test pressure **must** comply with AS/NZS 5149.1 when leak testing.

Tube-piercing valves or equivalent devices **must** only be used to gain temporary access to the system where there is no other means of access in order to remove refrigerant. They **must** be removed prior to the completion of service.

The technician **should** ensure that the condenser is clean and serviceable.

If the system has electric defrost, the compressor **should** be switched off and the defrost cycle initiated without pumping down the system to increase the system pressure.

The charging and/or temporary gauge lines and connecting lines and/or flexible hose **should** be evacuated using a vacuum pump to less than 5,000 microns to eliminate air intake.

9.6 Leakage inspection frequency

9.6.1 Mandatory leak inspection frequency

AS/NZS 5149.4 requires that each refrigerating system be subjected to preventive maintenance with respect to leakage in accordance with the system instruction manual, including the frequency of in-service leakage inspections.

9.6.2 Recommended leak inspection frequency

In the absence of instructions in the operating manual, the recommended frequency of in-service leakage inspections of AS/NZS 5149.4 **should** be followed.

AS/NZS 5149.4 Recommended in-service leak inspection frequency

System type/refrigerant charge	Leak inspection frequency
Self-contained systems, Unit systems	After repair or when leakage is suspected
Hermetic systems ≤ 6kg refrigerant charge	Every 12 months
All other systems ≤ 3kg refrigerant charge	After repair or when leakage is suspected
All other systems > 3kg ≤ 30kg refrigerant charge	Every 12 months
All other systems > 30kg ≤ 300kg refrigerant charge	Every 6 months
All other systems > 300kg refrigerant charge	Every 3 months
Stored refrigerant in cylinders	Every 3 months

9.6.3 Best practice leakage inspection frequency

The best practice approach to in-service leakage inspections is currently reflected in the European Union (EU) F-Gas regulations, where the frequency is based on tonnes of CO_2 equivalent of the refrigerant charge, and whether a fixed refrigerant leak detection system is fitted.

The tonnes of CO_2 equivalent (tCO_2e) of a refrigerant charge is calculated by multiplying the mass of refrigerant charge in tonnes by the global warming potential (GWP) of that refrigerant.

The EU regulations also mandate inspection frequencies for HFO refrigerants, based on refrigerant charge mass.

European Union (EU) F-Gas regulation – Leak inspection frequency

Refrigerant type	Refrigerant charge (tonnes CO_2e or kg refrigerant)	Leak inspection frequency (months)	
		No fixed leak defection	With fixed leak detection
HFC and HFC/HFO Blends	5t CO_2e ≤ refrigerant charge < 50t CO_2e	12	24
	50t CO_2e ≤ refrigerant charge < 500t CO_2e	6	12
	refrigerant charge ≥ 500t CO_2e	3	6
HFO	1kg ≤ refrigerant charge < 10kg	12	24
	10kg ≤ refrigerant charge < 100kg	6	12
	refrigerant charge ≥ 100kg	3	6

9.7 Shutdown systems

In preparation for seasonal shutdown, it is **recommended** that the system be pumped down and the bulk of the refrigerant charge be valved off in the condenser.

Systems equipped with an open-type compressor that have been shut down for periods longer than a month **should** be treated as follows.

9.7.1 Positive pressure systems

For systems with separate oil pumps, these pumps **should** be run at least once a month.

On systems where a separate oil pump is not fitted, the shaft **should** be rotated at least once a week to ensure the seal is kept lubricated.

If a system is to be shut down for more than one month the system **should** be:

1. pumped down
2. all necessary valves closed to prevent the escape of refrigerant
3. suitably labelled.

If this is not possible, the system **should** be run once a week for at least half an hour in order to ensure that mechanical seal faces, bearings, etc. have a continuous oil film on their surfaces. This procedure could prevent seal failure occurring over a long period of shutdown.

If, after any shut down period of more than one month:

- the oil pump has not been run, or
- on compressors with no oil pump, if the shaft has not been rotated periodically,

the shaft seal **must** be thoroughly inspected, lubricated and leak tested before starting any maintenance.

9.7.2 Negative pressure systems

Negative pressure systems can be under a vacuum and could draw in air and moisture both while operating and when they are off.

A method of pressurising the system and controlling the pressure to between 0.3kPa and 2.0kPa gauge **should** be implemented when the system would otherwise equilibrate at a vacuum when not operating.

Once a week the compressor **should** be stopped and the shaft seal checked for excessive oil leakage.

The seal **must** be checked with a refrigerant leak detector if oil leakage is found, opening the compressor only.

This minimises the quantity of refrigerant that might be lost due to any minor leak on the low-pressure side of the system and refrigerant that might leak through the shaft seal.

The compressor **should not** be allowed to pump the suction pressure into a vacuum.

A slight positive pressure is necessary to prevent air and moisture from being drawn into the system through minor leaks and through the now unmoving shaft seal.

9.8 Seasonal start-up

The compressor oil line sight glass, oil pressure and liquid line sight glass **should** be checked upon seasonal startup, after the system has been operated for 15 to 20 minutes.

The condenser and liquid receiver (if used) **must** be checked for refrigerant leaks using a refrigerant leak detector.

The system temperature controller **should** be readjusted to the proper temperature setting if no leakage is confirmed.

9.9 Repairs

9.9.1 General

Replacement of components or changes to the refrigerating system **should** be ordered and carried out by a competent person.

System components **should** be replaced with parts that are more leak-resistant or have a reduced number of potential leak sources.

An equivalent replacement 'O' ring seal **should** be used each time an 'O' ring connection is remade.

9.9.2 Repair procedure

Repairs on refrigerant containing components **should** be carried out in the following order, where applicable:

1. recovery of refrigerant, emptying and evacuation
2. disconnecting and safeguarding of the components to be repaired
3. cleaning and purging (e.g. with OFN)
4. carrying out the repair
5. testing and checking of the repair (pressure test, leakage test, functional test)
6. evacuating and recharging with refrigerant.

Following any repair, all safety, control and measurement devices as well as alarm systems **must** be checked to verify operation.

9.9.3 Breaking into systems

Where not in the open, the area **must** be adequately ventilated before breaking into the system or conducting any hot work.

Systems, or the isolated section of the system, **must** be evacuated and purged with OFN prior to any hot work.

If the system contains any refrigerant, or any other gas under pressure, it **must not** be broken into by means of cutting or breaking pipework.

A portable leak detector **should** be considered when completing cut-in tasks for toxic or flammable fluids.

9.9.4 Brazing and de-brazing

Where repair work requires brazing or de-brazing or any hot work, all refrigerant **must** be recovered from the system, or isolated (by means of shut off valves) in a part of the system remote from the repair.

OFN **must** then be purged through the system both before and during the brazing process.

9.10 Oil removal

The compressor crankcase **must** be brought to atmospheric pressure before oil is removed.

Refrigerant content of the oil **must** be minimised using procedures such as evacuation, or the use of crankcase heaters, since the refrigerant vapours are soluble in compressor lubricating oils.

9.11 Tube piercing/line tap valves

Tube piercing/line tap valves or equivalent devices **must** only be used to gain temporary access to the system. They **must** be removed prior to the completion of service.

9.12 Cleaning and flushing

This procedure covers cleaning and flushing a contaminated system after a hermetic or semi-hermetic compressor failure or motor burnout.

9.12.1 Refrigerant recovery

As many parts of the system as practical **must** be isolated.

All scheduled refrigerants including contaminated refrigerant **must** be fully recovered.

The recovery cylinder **must not** be over-filled, as per AS 2030.5, see Clause 13.4.

Contaminated refrigerant **must not** be recovered in the same cylinder as clean/reusable refrigerant.

Flammable scheduled refrigerants **must** be recovered into appropriately labelled cylinders.

When the system is empty and at atmospheric pressure, the faulty component parts should be removed and the system capped off. Small systems **should** be taken to a workshop with appropriate facilities for cleaning and reinstating.

9.12.2 Cleaning solvents

Scheduled refrigerant **must not** be used for flushing components.

WHS/OHS safety standards **must** be observed when handling solvents. Relevant Safety Data Sheets **must** be obtained and made available to the technician handling solvents.

The cleaning solvent **should** be pumped throughout the system until only clean solvent emerges. After ensuring the system has been thoroughly cleaned, caution **should** be taken to ensure no solvent residue remains in the system after purging.

All spent solvents **must** be disposed of in accordance with the Australian state and territory hazardous substance disposal regulations or the New Zealand Hazardous Substances (Health and Safety Reform Revocations) Regulations 2017, as applicable.

Each Australian state or territory has their own laws and policies, and relevant permits, licences and/or registrations that cover transporting, storing, treating and disposing of hazardous waste.

9.12.3 Cleaning with filter dryers

If it has been established after testing the refrigerant and oil for acidity that the system has only been locally contaminated by the burnout, moisture, or mechanical failure, and does not require the cleaning procedure outlined in Clause 9.12.2, then cleaning of the system by using purpose selected suction and liquid line filter dryers is an acceptable alternative.

When using this method all filters fitted **must** be capable of being replaced with a minimal loss of refrigerant to the atmosphere.

9.12.4 Reassembly and test

When cleaning is complete, the major component parts **should** be reassembled in the system with the replacement compressor.

It is **recommended** that a suction line filter/dryer (a burnout dryer) be fitted.

The system **must** be pressurised and strength and leak tested in accordance with Clause 8.2.

9.12.5 Evacuation

The system **must** then be evacuated prior to charging with refrigerant. Refer to Section 5.

A new dryer **should** be fitted while there is zero gauge pressure in the system. If triple evacuation is used, this **should** be done between the second and third stages. If deep evacuation is used, it **should** be done at the beginning of the process.

The system can then be recharged with refrigerant.

9.12.6 Recharge

The system **must not** be recharged before the system has been fully leak tested, all identified leaks repaired and the system has been evacuated in accordance with Section 5.

Refrigerant used to recharge a system **must** meet the specification for new refrigerant set out by AHRI 700.

Because most lubricants are very hygroscopic and will absorb moisture from the air, they **should not** be exposed to atmosphere for any longer than is necessary.

The system **should** be recharged to the refrigerant quantity shown on the identification plate.

9.13 Decommissioning

9.13.1 Refrigerant

All scheduled refrigerant **must** be recovered from all parts of the system at the time of decommissioning.

Recovered refrigerant **must** be reclaimed or disposed of in accordance with Section 12.

9.13.2 Equipment labelling

The RAC equipment **must** be labelled stating that it has been decommissioned and emptied of refrigerant.

The label **must** be dated and signed.

10. ADVICE TO EQUIPMENT OWNERS AND OPERATORS

10.1 Owner's responsibilities

The owner of RAC plant and equipment is responsible for its use and care.

A malfunctioning unit **should** be attended to by a competent service technician as soon as the condition occurs, to ensure that any leakage of refrigerant is minimised. See also AS/NZS 5149.4, Annex D In-service inspection.

All scheduled refrigerants **must** be recovered and either recycled, reclaimed, or sent for destruction in an approved manner.

The system **must not** be recharged before the system has been fully leak tightness tested and all identified leaks repaired.

Scheduled refrigerant **must** never be deliberately vented or leaked from a refrigerating system.

10.2 Leaking systems

Owners and operators of RAC equipment in Australia are advised that licensed technicians are required by legislation to observe this code of practice.

A system known to be leaking **must not** be topped up with refrigerant until all leaks are fixed. A technician cannot do other work on leaking equipment, without repairing the leak.

Some modification to plant or equipment may be necessary to avoid leaks and achieve the aim of the code of practice to minimise loss of refrigerant.

10.3 Maintenance

To keep a system operating efficiently and effectively, and reduce the chance of major breakdown, it is in the interest of the operator to properly maintain the system by following the operating and maintenance instructions from the manufacturers, ensuring the system is regularly maintained and accepting the necessary repairs and adjustments proposed by the service technician.

If the equipment operator does not have appropriately trained staff to undertake service or maintenance work it is **recommended** that a routine maintenance agreement be entered into with a competent service technician or organisation.

Periodic preventative maintenance is **recommended** to minimise refrigerant leakage and keep the system operating efficiently and effectively. The appropriate service intervals and steps depend on the system type, size and refrigerant charge.

All users **should** monitor the operation of their installation regularly and call the service technician immediately if any abnormal condition is found. Apart from minimising the loss of refrigerant to the atmosphere, this may also save the cost of an expensive repair or replacement and ensure the ongoing efficient operation of the system.

10.4 Leakage detection

The installation of a suitable sensing and alarm system to detect a loss of refrigerant charge or the presence of leaked refrigerant is:

- **required** *in some cases* by AS/NZS 5149
- **recommended** *in all systems* that contain more than 3kg of refrigerant.

Leakage detection systems **should** also be maintained periodically in accordance with the manufacturer's instructions.

An oxygen monitoring system **should** be provided when accessing installations that are installed in spaces defined as enclosed spaces.

11. CHANGE OF REFRIGERANT/ LUBRICANT PROCEDURE

11.1 Prohibited refrigerant charging

Under Australian regulations, systems **must not** be charged with a higher global warming potential (GWP) refrigerant than the equipment was designed to use. See Clause 1.2.2 for more detail.

11.2 Procedures

The procedures specified in AS/NZS 5149.4 *Change of refrigerant type* **must** be followed when a refrigerant change is to be carried out.

11.3 Manufacturer's advice

Guidance on equipment suitability for refrigerant type change **should** be sought from the original equipment manufacturer, new refrigerant manufacturer and lubricant manufacturer.

11.4 Change of safety classification

The system **should not** be changed to a replacement refrigerant with a more hazardous AS/NZS 817 Safety Group Classification (see Appendix B) unless:

- The system has been re-engineered by a competent refrigeration or air conditioning engineer.
- The required changes to the system have been designed in accordance with the applicable compliance standard and carried out and documented, in accordance with AS/NZS 5149.4.
- Any introduced flammability concerns have been addressed in accordance with AS/NZS 5149 and AS/NZS 3000.
- The system complies with other relevant standards such as those relating to electrical and gas safety.

The person changing a refrigerant to a more hazardous refrigerant takes on a role similar to that of a designer of a refrigeration system. Where a different classification of refrigerant is being considered (e.g. changing from A1 to A2, A2L, or A3), a system conversion process is required.

Refer to the Heads of Workplace Safety Authorities (HWSA) *Flammable Refrigerant Gases Position Paper* and the AIRAH *Flammable Refrigerants Safety Guide* for more details on the system conversion process for flammable refrigerants.

11.5 Compatibility

The replacement refrigerant **must** be compatible with all parts of the system it is in contact with. This includes the lubricant, seals and all other wetted components.

A new filter dryer appropriate for the replacement refrigerant **must** be fitted.

11.6 Labelling and documentation

Refrigerating systems modified on site **must** be labelled, in accordance with Clause 5.2.

When a system refrigerant has been changed, the system's labelling, colour coding (if applicable) and nameplates **must** be changed to permanently identify the replacement refrigerant now contained in the system.

System operation and maintenance documentation **must** be updated.

12. REFRIGERANT RECOVERY, RECYCLING, RECLAMATION AND DISPOSAL

12.1 General

Refrigerant cylinders will often be used as temporary receivers for all or part of the refrigerant charge. Hazards can arise in the use of refrigerant cylinders in this way and the requirements of this section **must** be complied with.

Warning: Non-condensable gases mixed with refrigerant can be extremely hazardous, increasing the pressure above normal vapour pressure. They can cause a cylinder to burst during filling or warming.

Flammable refrigerants **must** be recovered using equipment rated for use with the appropriate flammability grade (2, 2L or 3). Refrigerant cylinders used **must** be designed for the refrigerant in use.

In Australia, it is an offence to act in a way that results in the unlawful discharge of scheduled refrigerants. Recovery and disposal of refrigerant at the end of its useful life using appropriate recovery equipment or recovery/recycling equipment is mandatory. Any person who handles a scheduled refrigerant **must** hold a Refrigerant Handling Licence.

In New Zealand, it is an offence under the *Ozone Layer Protection Act 1996* to wilfully release an ozone-depleting substance. It is also illegal to release synthetic greenhouse gases into the atmosphere under the *Climate Change Response Act (CCRA) 2022*.

In New Zealand, any person refilling a cylinder **must** hold a current Refrigerant Fillers Certificate relevant to the refrigerant involved.

To avoid mixing refrigerants that can be recycled or reused it is necessary to use dedicated recovery equipment for each refrigerant type being recovered.

To ensure that no recovery cylinder is over-filled, it is necessary to ensure that only cylinders marked with the correct filling ratio are used, and that this filling ratio is not exceeded for the refrigerant or mixture being reclaimed.

12.2 Refrigerant recovery

In Australia all scheduled refrigerant being removed from equipment **must** be recovered and either recycled, reclaimed or disposed of, in accordance with this section.

Scheduled refrigerants **must** be recovered into an appropriately labelled cylinder of suitable pressure rating for the refrigerant being recovered. Refrigerant **must not** be recovered into a flexible bag.

The entire refrigerant charge, refrigerant vapour as well as refrigerant liquid, **must** be recovered when a system is emptied.

12.2.1 Recovery equipment

Portable equipment is available for recovery of refrigerant in the field.

Refrigerant recovery equipment and recovery/recycling equipment **must** conform to AS 4211.3, ISO 11650 or AHRI 740. Refrigerant recovery units **must** be appropriate for the refrigerant being recovered.

Hoses, fittings and procedures used during recovery **must** be those which minimise the loss of refrigerant.

Recovery equipment **should** be used and maintained in accordance with the manufacturer's instructions.

12.2.2 Flammable scheduled refrigerant tools and equipment

Tools and equipment **must** be rated for use with the appropriate flammability grade.

A2L and A2 refrigerants are generally not compatible with the following 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 **must** be assessed individually to ensure:

- they conform with relevant international/Australian/New Zealand Standards
- the manufacturer's manual/specification states that it is designed for use with flammable refrigerants.

12.2.3 Recovery cylinders

Cylinders used for recovery **must** conform with AS 4484, AS 2030.1 and AS/NZS 1200.

Refrigerant **must not** be recovered into an out-of-date recovery cylinder, i.e. the current date **must not** be later than the expiry date of the most recent test station stamp on the cylinder.

Note: Refrigerant/oil mixtures have a lower density than refrigerant alone and for this reason the carrying capacity of refrigerant cylinders will be reduced for refrigerant/oil mixtures compared to pure refrigerants.

The designed maximum safe working pressure of a refrigerant cylinder determined in accordance with AS 2030.5 **must not** be exceeded in any filling operation, no matter how temporary.

Particular care **should** be taken when recovering modern high-pressure refrigerants because their ambient pressures can be much higher than previous generation refrigerants.

Cylinders **must** only be used within the application for which they are designed. The recovery cylinder **must** be appropriate for the refrigerant being recovered. A2/A2L refrigerant **must** be recovered into A2/A2L specific cylinders with the correct design pressure ratings.

The permission of the owner of the cylinder **must** be obtained in advance if a refrigerant cylinder belonging to a third party (for example, a refrigerant manufacturer, wholesaler or hirer) is to be used as a temporary receiver. Where granted, the owner **must** be given the opportunity to carry out an internal inspection for corrosion and contamination immediately after such use, and the refrigerant cylinder **must** be labelled indicating such use.

Valves and non-return valves on refrigerant cylinders **must not** be tampered with without the permission of the owner.

12.2.4 Contaminated refrigerant

Cross contamination of refrigerants and lubricants **should not** occur within the recovery equipment if the refrigerant is to be recycled or reused.

If contaminated refrigerant is decanted into a recovery cylinder, corrosion and contamination may occur.

If a cylinder is filled with contaminated refrigerant, an internal examination followed by cleaning **should** be carried out before it is reused.

Refrigerant suspected to be contaminated **must** be either disposed of or tested if it is to be re-used. If necessary, it may be recycled or reprocessed to ensure it complies with the provisions of AHRI 700 prior to re-sale or re-use.

12.2.5 Refrigerant mixtures

Cross contamination of scheduled refrigerants with non-scheduled refrigerants **must not** occur within the RAC equipment or during the recovery process. Where these mixtures are encountered, they **must** be recovered by a competent technician. They **must not** be vented to the atmosphere and **must** be reclaimed.

Note: It is possible that non-design refrigerants and mixtures of refrigerants with a different safety classification have been incorrectly used as replacements for HFCs, HCFCs and CFCs or have been used to 'top up' a refrigerant charge in existing systems. There is a risk that the equipment in question was not appropriately redesigned and/or relabelled to indicate that a more hazardous (flammable and/or toxic) refrigerant has been used. As the operating pressures of these replacements and mixtures can be similar to those of the original design refrigerant, identification in the field can be extremely difficult.

When technicians encounter RAC equipment in the field that they are not familiar with, and where the refrigerant cannot be positively identified, they **should** treat the system as if it contained a flammable and toxic refrigerant. If the presence of a flammable or toxic refrigerant is suspected in a system that is not appropriately redesigned and relabelled, proper care **should** be taken to recover it. Only personnel trained in using equipment designed to recover these types of mixtures **should** perform this task.

Mixing different types of refrigerants during recovery may render large quantities of refrigerant unable to be recycled or reclaimed, as separation may be impossible.

12.3 Refrigerant recycling and reclamation

Recycled refrigerant is refrigerant that is re-used, with or without some cleaning taking place.

Reclaimed refrigerant is refrigerant that is re-used after it has been reprocessed to meet the AHRI 700 specification.

The use of recycled refrigerant that has not been cleaned can be detrimental to a refrigerating system. Recovered refrigerant can contain moisture, oils, acidity, particulates and non-condensable gases. Re-using this refrigerant without cleaning may cause corrosion to copper and aluminium components, shortening the life of heat transfer coils and compressors.

Analysis of the recycled refrigerant to ensure it is fit for use **should** be undertaken prior to re-use.

Contaminated recycled refrigerant **should** be reclaimed prior to re-use.

Recovered refrigerant **should** be reclaimed before being used in a different system. Using recovered refrigerant that has not been reclaimed may void equipment warranty and seriously damage the system.

12.3.1 Refrigerant recycling

In some cases the recycling of refrigerant involves simple cleaning processes using filters and driers that remove certain contaminants, such as moisture and particulate. The recycling process is more complicated for blended refrigerants, because preferential leakage or separation within the system may have resulted in a change of blend composition.

These refrigerant recycling cleaning processes can be carried out on site using portable equipment. Some refrigerant recovery units include cleaning (for recycling) stages.

Refrigerant recovery/recycling equipment **must** conform to AS 4211.3, ISO 11650 or AHRI 740.

12.3.2 Refrigerant reclamation

Refrigerant reclamation **must** only be carried out at a specialist facility that reprocesses the refrigerant to a specification that is equivalent to the original refrigerant state.

Reclaimed refrigerant **must** be treated and processed so that it conforms to the AHRI 700 standard.

After reclamation, the refrigerant can be reused in any system designed for that refrigerant.

12.4 Disposal

12.4.1 Disposal of refrigerants

Unwanted scheduled refrigerant **must not** be discharged to the atmosphere and **must** be returned to a supplier or collection agent for safe disposal.

In Australia, under the Regulations, unwanted scheduled refrigerant **must** be recovered and recycled or sent to an appropriately licensed facility for reclamation or disposal. A Refrigerant Trading Authorisation holder **must** accept any surrendered refrigerant or scheduled substance that appears to be intended for use in RAC equipment. They **must** also ensure that destruction of refrigerant is carried out only by the operator of a refrigerant destruction facility.

See refrigerantreclaim.com.au for more information.

In New Zealand all refrigerant importers are required to accept refrigerant back under product stewardship requirements. Locations that accept returned refrigerant in New Zealand include A Gas NZ Ltd, Patton NZ Ltd and RefSpecs NZ Ltd. For additional locations that accept returned refrigerant in New Zealand, visit coolsafe.org.nz.

12.4.2 Appliance disposal

Scheduled refrigerant **must** be recovered from all appliances containing refrigerating systems before their disposal.

All domestic and commercial refrigerator and freezer cabinets **should** have any locks removed or rendered inoperative upon removal from service. Doors, drawers and/or lids **should** be removed or otherwise rendered safe and inaccessible where refrigerators and freezer cabinets are stored or removed from service and left in any public place or any other place where children could have access.

12.5 Disposable refrigerant containers (New Zealand only)

The importation and storage of scheduled refrigerant in disposable (non-refillable) refrigerant containers is prohibited by law in Australia. The following requirements apply to New Zealand only:

1. Any residual refrigerant in a disposable container **must** be recovered
2. A disposable container **must not** be refilled or used as a temporary receiver during service
3. A disposable container **must not** be repaired or modified in any way
4. Empty disposable containers **must** be disposed of at a recycling centre.

13. HANDLING AND STORAGE OF REFRIGERANTS

13.1 Chemical hazards

Under Australian WHS/OHS regulations, and New Zealand *Hazardous Substances and New Organisms Act 1996 (HSNO)*, 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. This system is independent of the refrigerant classifications of AS/NZS ISO 817.

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 on a product which is used as a basis for safely managing the related storage, and handling risks. Asphyxiation and freeze burns are also a risk.

Refrigerant SDS **should** be readily available and personnel **should** refer to the SDS before handling refrigerants.

13.2 Flammability hazards

For flammable scheduled refrigerants, technicians **must** take the relevant safety measures for the correct transport, storage, and handling of a flammable gas.

This includes ensuring that the refrigerant is not exposed to open flames or other ignition sources. Toxic substances like hydrogen fluoride and carbon monoxide are created when fluorinated refrigerants are burnt.

For additional information on flammability hazards refer to resources such as those listed in the Preface of this code.

13.3 Handling and storage losses

Losses of refrigerant to the atmosphere can occur during the handling and storage of refrigerant cylinders. Competent technicians can minimise such losses.

Where a scheduled refrigerant is to be transferred to a charging station, refrigerant vapour vented to atmosphere **must** be minimised.

13.4 Cylinder filling

13.4.1 Australian requirements

In Australia, it is a legal requirement that any person who handles a scheduled refrigerant, including a person filling cylinders, **must** hold a Refrigerant Handling Licence.

In Australia, refillable containers **must** be used for the storage of scheduled refrigerant.

13.4.2 New Zealand requirements

In New Zealand, it is a legal requirement that any person who fills gas containers with gases under pressure **must** be trained and hold a current, approved filler compliance certificate. This applies to all gases under pressure, including air.

All refillable gas cylinders approved for filling in New Zealand **must** be stamped with a record number, normally done at the time of manufacture. The record number is in the form of LAB YYYY, or in the case of special cylinders, LAB YYYY SP. The inspection interval for refrigerant cylinders in New Zealand is every 5 years from date of manufacture.

13.4.3 General filling

The maximum gross weight **must not** be exceeded when filling refrigerant cylinders. The cylinder **must not** be used if the maximum gross weight is not marked on the cylinder. The cylinder supplier **should** determine the maximum gross weight in accordance with AS 2030.5.

The maximum gross weight is a function of the internal volume of the cylinder, refrigerant composition and oil content and temperature.

The safe fill capacity (SFC) is the quantity of liquid refrigerant that can be safely added to a storage cylinder without causing undue stress on the cylinder. The SFC, expressed in kilograms, is determined by multiplying the water capacity (WC) stamped on the cylinder, expressed in litres, by the maximum fill ratio (FR) specified for the refrigerant in accordance with AS 2030.5, i.e.:

$$SFC = FR \times WC$$

The FR is a number that is based on the refrigerant properties, cylinder material and design, temperature considerations and the safety factor or ullage, the vacant space between the top of the liquid refrigerant and the top of the cylinder. AS 2030.5 requires a minimum ullage of 3% at the mean bulk liquid temperature of 57 °C for refrigerants except high pressure refrigerants such as carbon dioxide (R744). So, the FR can be obtained from refrigerant's specific gravity or liquid density (ρ_{liquid}) expressed in kg/L at 57 °C, i.e.:

$$FR = 0.97 \times \rho_{liquid@57\,°C}$$

Calculated FR based on AS 2030.5 Clause 7.1.3 and tabulated FR from AS 2030.5 Table 4 for some refrigerants are listed in the following table.

Common scheduled refrigerant fill ratios (FR)

Refrigerant	Tabulated FR taken from AS 2030.5 Table 4	Calculated FR based on AS 2030.5 Clause 7.1.3 (a), with liquid density* at 57 °C
R12	1.15	1.15
R22	1.03	1.02
R32	0.78	0.77
R134a	1.04	1.04
R410A	-	0.82
R404A	0.82	0.82
R407C	0.94	0.94
R448A	-	0.90
R454B	-	0.82
R454C	-	0.89

* liquid density predicted by NIST REFPROP software

For recovered and recycled refrigerants the safe fill capacity formula from AS 4211.3 requires a minimum ullage of 20%, so the SFC calculation becomes:

$$SFC = 0.80 \times FR \times WC$$

Refilling a cylinder **must** only be undertaken with the permission of the cylinder owner.

Refrigerant **must not** be vented to the atmosphere from the receiving cylinder.

The receiving cylinder may be cooled in an operating refrigerator or freezer.

Warming of the discharging cylinder is permissible under controlled conditions to increase the rate of discharge of refrigerant during transfer.

Refrigerant cylinders **must not** be directly heated by flame, radiant heat or uncontrolled direct contact heat. Heating of cylinders using indirect forms of heating, e.g. controlled temperature air flow, **must** only be conducted where the control system is designed to be fail safe.

13.5 Refrigerant transfer between cylinders

The provisions of Clause 12.4 also apply to refrigerant transfer between cylinders.

Where refrigerant is to be transferred from one cylinder to another, a pressure or height difference **must** be established between the cylinders and this may be achieved by means of a pump or temperature differential.

Refrigerant cylinders **should not** be manifolded together if there is a possibility of temperature differences between the cylinders, since this will result in refrigerant transfer and the danger of overfilling the cold cylinder.

Where cylinders are manifolded together:

- Care **should** be taken to ensure all the cylinders are at the same height to avoid gravity transfer between cylinders.
- It is **recommended** that single direction flow or check valves be installed at each cylinder.

13.6 Cylinder storage

13.6.1 Hazards

There are numerous hazards associated with the storage of refrigerant. These include asphyxiation in confined spaces due to leakage from refrigerant cylinders, and fire, which may overheat and explode refrigerant cylinders or decompose refrigerant into toxic substances.

Technicians **should** make reference to refrigerant manufacturer's Safety Data Sheets when handling refrigerant cylinders.

Gauges **should** be removed from the cylinder for storage and transport.

13.6.2 Storage

Cylinders containing scheduled refrigerants **must** be stored in accordance with AS/NZS 4332.

Refrigerant **must** be stored securely with appropriate signage (to provide ready identification by emergency teams).

There are limits on the amount that can be stored and reference **must** be made to current local legislation.

In Australia, to meet their permit conditions, holders of a Refrigerant Trading Authorisation **must**:

- regularly check refrigerant containers in their possession for leaks
- implement a risk management plan for handling and storing refrigerant in their possession.

They **must** also keep records relating to:

- refrigerant purchase, sale, recovery and disposal
- checks, tests and maintenance of equipment and refrigerant containers/cylinders, including leak checks.

13.6.3 Handling

The refrigerant cylinder and its valve **must** be handled carefully to avoid mechanical damage.

When a refrigerant cylinder is not in use its valve **must** be closed, the valve outlet sealing cap put in place and the valve protected.

Cylinders **must** be leak tested every 3 months. Refrigerant leak detectors can be used for this purpose.

The contents of a leaking cylinder **must** be transferred to a recovery cylinder immediately. The leaking cylinder **must** be returned to the supplier.

In Australia, Refrigerant Trading Authorisation holders **must** ensure that refrigerant in their possession is handled in accordance with applicable standards by the holder of an appropriate licence, and keep records of these licensees.

13.7 Refrigerant transport

13.7.1 Transporting in Australia

In Australia, the Australian Code for the Transport of Dangerous Goods by Road and Rail (the ADG Code) provides detailed technical specifications and recommendations applicable to the transport of dangerous goods by road and rail.

The ADG Code covers the requirements for classification, packaging, marking and labelling of substances and articles that meet the United Nations classification criteria for dangerous goods. The ADG Code adopts the structure, format, definitions and concepts of the United Nations Recommendations on the Transport of Dangerous Goods Model Regulations while retaining Australian-specific provisions.

13.7.2 Transporting in New Zealand

In New Zealand, the regulations for transporting dangerous goods on land are outlined in the Land Transport Rule: Dangerous Goods 2005. This rule, also based on the UN Dangerous Goods Model Regulations, covers various aspects related to dangerous goods, including packaging, identification, documentation, segregation of incompatible goods, transport procedures, and the responsibilities of those involved in transporting dangerous goods.

New Zealand Standard NZS 5433 provides detailed technical information to meet the requirements of the Land Transport Rule.

13.7.3 Flammable scheduled refrigerants

For transportation purposes, flammable scheduled refrigerants are classified as a Dangerous Goods Division 2.1 flammable gas under the Australian Dangerous Goods Code and therefore require additional handling and storage safeguards compared to Division 2.2 non-flammable gases (see also Appendix B). Cylinders for transport **should** be marked with the ADG Flammable Gas 2.1 Class Label (red diamond). Note that WHS regulations allow GHS pictograms to be substituted by the correct ADG class labels.

Refer to the AIRAH *Flammable Refrigerants Safety Guide* for additional details on transporting flammable refrigerants and a self-assessment tool for vehicle storage.

Appendix A
SCHEDULED REFRIGERANTS

The values listed in the tables below for common pure scheduled refrigerants are taken from Schedule 1 of the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (the Australian Act). The GWPs are the 100-year time-horizon values from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, 2007 (AR4). These are the same as used in the Montreal Protocol on Substances that Deplete the Ozone Layer.

The Australian Act and Montreal Protocol continue to use AR4 values to maintain consistency with HFC phase-down baseline calculations. Blend GWP values are calculated based on the AR4 values of their constituent HFCs.

Where possible, the refrigerant safety classification is sourced from AS/NZS ISO 817. Where this was not available it is sourced from other reputable sources such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). This information is provided for general reference only and anyone working with refrigerants **must** independently check the safety classification of any refrigerant.

In Australia, reporting on the import, export and manufacture of bulk ozone depleting substances and synthetic greenhouse gases, and imports of pre-charged equipment, under Part VII of the Australian Act **must** refer to the figures listed in Schedule 1 of that Act. For details on reporting requirements, contact the Ozone Protection and Synthetic Greenhouse Gas Team in the Australian Department of Climate Change, Energy, the Environment and Water.

New Zealand reference values differ to those listed here. New Zealand regulations require the use of GWP values prescribed under the IPCC Fifth Assessment Report (AR5). For details on reporting requirements, contact the Ministry for the Environment in New Zealand.

For refrigerants or refrigerant blends not listed below, consult the relevant national legislation or government department, or the latest IPCC assessment report, as applicable.

Common scheduled refrigerants (Australia only)

HFC

Refrigerant number	Chemical name	Chemical formula	GWP (AR4)	Safety classification
R23	Trifluoromethane/fluoroform	CHF_3	14,800	A1
R32	Difluoromethane	CH_2F_2	675	A2L
R125	Pentafluoroethane	CHF_2CF_3	3,500	A1
R-134a	1,1,1,2-Tetrafluoroethane	CH_2FCF_3	1,430	A1
R143a	1,1,1-Trifluoroethane	CF_3CH_3	4,470	A2L
R152a	1,1-Difluoroethane	CH_3CHF_2	124	A2

HFC blends

Refrigerant number	Blend composition	GWP (AR4)	Safety classification
R404A	HFC-125 (44%) HFC-134a (4%) HFC-143a (52%)	3,922	A1
R407C	HFC-32 (23%) HFC-125 (25%) HFC-134a (52%)	1,774	A1
R407F	HFC-32 (30%) HFC-125 (30%) HFC-134a (40%)	1,825	A1
R410A	HFC-32 (50%) HFC-125 (50%)	2,088	A1
R417A	HFC-125 (46.6%) HFC-134a (50%) HC-600a (3.4%)	2,346	A1
R422D	HFC-125 (65.1%) HFC-134a (31.5%) HC-600a (3.4%)	2,729	A1
R427A	HFC-32 (15%) HFC-125 (25%) HFC-143a (10%) HFC-134a (50%)	2,138	A1
R438A	HFC-32 (8.5%) HFC-125 (45%) HFC-134a (44.2%) HC-600 (1.7%) HC-601a (0.6%)	2,264	A1
R448A	HFC-32 (26%) HFC-125 (26%) HFC-134a (21%) HFO-1234yf (20%) HFO-1234ze (7%)	1,386	A1
R449A	HFC-32 (24.3%) HFC-125 (24.7%) HFC-134a (25.7%) HFO-1234yf (25.3%)	1,396	A1
R450A	HFC-134a (42%) HFO-1234yf (58%)	601	A1
R452A	HFC-32 (11%) HFC-125 (59%) HFO-1234yf (30%)	2,139	A1
R454B	HFC-32 (68.9%) HFO-1234yf (31.1%)	465	A2L
R454C	HFC-32 (21.5%) HFO-1234yf (78.5%)	145	A2L
R507A	HFC-125 (50%) HFC-143a (50%)	3,985	A1
R508B	HFC-23 (46%) PFC-116 (54%)	13,396	A1
R513A	HFC-134a (44%) HFO-1234yf (56%)	629	A1
R515B	HFO-1234ze (91.1%) HFC-227ea (8.9%)	292	A1

HCFC

Refrigerant number	Chemical name	Chemical formula	GWP (AR4)	Safety classification	ODP
R22	Chlorodifluoromethane	$CHClF_2$	1,810	A1	0.055
R123	Dichlorotrifluoroethane	$C_2HCl_2F_3$	77	B1	0.02

Appendix B
SAFETY CLASSIFICATIONS

B.1 Safety classification of refrigerants

Refrigerants are classified into safety groups according to the criteria of AS/NZS ISO 817.

The safety classifications consist of two alphanumeric characters (e.g. A2 or B1). The capital letter indicates the toxicity and the numeral denotes the flammability.

B.2 Toxicity classification

Refrigerants are assigned to one of two classes, A or B, based on the following exposure:

- **Class A (lower chronic toxicity)** signifies refrigerants that have an occupational exposure limit of 400ppm or greater,
- **Class B (higher chronic toxicity)** signifies refrigerants that have an occupational exposure limit of less than 400ppm.

B.3 Flammability classification

Refrigerants are assigned to one of four classes based on flammability: 1, 2L, 2 or 3.

Class 1 (no flame propagation)

Single compound refrigerants or refrigerant blends that do not exhibit flame propagation when tested in air at 60°C and 101.3kPa.

Examples: R22, R134a, R404A. R410A, R744.

Class 2L (lower flammability)

Single compound refrigerants or refrigerant blends that meet all of the following conditions:

- exhibit flame propagation when tested at 60°C and 101.3kPa
- have a lower flammability limit (LFL) ≥ 3.5% by volume
- have a heat of combustion < 19,000kJ/kg
- have a maximum burning velocity of < 10cm/s when tested at 23°C and 101.3kPa.

Examples: R32, R1234yf, R1234ze, R717.

Class 2 (flammable)

Single compound refrigerants or refrigerant blends that meet all of the following conditions:

- exhibit flame propagation when tested at 60°C and 101.3kPa
- have an LFL ≥ 3.5% by volume
- have a heat of combustion < 19,000kJ/kg.

Examples: R152a, R439A.

Class 3 (higher flammability)

Single compound refrigerants or refrigerant blends that meet the following conditions:

- exhibit flame propagation when tested at 60°C and 101.3kPa
- have an LFL < 3.5% by volume
- have a heat of combustion that is ≥ 19,000kJ/kg.

Examples: R290, R600, R601, R1270.

B.4 Safety classification of refrigerant blends

Blends whose flammability and/or toxicity characteristic may change as the composition changes during fractionation are assigned a dual safety group classification, with the two classifications separated by a slash (/).

Each of the two classifications has been determined according to the same criteria as a single component refrigerant.

- The first classification listed is the classification of the 'as formulated' composition of the blend.
- The second classification is the classification of the blend composition of the 'worst case fractionation'.

For flammability, 'worst case of fractionation' is defined as the composition during fractionation that results in the highest concentration of the flammable component(s) in the vapour or liquid phase.

For toxicity, 'worst case of fractionation' is defined as the composition during fractionation that results in the highest concentration(s) in the vapour or liquid phase for which the Threshold Limit Value – Time Weighted Average (TLV-TWA) is less than 400ppm. The TLV-TWA for a specified blend composition has been calculated from the TLV-TWA of the individual components.

B.5 ADG Code classification

The Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code), available online at www.ntc.gov.au, provides detailed technical specifications and recommendations applicable to the transport of dangerous goods in Australia by road and rail including refrigerants.

The ADG Code covers the requirements for classification, packaging, marking and labelling of substances and articles that meet the United Nations classification criteria for dangerous goods.

ADG Class 2 substances are assigned to one of three divisions based on the primary hazard of the gas during transport. These divisions are designated:

- Division 2.1 Flammable gases,
- Division 2.2 Non-flammable, non-toxic gases
- Division 2.3 Toxic gases.

Division 2.1 Flammable gases

Division 2.1 Flammable gases are gases which at 20°C and a standard pressure of 101.3kPa:

- are ignitable when in a mixture of 13% or less by volume with air, or
- have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit. Flammability should be determined by tests or by calculation in accordance with methods adopted by ISO (see ISO 10156). Where insufficient data are available to use these methods, tests by a comparable method recognised by the relevant authority may be used.

Examples: R32, R143A, R600, R1270.

Division 2.2 Non-flammable, non-toxic gases

Division 2.2 Non-flammable, non-toxic gases are gases which:

- are asphyxiant – gases that dilute or replace the oxygen normally in the atmosphere, or
- are oxidising – gases that may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does, or
- do not come under the other divisions.

Examples: R22, R134a, R404A, R407A, R410A, R744 (carbon dioxide).

Division 2.3 Toxic gases

Division 2.3 Toxic gases are gases which:

- are known to be so toxic or corrosive to humans as to pose a hazard to health, or
- are presumed to be toxic or corrosive to humans because they have an LC_{50} value equal to or less than 5,000ml/m^3 (ppm).

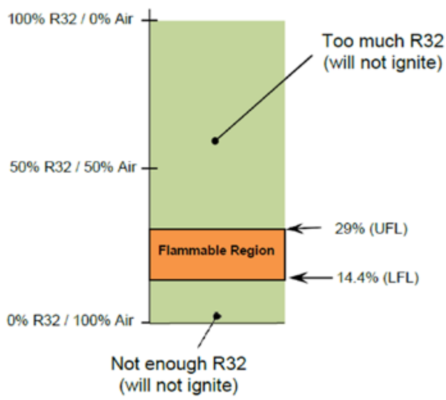
Example: R717 (ammonia).

B.6 Lower flammability limit (LFL)

Class 2L, 2 and 3 flammable refrigerants (under AS/NZS ISO 817) are flammable when mixed with air (oxygen) at a percentage range specific to each refrigerant.

The lower flammability limit (LFL) is the minimum concentration of the refrigerant that can propagate a flame through a homogeneous mixture of the refrigerant and air under the specified test conditions at 23°C and 101.3kPa. That is, the mixture capable of producing a flame.

For example, 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%, see the diagram below. The LFL of 14.4% for R32 is equivalent to 307g/m3.



R32 lower flammability limit

Referring to the figure above, if there is less than 14.4% 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 (air) for combustion. When the mixture is within these concentrations it is said to be in its 'flammable region'.

The bottom of this region is called the 'lower flammability limit' (LFL) and minimum design standards attempt to ensure that the LFL of the refrigerant cannot be reached if there is a leak. Note that these percentage values may also be expressed in kg/m^3 or g/m^3.

Appendix C
DEFINITIONS AND ACRONYMS

C.1 Definitions

For the purpose of this code the following definitions apply:

Blend
A combination of two or more refrigerants in a defined ratio which form a refrigerant with specified thermodynamic properties and a refrigerant R number designation.

Compatible
Components having features and composition that do not significantly degrade longevity or functionality of the composite system.

Competent
A person who has acquired, through training, qualifications, experience or a combination of these, the knowledge and skill, and where relevant the applicable licence, enabling the person to safely perform the assigned work

Contaminated refrigerant
A refrigerant containing oil, acid, non-condensable substances and/or moisture and/or other foreign substances. This could include mixed refrigerants (cocktails) which are not a manufactured product.

Cylinder
A portable storage vessel designed for the safe storage and handling of refrigerant under pressure.

Decommissioning
The process whereby a system is deliberately rendered inoperable, including the removal and recovery of any scheduled refrigerant.

Destruction
A process whereby a refrigerant is permanently transformed or decomposed into other substances.

Disposable container, disposable refrigerant container
A non-refillable cylinder.

Factory matched
Systems that require interconnecting pipework and electrical connections between the separate evaporator unit and the condensing unit, where the evaporator and condenser unit have been matched by the manufacturer.

Flammable refrigerant
A refrigerant with a flammability classification of Class 2L, Class 2 or Class 3 in accordance with AS/NZS ISO 817.

Flammable scheduled refrigerant
A flammable refrigerant that is also listed under Schedule 1 of the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*, (see Appendix A).

Fluorocarbon
A hydrocarbon in which some or all of the hydrogen atoms have been replaced by fluorine.

Global warming potential (GWP)
The atmospheric warming impact of a refrigerant compared with an equal mass of carbon dioxide over a specified period of time (usually 100 years).

Heat pump
A piece of equipment capable of using ambient or waste heat from air, water or ground sources to provide heat or cooling. It is based on the interconnection of one or more components forming a closed cooling circuit in which a refrigerant circulates to extract and release heat.

Major components and sub-assemblies
Equipment including compressors, air/water cooled condensers, liquid receivers, chilled water heat exchangers, evaporators and air/water cooled condensing units.

Maximum allowable pressure (PS)
Maximum pressure which system or component is designed for, as specified by the manufacturer in accordance with AS/NZS 5149.2.

Must
When used for a provision, indicates that the provision is mandatory for compliance with this code.

Negative pressure systems
Systems in which the pressure may fall below atmospheric under normal operating conditions.

Ozone depletion potential (ODP)
The capacity of a refrigerant to destroy stratospheric ozone. ODP is stated relative to the ODP of CFC-11, which is taken as having an ODP of 1.

Plant
A combination of one or more refrigerating systems at a single site.

RAC equipment (refrigeration and air conditioning equipment)
Equipment used for the cooling or heating of anything, and that uses a scheduled refrigerant.

Reclaim
To reprocess used refrigerant to new product specification by means that may include distillation. Chemical analysis of the refrigerant is required to determine that appropriate product specifications have been met. This term usually implies the use of processes or procedures available only at a specialised reclaim or manufacturing facility.

Recover, recovery
To remove refrigerant in any condition from a system and store it in an external cylinder, without necessarily testing or processing it in any way.

Refrigerant
The medium used for heat transfer in a refrigerating system, which absorbs heat on evaporating at a low temperature and a low pressure and rejects heat on condensing at a higher temperature and higher pressure. The term 'gas' should be avoided when referring to refrigerants. Unless specified otherwise, 'refrigerant' in this code refers to scheduled refrigerants only.

Refrigerating system
An assembly of piping, vessels, and other components in a closed circuit in which a refrigerant is circulated for the purpose of transferring heat.

Retrofit
To replace the original refrigerant (and components, lubricant, etc. as required) in a system with an alternative.

Returned refrigerant
Refrigerant recovered from a system and returned to the supplier or equivalent for reclaim or destruction.

Scheduled refrigerant
A refrigerant with an ozone depletion potential and/or a global warming potential that is listed under Schedule 1 of the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*, (see Appendix A). Generally synthetic chemicals consisting of or containing fluorocarbon, which include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFC), but not hydrofluoroolefins (HFO).

Self-contained low charge systems
Appliances that contain a refrigerant charge of 2kg or less, and do not require any work to be done on the refrigerating system at the time of installation.

Should, recommended
Indicate provisions that are not mandatory for compliance with this code but which are desirable as good and best practice.

Split systems

Systems that require interconnecting pipework and electrical connections between the separate evaporator unit and the condensing unit.

Transport refrigeration

Any mobile refrigeration system other than air conditioning systems for passenger vehicles.

For definitions of other components, refer to AS/NZS 5149.1, Section 3: Terms and definitions.

C.2 Acronyms and initialisms

Acronyms and abbreviations for standards organisations and relevant websites

Acronym / abbreviation	Standard / organisation	Website
AIRAH	Australian Institute of Refrigeration Air Conditioning and Heating	www.airah.org.au
ANSI	American National Standards Institute	www.ansi.org
ARC	Australian Refrigeration Council	www.arctick.org
AHRI	The Air-Conditioning, Heating, and Refrigeration Institute (American)	www.ahrinet.org
AS	Australian Standard	www.standards.org.au
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers	www.ashrae.org
CCCANZ	Climate Control Companies Association of New Zealand	CCCANZ - HVAC&R Centre
DCCEEW	Department of Climate Change, Energy, Environment and Water	www.dcceew.gov.au
IRHACE	Institute of Refrigeration, Heating and Air Conditioning Engineers New Zealand	www.irhace.org.nz
NZCCO	New Zealand Climate Change Office	www.mfe.govt.nz
NZS	New Zealand Standard	www.standards.co.nz
RRA	Refrigerant Reclaim Australia	www.refrigerantreclaim.com.au

Other acronyms and initialisms used in this code have the following meaning:

CO_2e Carbon dioxide equivalent

GWP Global warming potential

IPCC Intergovernmental Panel on Climate Change

LFL Lower flammability limit

ODP Ozone depletion potential

OFN Oxygen-free nitrogen

OHS Occupational Health and Safety

PPE Personal protective equipment

QLMV Quantity limit with minimum ventilation

RAC Refrigeration and air conditioning

RCL Refrigerant charge limit

SDS Safety Data Sheets

SFC Safe fill capacity

WHS Work Health and Safety

Appendix D

REFERENCED DOCUMENTS AND RESOURCES

The documents referenced in this code are listed in this Appendix.

Standards in place at the time of publication of this code **should** be referred to.

The standards and other documents listed are revised and updated from time to time. Best practice is to always consult the latest current versions and any amendments.

D.1 Regulatory documents

Australia

- *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*
- Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995
- Australia and New Zealand Refrigerant Handling Code of Practice Part 1 – Self-contained low charge systems
- Australian automotive code of practice for the control of refrigerant gases during manufacture, installation, servicing or de-commissioning of motor vehicle air conditioners
- Australian Code for the Transport of Dangerous Goods by Road and Rail
- Heads of Workplace Safety Authorities: Flammable Refrigerant Gases Position Paper.

New Zealand

- *Ozone Layer Protection Act 1996*
- *Climate Change Response (Zero Carbon) Amendment Act 2019*
- *Hazardous Substances and New Organisms Act 1996*
- NZ Approved Code of Practice – Pressure Equipment (excluding Boilers).
- Guide to gas cylinders – Worksafe NZ
- Land Transport Rule: Dangerous Goods 2005 (NZ)

D.2 Australian, New Zealand and international standards

AS/NZS ISO 817	Refrigerants – Designation and safety classification
AS/NZS 1200	Pressure Equipment
AS 1210	Pressure Vessels
AS 1345	Identification of the contents of pipes, conduits and ducts
AS/NZS 1571	Copper – Seamless tubes for air-conditioning and refrigeration
AS 2030.1	Gas cylinders. Part 1: General requirements
AS 2030.5	Gas cylinders. Part 5: Filling, inspection and testing of refillable cylinders
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)

AS 3992	Pressure equipment — Welding and brazing qualification
AS/NZS 4024	Series, Safety of machinery standards
AS 4041	Pressure piping
AS 4211.3	Gas recovery or combined recovery and recycling equipment. Part 3: Fluorocarbon refrigerants from commercial/domestic refrigeration and air conditioning systems
AS/NZS 4332	Storage of gases in cylinders
AS 4484	Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding.
AS/NZS 5149	Refrigerating systems and heat pumps – Safety and environmental requirements
AS/NZS 5149.1	Part 1: Definitions, classification and selection criteria (ISO 5149-1:2014, MOD) (incorporating Amd 1 and Amd 2)
AS/NZS 5149.2	Part 2: Design, construction, testing, marking and documentation (ISO 5149-2:2014, MOD)
AS/NZS 5149.3	Part 3: Installation site (ISO 5149-3:2014, MOD)
AS/NZS 5149.4	Part 4: Operation, maintenance, repair and recovery (ISO 5149-4:2014, MOD)
AS/NZS 60335.2.40	Household and similar electrical appliances – Safety. Part 2.40: Particular requirements for electrical heat pumps, air-conditioners, and dehumidifiers (IEC 60335-2-40 Ed 7)
NZS 5433	Transport of dangerous goods on land
ISO 10156	Gas cylinders — Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets
ISO 11650	Performance of refrigerant recovery and/or recycling equipment

D.3 Other documents

AIRAH	Flammable Refrigerants Safety Guide (including update 1 2018)
AIRAH DA19	HVAC&R Maintenance
AIRAH DA27	Building Commissioning
ANSI/AHRI 580	Non-Condensable Gas Purge Equipment for Use with Low Pressure Centrifugal Liquid Chillers
AHRI 700	Specification for Refrigerants
AHRI 740	Performance Rating of Refrigerant Recovery Equipment and Recovery/ Recycling Equipment
ASHRAE	Refrigeration Commissioning Guide for Commercial and Industrial Systems
ASHRAE	Guideline 1-1: HVAC&R Technical Requirements for the HVAC Commissioning Process
ARC	Handle Class A2/A2L Flammable Refrigerants
CIBSE Code M	Commissioning – Management
CIBSE Code R	Commissioning – Refrigerating systems
NIST REFPROP	Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 10

D.4 Fact sheets

Refrigerants Australia	Flammables fact sheets (WA)
CCCANZ	Flammable refrigerants – be informed, be aware (NZ)