Australia and New Zealand

Refrigerant handling code of practice 2007

Part 1 —

Self-contained low charge systems

Australian Government
Department of the Environment and Water Resources

Prepared by the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) and the Institute of Refrigeration, Heating and Air Conditioning Engineers New Zealand (IRHACE)

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II Scope

This code applies only to appliances which contain a fluorocarbon refrigerant charge of two kilograms or less, and do not require any work to be done on the refrigeration system at the time of installation.

This code has been developed with the intention of reducing emissions into the atmosphere of refrigerants listed in Appendix 2, or any other fluorocarbon refrigerant. This code specifies requirements which are mandatory for compliance with the code, and also includes best practice recommendations. Environmental benefits and cost savings from reduced losses can be expected from the application of this code including the use of alternative refrigerants.

Systems which do not use a fluorocarbon refrigerant (or do not use a refrigerant blend containing a fluorocarbon) are not covered by this code.

III Referenced Documents

Document		Title
AS/NZS	1200:2000	Pressure Equipment
	1677.2:1998	Refrigerating systems. Part 2: Safety Requirements for fixed applications
AS	2030.1:1999	The verification, filling, inspection, testing and maintenance of cylinders for storage and transport of compressed gases – Cylinders for compressed gases other than acetylene
	4211.3:1996	Gas recovery on combined recovery and recycling equipment. Part 3: Fluorocarbon refrigerants from commercial/domestic refrigeration and air conditioning systems
	4484:2004	Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding.
ARI	700-2004	Specification for Fluorocarbon Refrigerants
Australian Act		Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 (as amended in 2003)
Australian Regulation		Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995
Australia / New Zealand Code of Practice		Australia and New Zealand refrigerant handling code of practice Part 2 – systems other than self-contained low charge systems
New Zealand Act		Ozone Layer Protection Act 1996

IV Acronyms for standards and organisations and relevant websites

Acronym	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
ARI	Air-Conditioning and Refrigeration Institute (American)	www.ari.org
AS	Australian Standard	www.standards.org.au
DEW	Department of Environment and Water Resources (Australia)	www.environment.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
SAE	Society of Automotive Engineers (American)	www.sae.org

V Definitions

For the purp ose of this code the following definitions apply:

Alternative refrigerant
Alternative refrigerant means a **refrigerant** other than that for which a system was designed.

Blend
A combination of two or more **refrigerants** in a defined ratio which forms a **refrigerant** with specified thermodynamic properties.

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 manufactured product.

Compatible
Components are **compatible** when they can be operated together without degrading the overall performance of the system.

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

Decommissioning
The process whereby a system is deliberately rendered inoperable.

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

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

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

Fluorocarbon refrigerant
A **refrigerant** consisting of or containing **fluorocarbon.**

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

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.

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

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.

Reclaim
To reprocess used **refrigerant** to new product specification by means which 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 **fluorocarbon refrigerant 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**.

Self-contained low charge systems
Appliances which contain a **fluorocarbon refrigerant** charge of two kilograms or less, and do not require any work to be done on the refrigeration system at the time of installation.

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

Split systems
Systems that require interconnecting pipe work and electrical connections between the separate evaporator unit and the condensing unit. Note that split systems fall outside the scope of this code – refer instead to the *Australia and New Zealand refrigerant handling code of practice 2007 Part 2 – systems other than self-contained low charge systems.*

For definitions of other components, refer to AS/NZS 1677.2-1998 section 1.4: Definitions.

VI How to read this code

Text in the remainder of this document is colour coded for ease of use.

Text with a blue background, and containing the term '**must**' in bold font, indicates compliance is mandatory.

Sections with a green background, and containing the terms '**should**' or '**recommended**' are not mandatory but are recommended as best practice.

Sections with plain background are explanatory notes, and are for informative purposes only.

Note for Australian users:

The use of **fluorocarbon refrigerants** in Australia is governed by the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (as amended in 2003) and the *Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995*.

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

1 General

1.1 Personnel

1.1.1 In Australia, any person whose business includes the manufacturing, installation, servicing, modifying, or dismantling of any refrigeration and/or air conditioning equipment which:

(a) contains

(b) is designed to use, or

(c) is manufactured using

fluorocarbon refrigerant, **<u>must</u>** ensure that they and/or any of their employees who handle **fluorocarbon refrigerant** are appropriately licensed under the *Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995* and any regulations that supersede it.

For further details on the Australian licensing system, see www.environment.gov.au or www.arctick.org

1.1.2 In New Zealand, any person whose business is or includes the manufacturing, installation, servicing, modifying, or dismantling of any refrigeration and/or air conditioning equipment which:

(a) contains

(b) is designed to use, or

(c) is manufactured using

fluorocarbon refrigerant, **<u>must</u>** ensure that they and/or any of their employees who handle **fluorocarbon refrigerant** possess a 'No-Loss' card.

The No-Loss card is a card indicating the completion of a voluntary training program run by the New Zealand government and the Institute of Refrigeration, Heating and Air Conditioning Engineers New Zealand (IRHACE). For more details see www.irhace.org.nz.

1.1.3 Any person whose business is or includes the manufacturing, installation, servicing, modifying, or dismantling of any refrigeration and/or air conditioning equipment which:

(a) contains

(b) is designed to use, or

(c) is manufactured using

a **fluorocarbon refrigerant**, **<u>must</u>** ensure that they and / or any of their employees who handle **fluorocarbon refrigerant** are provided with a copy of this code and work to the standards set out herein.

1.2 Refrigerant venting

1.2.1 Where the release is avoidable, **fluorocarbon refrigerant** **<u>must not</u>** be willingly released to the atmosphere by any person by any means, including:

(a) venting **refrigerant** directly, and

(b) charging **refrigerant** into equipment with identified leaks.

2 Design

This section deals with the design considerations of new air conditioning and refrigeration systems and components and alterations to existing systems. It also identifies possible sources of inadvertent loss of **refrigerants** to the atmosphere

2.1 Design to an equivalent or better standard

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

(a) manufactured,

(b) installed,

(c) operated,

(b) serviced, and

(c) decommissioned

without the avoidable loss of **refrigerant** as described in 1.2.1.

2.1.2 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 clause 2.1.1, the design will be exempt from sections 2.2 to 2.7 inclusive.

Where this can **not** be demonstrated, the system design **must** comply with sections 2.2 to 2.7 in their entirety.

2.2 General

A sound understanding of system design is necessary for the prevention of **refrigerant** leakage.

2.2.1 All systems **must** be designed in accordance with the applicable Australian and New Zealand standards.

2.2.2 **Refrigerating systems should** be designed to minimise the amount of **refrigerant** required.

2.3 Compressors

Leaks associated with compressors in **self-contained low charge systems** can generally be attributed to the connecting pipe work. Proper initial installation, combined with a correct ongoing maintenance program **should** minimise if not eliminate these problems.

Due to the small amount of **refrigerant** in **self-contained low charge systems** the cost/benefit of equipping such systems with service valves is considered to be inappropriate.

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 dry system is essential for prolonged system life.

2.3.1 Where compressors are fitted with a process tube, a length greater than 100mm **must** be provided to the compressor for the purpose of evacuating and charging the system with **refrigerant** and the subsequent sealing and the later use (if ever required for servicing) of a temporary clamp-on piercing type valve assembly.

2.4 Refrigerant condensers and evaporators

Properly designed and manufactured condensers and evaporators have few leakage problems, however, the following points need to be considered and appropriate action taken.

2.4.1 All systems **must** be designed and materials selected to minimise the risk of corrosion.

2.5 Refrigerant pipelines and fittings

2.5.1 All pipelines **must** be designed so that the number of joints is kept to the practical minimum.

2.5.2 Welding, brazing or another permanent hermetic sealing method are **recommended** wherever practicable for joining **refrigerant** pipelines since they offer increased resistance to pressure, temperature and vibration stresses.

2.5.3 All joints **must** be hermetically sealed and not flanged.

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

2.6 Valves

Due to the size of **self-contained low charge systems**, valves are not normally included in the design.

2.6.1 Tube piercing or line tap valves and other similar devices **must** be used only to gain service access to the system in order to remove **refrigerant**. They **must** be removed before the completion of service. The system design **must not** require these valves to be left on the system after the completion of service.

2.7 Pump down capability

2.7.1 Due to the size of **self-contained low charge systems**, liquid receivers used for pump down are not normally included in the design. For these applications, one of the following two options **must** be undertaken:

(a) valves fitted to the system to allow the connection of a pump down unit for the removal of **refrigerant** prior to service or repair operations, or

(b) a process tube can be used for this purpose with the addition of a temporary clamp-on piercing type valve.

3 *Manufacture and assembly*

3.1 General

It is imperative that all supervisory personnel involved in the manufacturing process are conversant with **refrigerant** technology and familiar with all aspects of the manufacturing process.

3.1.1 Complete systems **must** be clean, dry, leak tested, evacuated, pressurised, sealed, labelled with the **refrigerant** type and run tested prior to despatch.

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

3.2 Leak Testing

3.2.1 Except where used as a trace gas (see 3.2.2), **fluorocarbon refrigerant must not** be put into a system for the purposes of leak testing.

Acceptable leak test methods include (but are not limited to):

(a) liquid submersion testing

(b) foam enhancer leak detection

(c) positive pressure holding test / pressure drop off test (gross leaks only)

(d) vacuum degradation test (gross leaks only)

(e) fluorescent leak detection

(f) electronic leak testing

(g) mass spectrometer

3.2.2 A **fluorocarbon** substance may be used as a trace gas for leak testing by manufacturers, however, they **must** comply with the following conditions:

(a) the trace gas **must** be pre-mixed with nitrogen as a homogenous mixture, with a fluorocarbon content not greater than 10% by volume in the nitrogen

(b) the trace gas mixture **must** be fully **recovered** after final leak testing and **must not** be dispatched with the unit as a holding charge

(c) the unit **must** be tested for gross leaks using one of the methods described in 3.2.1 prior to introducing the trace gas.

3.3 Charging of refrigerant

3.3.1 All charging **must** be carried out in accordance with AS/NZS 1677.2:1998 Section 6.1: *Charging and discharging refrigerant*, with the exception that **self-contained low charge systems** are **not** required to be charged into the low side of the system.

4 Provision of information on installation, use and maintenance

4.1 Instructions **must** be furnished with each new product, detailing correct methods and recommended procedures for installation, use, and maintenance that prevent the deliberate emission, and minimise the potential for accidental emission, of **refrigerants**.

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

5 Installation procedures

The systems covered by this code are self-contained products which are manufactured and sold as completed units. As no work on the **refrigeration system** is required on site, installation is normally the responsibility of the purchaser.

6 Evacuation

This section refers to evacuation in the field **only** – not evacuation during the manufacturing process.

As the systems covered by this code are supplied pre-charged with **refrigerant** there is no need to evacuate the system upon installation. If evacuation is required at a later stage, however, the following procedure **must** be followed:

6.1 Instructions **must** be followed if the system manufacturer has supplied instructions for evacuation, except where the instructions specify a practice that will lead to emission of **refrigerant**.

6.2 The system **must** be evacuated to less than 117 Pa absolute (900 microns of mercury) if the system manufacturer has not supplied instructions with the system for evacuation.

6.3 After the system has been evacuated the vacuum pump **should** be isolated from the system. As a guide, with constant ambient conditions, the vacuum **should not** rise more than 13 Pa (100 microns of mercury) in one hour. A greater rate of rise may indicate a leak or the presence of moisture (see also 7.1.9).

6.4 Absolute vacuums **must** be measured using accurate measuring equipment selected for the specific application.

7 *Servicing of equipment*

Many of the points in this section also need to be considered in Section 1.1 on Personnel and Section 13 on Recovery, Recycling and Disposal of Refrigerants.

Note: if the system is being **retrofitted** with a **refrigerant**, lubricant or components other than those for which it was originally designed, see Section 11 on Retrofitting.

7.1 A service person **should** be aware of the possibility that the system may have been incorrectly charged or incorrectly labelled (See also Section 9).

7.2 Where there is any suspicion that the **refrigerant** is not true to label, or there is no label and the **refrigerant** cannot be identified by other means, the **refrigerant** **<u>must not</u>** be vented from the system. If the **refrigerant** is to be disposed of, it **<u>must</u>** be fully **recovered**.

7.3 Only qualified persons with relevant experience **should** work on refrigeration and air conditioning systems which contain toxic or flammable **refrigerants** (ie: non-A1 safety class) since they demand special precautions (see Appendix 1).

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

7.5 The compressor crankcase **<u>must</u>** be brought to atmospheric pressure before oil is removed.

7.6 The service person **<u>must</u>** check and repair as necessary all potential leak sites.

Various methods may be used for leak testing, eg. electronic leak detectors, ultrasonic leak detectors, proprietary bubble solution, halide lamp, and/or ultra violet lamp. Some leak test methods are specific to **refrigerant** types.

7.7 If work has been done on the refrigeration circuit, the systems **<u>must</u>** be leak tested after service and any identified leaks **<u>must</u>** be repaired. **Refrigerant** **<u>must</u>** **<u>not</u>** be put into the system for the purpose of leak testing.

7.8 The service person **should** examine the system for traces of **refrigerant** oil, which could indicate leaks, and repair where necessary

7.9 A system **<u>must</u>** **<u>not</u>** be recharged until appropriate repairs and leak testing have been undertaken if the service person doubts the integrity of the system due to leakage rate and charging history.

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

7. 11 Where a tube piercing or line tap valve has been used and the remaining length of process tube is still 100mm or greater, the tube **<u>must</u>** be crimped off, the process fitting removed and the end of the pipe sealed.

7.12 Where a tube piercing or line tap valve has been used and the remaining length of process tube is less than 100mm, a new process pipe of equal length to that originally fitted to the system **must** be fitted and sealed.

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

7.14 Due to the ease of contamination of **refrigerant** in **self-contained low charge systems**, only virgin **refrigerant should** be used to recharge the system.

7.15 In all cases, **refrigerant** used to recharge a system **must** meet the specification for new **refrigerant** set out by ARI 700-2004 *Specification for Fluorocarbon Refrigerants*.

7.16 Some lubricants are very hygroscopic (attracted to moisture) and will absorb moisture from the air. These lubricants **must** **not** be exposed to atmosphere for any longer than is necessary to complete the service.

8 *Cleaning and flushing*

Cleaning and flushing a contaminated system after a hermetic or semi-hermetic compressor failure or motor burnout.

8.1 **Contaminated refrigerant must** be fully **recovered.**

8.2 The **cylinder must not** be over-filled, as per AS 2030.1:1999.

8.3 **Refrigerants must not** be mixed in the same **cylinder** as clean / reusable **refrigerant**.

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

8.5 Where possible, **self-contained low charge systems should** be taken to a workshop with appropriate facilities for cleaning and reinstating. When the system is empty and at atmospheric pressure, the faulty component parts **should** be removed and the system capped off.

8.6 F**luorocarbon refrigerant must not** be used for flushing components.

8.7 Occupational Health and Safety standards **must** be observed when handling solvents.

8.8 Relevant material safety data sheets (safety data sheets in New Zealand) **must** be obtained and made available to the technician handling solvents.

8.9 The cleaning solvent **should** be pumped throughout the system until only clean solvent emerges.

8.10 After ensuring the system has been thoroughly cleaned, caution **should** be taken to ensure no solvent residue remains in the system after purging.

8.11 All spent solvents **must** be disposed of in accordance with New Zealand *Hazardous Substances (Disposal) Regulations 2001* and / or Australian state and territory hazardous substance disposal regulations.

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

8.13 In the event of a burnout in a **self-contained low charge** system, it is highly **recommended** that a suction line filter/dryer (a burnout dryer) be fitted.

8.14 The system **<u>must</u>** be flow tested to ensure there are no blockages or restrictions.

8.15 A new filter dryer **<u>must</u>** be fitted.

8.16 The system **<u>must</u>** then be pressurised, then leak tested, re-evacuated using the deep evacuation method and recharged with refrigerant.

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 8.1.5 and 8.1.6, then cleaning of the system by using purpose selected suction and liquid line filter dryers is an acceptable alternative.

8.17 All filters fitted **<u>must</u>** be capable of being replaced with a minimal loss of **refrigerant** to the atmosphere if cleaning of the system by using purpose selected suction and liquid line filter dryers is undertaken.

9 Labelling

9.1 Whenever the type of **refrigerant** and/or lubricant in a system is changed, the service person **<u>must</u>** clearly label the system with:

(a) the **refrigerant** type,

(b) name of service person, licence number (Australia only) and service organisation,

(c) date of service,

(d) any ultraviolet dye that has been added.

Wherever the type of lubricant in a system is changed (other than when it has been pre-charge d into a replacement compressor by its manufacturer), the service person **<u>must</u>** also clearly label the system with:

(e) the lubricant type

9.2 **Refrigerating systems** modified on site **<u>must</u>** be labelled as per Clause 9.1.1.

10 Maintenance

10.1 The owner of the unit **should** be held responsible for its use and care.

10.2 A malfunctioning unit **should** be attended to by a licensed service organisation as soon as the condition occurs to ensure that any leakage of **refrigerant** is minimised.

10.3 Users are advised that persons who service refrigeration and air conditioning equipment are required by legislation to observe this code of practice and not to "top up" systems known to be leaking or to service equipment unless it can be returned into service in a leak free condition. Some modification of the system may be necessary to achieve the aim of the code of practice to minimise loss of **refrigerant**.

10.4 All **refrigerants** **<u>must</u>** be **recovered** and either recycled, **reclaimed** or held for **destruction** in an approved manner.

11 *Retrofitting*

11.1 Any procedures recommended by the system manufacturer or their distributor **<u>must</u>** be followed when **retrofitting** is to be carried out.

11.2 **Retrofitting** a system with an **alternative refrigerant** and/or lubricant **<u>must</u>** only be carried out based on written advice from the equipment and/or component manufacturers.

11.3 If the equipment and/or component manufacturers cannot be contacted and written advice from them is not available, written advice from a suitably qualified refrigeration or air conditioning engineer **<u>must</u>** be obtained prior to the **retrofit.**

11.4 High pressure, flammable or toxic **refrigerants** **<u>must</u>** **<u>not</u>** be used in systems where they will pose a safety risk.

11.5 **Alternative refrigerants** **<u>must</u>** be **compatible** with all parts of the system.

11.6 Correct lubricants **<u>must</u>** be used with **alternative refrigerants** (check with the **refrigerant** supplier if in doubt).

11.7 When an **alternative refrigerant** has been **retrofitted** to a system, the system's labelling, colour coding (if applicable) and nameplates **<u>must</u>** be changed to permanently identify the **refrigerant** contained and the type of lubricant.

11.8 A new filter drier appropriate for the new **refrigerant** **<u>must</u>** be fitted.

11.9 Where it is technically and economically feasible, **alternative refrigerants** with a lower **ozone depletion** and **global warming potential** than the original **refrigerant should** be used.

12 *Decommissioning*

12.1 All **refrigerant** **<u>must</u>** be **reclaimed** from all parts of the system at the time of **decommissioning**, unless the system is being **decommissioned** for service or immediate recommissioning.

13 Recovery, recycling and disposal of refrigerants

13.1 During manufacture, installation and servicing

Note: 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.

In Australia, **recovery** and recycling of **refrigerant** at the end of its useful life using **recovery** and/or recycling equipment is mandatory. In New Zealand it is an offence under the Ozone Layer Protection Act 1996 to wilfully release an ozone depleting substance.

To avoid mixing **refrigerants** that can be recycled or reused and to ensure that no r**ecovery cylinder** is over-filled, it is necessary to either use dedicated **recovery** equipment for each **refrigerant** or to ensure that only **cylinders** marked with the correct filling ratio are used, and that this filling ratio is not exceeded for the **refrigerant** being **reclaimed.**

In smaller capacity systems using capillary expansion devices, or critical charge systems where pump down facilities are not provided, **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 following two provisions apply:

13.1.1 The designed maximum safe working pressure of a **refrigerant cylinder** <u>**must**</u> <u>**not**</u> be exceeded in any filling operation, as per AS 2030.1:1999, no matter how temporary.

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

13.1.2 **Refrigerant** <u>**must**</u> <u>**not**</u> be **recovered** into a flexible bag.

13.1.3 **Cylinders** <u>**must**</u> only be used within the application for which they are designed.

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

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

13.1.5 The permission of the owner of the **cylinder** <u>**must**</u> 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.

13.1.6 Where granted, the owner <u>**must**</u> be given the opportunity to carry out an internal inspection for corrosion and contamination immediately after such use, and the **refrigerant cylinder** <u>**must**</u> be labelled indicating such use.

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

13.1.8 **Cylinders** <u>**must**</u> conform with AS 4484:2004, AS 2030.1:1999 and AS/NZS 1200:2000 Appendix G: *Organisation of Australian, New Zealand and other pressure equipment standards.*

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

13.1.9 **Refrigerant recovery** units **must** be appropriate for the **refrigerant** being **recovered.**

See Appendix 1 for further information if the presence of flammable **refrigerant** is suspected.

13.1.10 Special care **must** be taken to ensure cross contamination of **refrigerants** and lubricants does not occur within the equipment if the **refrigerant** is to be recycled or reused.

13.1.11 Proprietary equipment **must** be used in accordance with the manufacturer's instructions.

13.1.12 Hoses, fittings and procedures used during service, installation and decommissioning **must** be those which minimise the loss of **refrigerant.**

13.1.13 **Refrigerant must** be either disposed of or tested when it is suspected to be contaminated or is to be re-used in a system other than that from which it was removed.

13.1.14 **Refrigerant recovery** equipment and/or recycle equipment **must** conform to AS 4211.3:1996.

13.1.15 **Refrigerant** vapour as well as **refrigerant** liquid **must** be **recovered** when a system is repaired.

13.2 Disposal of refrigerants

If **refrigerant** is to be recycled or reprocessed, mixing different types of **refrigerants** may render large quantities of **refrigerant** unusable as separation may be impossible.

13.2.1 Unusable or unrequired **fluorocarbon refrigerant must not** be discharged to the atmosphere, and **must** be returned to a supplier or collection agent for disposal.

In Australia, **reclaimed refrigerant** can be returned to the supplier for disposal. See www.refrigerantreclaim.com.au for more information.

For locations that accept r**eturned refrigerant** in New Zealand, visit www.opc.co.nz.

The importation and use of **fluorocarbon refrigerant** in **disposable refrigerant containers** is prohibited by law in Australia. Clauses 13.2.2 through 13.2.5 apply to New Zealand only.

13.2.2 Any residual **refrigerant** in a **disposable container must** be **recovered.**

13.2.3 A **disposable container must not** be refilled or used as a temporary receiver during service.

13.2.4 A **disposable container must not** be repaired or modified in any way.

13.2.5 Empty **disposable containers must** be disposed of at a recycling centre.

13.2.6 Refrigerators and freezer cabinets **must** have any locks removed or rendered inoperative upon removal from service. Doors, drawers and/or lids **must** 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.

13.2.7 The **refrigerant must** be **recovered** before disposal if the refrigeration system contains **refrigerant.**

14 Handling And Storage Of Refrigerants

14.1 Handling and storage

Losses of **refrigerant** to the atmosphere can occur during the handling and storage of **refrigerant cylinders**. Service persons have a duty of care to avoid such losses.

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

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

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

14.1.3 **Refrigerant cylinders must not** be directly heated by flame, radiant heat or uncontrolled direct contact heat, however, warming of the discharging **cylinder** under controlled conditions to increase the rate of discharge of **refrigerant** during transfer is permissible.

14.1.4 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.

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

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.

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

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

14.1.8 Service personnel **should** make reference to **refrigerant** manufacturers' Material Safety Data Sheets (safety data sheets in New Zealand) when handling **refrigerants.**

14.1.9 To avoid mechanical damage to the **refrigerant cylinder** and its valve, it **must** be handled carefully.

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

14.1.11 **Cylinders <u>must</u>** be leak tested every three months and leaking **cylinders <u>must</u>** be returned to the supplier.

14.2 Charging

14.2.1 Except where charging is being carried out by the manufacturer on an assembly line, the pipework connecting a **cylinder** to a refrigeration system **<u>must</u>** 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 pipework.

14.2.2 **Refrigerant** being transferred **<u>must</u>** be accurately measured into the system with due reference to temperature as per AS 4211.3:1996.

14.2.3 Charging lines **<u>must</u>** be as short as possible and have suitable fittings to minimise losses during disconnection at the end of the transfer.

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

14.2.5 **Refrigerant cylinders <u>must</u> <u>not</u>** 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.**

14.2.6 **Refrigerant cylinders <u>must</u> <u>not</u>** be connected to systems or other **cylinders** at a high temperature for similar reasons.

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

14.3 Refrigerant transfer between cylinders

Note that the provisions of section 14.1 also apply to **refrigerant** transfer between **cylinders.**

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

14.3.1 The maximum gross weight **<u>must</u> <u>not</u>** be exceeded when filling **refrigerant cylinders.** The **cylinder <u>must</u> <u>not</u>** be used if the maximum gross weight is not marked on the **cylinder**.

The maximum gross weight is a function of the internal volume of the **cylinder**, **refrigerant** composition and oil content and temperature. The **cylinder** supplier **should** determine the maximum gross weight in accordance with AS 2030.1:1999.

14.3.2 **Refrigerant cylinders should <u>not</u>** be manifolded together if there is a possibility of temperature differences between the **cylinders**, since this will result in r**efrigerant** transfer and the danger of overfilling the cold **cylinder** (see also 14.2.5).

14.3.3 Care **should** be taken to ensure all the **cylinders** are at the same height to avoid gravity transfer between **cylinders** where **cylinders** are manifolded together.

14.3.4 It is highly **recommended** that single direction flow or check valves be installed at each **cylinder** when **cylinders** are manifolded together.

15 Appendices

15.1 Appendix 1 — dealing with the recovery of fluorocarbons mixed with other refrigerants

Over the past few years a number of different refrigerants and refrigerant mixtures have been used as replacements for CFCs and HCFCs. In some cases hydrocarbons and hydrocarbon mixtures have been used for this purpose.

In many instances the equipment in question may not be labelled to indicate the refrigerant used and as the operating pressures of these replacements are usually similar to those of the original refrigerant, identification in the field is extremely difficult.

Hydrocarbons or other refrigerants may have been used to 'top up' fluorocarbon refrigerant in some refrigeration or air conditioning systems.

If the presence of flammable refrigerant is suspected in a system, proper care should be taken to recover the flammable refrigerant. Only properly trained personnel using equipment designed for recovering flammable refrigerant should perform this task.

Refrigerant containing a fluorocarbon **must** **not** be vented to the atmosphere.

15.2 Appendix 2 – Fluorocarbon Refrigerants

A long term replacement refrigerant should have a zero Ozone Depleting Potential (ODP), and a low Global Warming Potential (GWP).

The ODP and GWP figures listed below for refrigerant blends must not be used for the purposes of reporting on the import, export and manufacture of bulk Ozone Depleting Substances and Synthetic Greenhouse Gases, or imports of pre-charged equipment under Part VII of the *Ozone Protection and Synthetic Greenhouse Gas Management Act*. For further information on these reporting requirements, please contact the Ozone and Synthetic Gas Team in the Australian Department of the Environment and Water Resources.

No:	Name:	Chemical Formula or % Mass Mixture:	O.D.P.:	G.W.P.: 100 yrs	Safety
CFCs and CFC blends:					
R11	Trichlorofluoromethane	$C.Cl_3.F$	1.00	4,600	A1
R12	Dichlorodifluoromethane	$C.Cl_2.F_2$	1.00	10,600	A1
R113	Trichlorotrifluoroethane	$C.Cl_2.F.C.Cl.F_2$	0.80	6,000	A1
R114	Dichlorotetrafluoroethane	$C.Cl.F_2.C.Cl.F_2$	1.00	9,800	A1
R500	CFC Blend	CFC-12 (74%) HFC-152a (26%)	0.60	7,900	A1
R502	CFC Blend	CFC-115 (51%) HCFC-22 (49%)	0.22	4,500	A1
HCFCs and HCFC blends:					
R22	Chlorodifluoromethane	$C.H.Cl.F_2$	0.055	1,700	A1
R123	Dichlorotrifluoroethane	$C.H.Cl_2.C.F_3$	0.020	120	A1
R124	Chlorotetrafluoroethane	$CH.F.Cl.C.F_3$	0.022	620	A1
R401A	HCFC Blend	HCFC-22 (53%) HCFC-124 (34%) HFC-152a (13%)	0.027	1,100	A1/A1
R401B	HCFC Blend	HCFC-22 (61%) HFC-124 (28%) HFC-152a (11%)	0.028	1,200	A1/A1
R401C	HCFC Blend	HCFC-22 (33%) HFC-124 (52%) HFC-152a (15%)	0.025	900	A1/A1
R402A	HCFC Blend	HCFC-22 (38%) HFC-125 (60%) HC-290(Propane) (2%)	0.013	2,700	A1/A1
R402B	HCFC Blend	HCFC-22 (60%) HFC-125 (38%) HC-290(Propane) (2%)	0.020	2,300	A1/A1
R403A	HCFC Blend	HCFC-22 (75%) HFC-218 (20%) HC-290(Propane) (5%)	0.026	3,000	A1/A1

No:	Name:	Chemical Formula or % Mass Mixture:	O.D.P.:	G.W.P.: 100 yrs	Safety
R403B	HCFC Blend	HCFC-22 (56%) HFC-218 (39%) HC-290(Propane) (5%)	0.019	4,300	A1/A1
R405A	HCFC Blend	HCFC-22 (45%) HFC-142b (5.5%) HFC-152a (7%) HFC-318 (42.5%)	0.018	5,200	A1/A1
R406A	HCFC Blend	HCFC-22 (55%) HCFC-142b (41%) HC-600a (Isobutane) (4%)	0.036	1,900	A1/A2
R408A	HCFC Blend	HCFC-22 (47%) HFC-125 (7%) HFC-143a (46%)	0.016	3,000	A1/A1
R409A	HCFC Blend	HCFC-22 (60%) HCFC-124 (25%) HCFC-142b (15%)	0.039	1,500	A1/A1
R409B	HCFC Blend	HCFC-22 (65%) HCFC-124 (25%) HCFC-142b (10%)	0.039	1,500	A1/A1
R411A	HCFC Blend	HCFC-22 (87.5%) HCFC-152a (11%) HCFC-1270 (1.5%)	0.030	1,500	A1/A2
R411B	HCFC Blend	HCFC-22 (94%) HCFC-152a (3%) HCFC-1270 (3%)	0.032	1,600	A1/A2
R412A	HCFC Blend	HCFC-22 (70%) HCFC-142b (25%) HFC-218 (5%)	0.035	2,200	A1/A2
R416A	HCFC Blend	HCFC-124 (39.5%) HCFC-134a (59%) HFC-600 (1.5%)	0.009	1,000	A1/A1
R509A	HCFC Blend	HCFC-22 (44%) HFC-218 (56%)	0.015	5,600	A1

No:	Name:	Chemical Formula or % Mass Mixture:	O.D.P.:	G.W.P.: 100 yrs	Safety
HFCs and HFC blends:					
R125	Pentafluoroethane	$C_2.H.F_5$	0.0	2,800	A1
R134a	Tetrafluoroethane	$C.F_3.C.H_2.F$	0.0	1,300	A1
R143a	Trifluoroethane	$C.F_3.C.H_3$	0.0	4,300	A2
R404A	HFC Blend	HFC-125 (44%) HFC-134a (4%) HFC-143a (52%)	0.0	3,800	A1/A1
R407A	HFC Blend	HFC-32 (20%) HFC-125 (40%) HFC-134a (40%)	0.0	2,000	A1/A1
R407B	HFC Blend	HFC-32 (10%) HFC-125 (70%) HFC-134a (20%)	0.0	2,700	A1/A1
R407C	HFC Blend	HFC-32 (23%) HFC-125 (25%) HFC-134a (52%)	0.0	1,700	A1/A1
R410A	HFC Blend	HFC-32 (50%) HFC-125 (50%)	0.0	2,000	A1/A1
R507A	HFC Blend	HFC-125 (50%) HFC-143a (50%)	0.0	3,900	A1/A1

15.3 Appendix 3 – Safety Group Classifications

Introduction

Refrigerants have been classified into safety groups according to the following criteria:

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

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

Class A signifies refrigerants with an LC50 ≥ 10,000 ppm.

Class B signifies refrigerants with an LC50 < 10,000 ppm..

Flammability Classification: Refrigerants are assigned to one of three classes, 1, 2 or 3, based on flammability. Tests have been conducted in accordance with ASTM E681-04 Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases) except that the ignition source must be an electrically activated kitchen match head for halocarbon refrigerants.

Class 1 refrigerants are non-flammable.

Class 2 refrigerants have a lower explosive limit (LEL) ≥ 3.5% volume.

Class 3 refrigerants have a lower explosive limit (LEL) < 3.5% volume.

All flammability classes are as tested in air at 101 kPa (standard atmospheric pressure) and 21°C ambient temperature.

Definitions of flammability differ depending on the purpose. For example, ammonia is classified for transportation purposes as a non-flammable gas by the U.S. Department of Transportation, but it is a Class 2 refrigerant.

Safety Classification of Refrigerant Blends: Blends whose flammability and/or toxicity characteristic may change as the composition changes during fractionation must be 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 TLV-TWA is less than 400 ppm. The TLV-TWA for a specified blend composition has been calculated from the TLV-TWA of the individual components.

Australia and New Zealand

Refrigerant handling code of practice 2007

Part 2 —

Systems other than self-contained low charge systems

Australian Government
Department of the Environment and Water Resources

AIRAH
achieving recognition

IRHACE NEW ZEALAND
The Institute of Refrigeration, Heating & Air Conditioning Engineers of New Zealand Inc.

Prepared by the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) and the Institute of Refrigeration, Heating and Air Conditioning Engineers New Zealand (IRHACE)

Part 2 –

Systems other than self-contained low charge systems

Prepared by the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH)
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II Scope

This code applies to all refrigeration and air conditioning systems which use fluorocarbon refrigerants, including heat pumps and transport refrigeration and air conditioning systems, but excluding:

- Appliances which contain a fluorocarbon refrigerant charge of two kilograms or less, and do not require any work to be done on the refrigeration system at the time of installation (such systems are covered by the *Australia and New Zealand refrigerant handling code of practice 2007 Part 1 – self contained low charge systems)*

This code has been developed with the intention of reducing emissions into the atmosphere of refrigerants listed in Appendix 2, or any other fluorocarbon refrigerant. This code specifies requirements which are mandatory for compliance with the code, and also includes best practice recommendations. Environmental benefits and cost savings from reduced losses can be expected from the application of this code including the use of alternative refrigerants.

Systems which do not use a fluorocarbon refrigerant (or do not use a refrigerant blend containing a fluorocarbon) are not covered by this code.

III Referenced Documents

The following documents are referred to in this code:

Document		Title
AIRAH	DA19	HVAC&R Maintenance
AS/NZS	1200:2000	Pressure Equipment
	1571:1995	Copper - Seamless tubes for air conditioning and refrigeration
	1677.2:1998	Refrigerating systems. Part 2: Safety Requirements for fixed applications
	3823.1.1:1998	Performance of electrical appliances – air conditioners and heat pumps – test methods – non-ducted air conditioners and heat pumps – testing and rating for performance
AS	1210:1997	Pressure Vessels
	3823.1.2:2001	Performance of electrical appliances – Air conditioners and heat pumps - Test methods - Ducted air conditioners and air-to-air heat pumps - Testing and rating for performance
	2030.1:1999	The verification, filling, inspection, testing and maintenance of cylinders for storage and transport of compressed gases – Cylinders for compressed gases other than acetylene
	4041:1998	Pressure Piping
	4211.3:1996	Gas recovery on combined recovery and recycling equipment. Part 3: Fluorocarbon refrigerants from commercial/domestic refrigeration and air conditioning systems
	4484:2004	Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding
ANSI/ARI	580-2001	Non-Condensable Gas Purge Equipment for Use with Low Pressure Centrifugal Liquid Chillers
ARI	700-2004	Specification for Fluorocarbon Refrigerants
ASHRAE	Guideline 1-1996	The HVAC Commissioning Process
	Code M	Commissioning - Management

Australian Act		Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 (as amended in 2003)
Australian Regulation		Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995
Australia / New Zealand Code of Practice		Australia and New Zealand refrigerant handling code of practice Part 2 – systems other than self-contained low charge systems
CIBSE	Code C	Commissioning – Controls
New Zealand Act		Ozone Layer Protection Act 1996
SAE	J51	Refrigerant 12 Automotive Air Conditioning Hose

IV Acronyms for Standards and Organisations and Relevant Websites

Acronym	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
ARI	Air-Conditioning and Refrigeration Institute (American)	www.ari.org
AS	Australian Standard	www.standards.org.au
DEW	Department of Environment and Water Resources (Australia)	www.environment.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
SAE	Society of Automotive Engineers (American)	www.sae.org

V Definitions

For the purp ose of this code the following definitions apply:

Alternative refrigerant
Alternative refrigerant means a **refrigerant** other than that for which a system was designed.

Blend
A combination of two or more **refrigerants** in a defined ratio which forms a **refrigerant** with specified thermodynamic properties.

Compatible
Components are **compatible** when they can be operated together without degrading the overall performance of the system.

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** gases under pressure.

Decommissioning
The process whereby a system is deliberately rendered inoperable.

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 pipe work and electrical connections between the separate evaporator unit and the condensing unit, where the evaporator and condenser unit have been matched by the manufacturer.

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

Fluorocarbon refrigerant
A **refrigerant** consisting of or containing **fluorocarbon**.

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

Heat pump
A **refrigerating system** where the main purpose is to make use of the heat rejected by the system, for example to provide space, process or water heating.

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.

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.

Reclaim
To reprocess used **refrigerant** to new product specification by means which 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 **fluorocarbon refrigerant** 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**.

Self-contained low charge systems
Appliances which contain a **fluorocarbon refrigerant** charge of two kilograms or less, and do not require any work to be done on the refrigeration system at the time of installation.

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

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

For definitions of other components, refer to AS/NZS 1677.2-1998 section 1.4: Definitions.

VI How to read this code

Text in the remainder of this document is colour coded for ease of use.

Text with a blue background, and containing the term '**must**' in bold font, indicates compliance is mandatory.

Sections with a green background, and containing the terms '**should**' or '**recommended**' are not mandatory but are recommended as best practice.

Sections with plain background are explanatory notes, and are for informative purposes only.

Note for Australian users:

The use of fluorocarbon refrigerants in Australia is governed by the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (as amended in 2003) and the *Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995*.

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

1 General

1.1 Personnel

1.1.1 In Australia, any person whose business includes the manufacturing, installation, servicing, modifying, or dismantling of any refrigeration and/or air conditioning equipment which:

(a) contains

(b) is designed to use, or

(c) is manufactured using

any **fluorocarbon refrigerant, <u>must</u>** ensure that they and/or any of their employees who handle **fluorocarbon refrigerant** are appropriately licensed under the Ozone Protection and Synthetic Greenhouse Gas Management Act and any regulations that supersede it.

For further details on the Australian licensing system, see www.environment.gov.au or www.arctick.org

1.1.2 In New Zealand, any person whose business is or includes the manufacturing, installation, servicing, modifying, or dismantling of any refrigeration and/or air conditioning equipment which:

(a) contains

(b) is designed to use, or

(c) is manufactured using

any **fluorocarbon refrigerant, <u>must</u>** ensure that they and/or any of their employees who handle **fluorocarbon refrigerant** possess a 'No-Loss' card.

The No-Loss card is a card indicating the completion of a voluntary training program run by the New Zealand government and the Institute of Refrigeration, Heating and Air Conditioning Engineers New Zealand (IRHACE). For more details see www.irhace.org.nz.

1.1.3 Any person whose business is or includes the manufacturing, installation, servicing, modifying, or dismantling of any refrigeration and/or air conditioning equipment which:

(a) contains

(b) is designed to use, or

(c) is manufactured using

a **fluorocarbon refrigerant, <u>must</u>** ensure that they and/or any of their employees who handle **fluorocarbon refrigerant** are provided with a copy of this code and work to the standards set out herein.

1.2 Refrigerant venting

1.2.1 **Fluorocarbon refrigerant <u>must</u> <u>not</u>** be willingly released to the atmosphere by any person by any means where the release is avoidable, including:

(a) venting **refrigerant** directly, and

(b) charging r**efrigerant** into equipment with identified leaks.

2 Design

This section deals with the design considerations of new air conditioning and refrigeration systems and components and alterations to existing systems. It also identifies possible sources of inadvertent loss of **refrigerants** to the atmosphere

2.1 Design of mass-manufactured systems

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

(a) manufactured,

(b) installed,

(c) operated,

(b) serviced, and

(c) **decommissioned**

without the avoidable loss of **refrigerant** as described in 1.2.1.

2.1.2 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 clause 2.1.1, the design will be exempt from sections 2.2 to 2.10 inclusive.

Where this can **not** be demonstrated, the system design **must** comply with sections 2.2 to 2.10 in their entirety.

2.2 General

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

2.2.1 All systems **must** be designed in accordance with the applicable Australian and New Zealand standards.

2.2.2 Pipework **must** have sufficient flexibility to accept structural movement during earthquakes, in accordance with AS 4041:1998, section 1: Scope and general.

2.2.3 For **transport refrigeration** systems, vibration absorbing mountings, flexible refrigerant hosing and/or vibration eliminators **must** be incorporated into the system design as appropriate to minimise the effect of vibration.

Refer to section 1 of AS 4041:1998 to determine class of piping and requirements. **Fluorocarbon** systems are generally class 3, with limited requirements for design installation and testing.

2.2.4 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.

2.2.5 **Refrigerating systems should** be designed to minimise the amount of refrigerant required.

2.3 Compressors

Leaks associated with compressors can generally be attributed to either the ancillary equipment attached to the compressor, (gauge and control connections, oil return, oil drain, oil sight glass, service valves, relief valve and connecting pipe work) or, in the case of open drive compressors the shaft seal. Proper initial installation, combined with a correct ongoing maintenance program, should minimise if not eliminate these problems (see also 11.1).

If contaminated oil reaches the seal it can cause damage to the shaft and seal. 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 dry system is essential for prolonged shaft seal effectiveness.

2.3.1 The shaft seal **must** be **compatible** with the compressor, oil and **refrigerant** used in the system.

2.3.2 The shaft seal **must** be capable of containing any pressure or vacuum that may be attained during both operational and any shut down periods.

2.3.3 Technicians **must** ensure manufacturers' specifications are always complied with, especially when changing **refrigerants** and lubricants.

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

2.3.5 **Refrigerant** dryers **must** be **compatible** with the **refrigerant** and lubricant used in the system.

2.3.6 Provisions for removing moisture and solids, and oil filtration, **must** be made to ensure the necessary level of cleanliness is maintained.

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

2.3.8 Isolation valves **must** be installed where gauges are fitted to minimise the chance of **refrigerant** loss during servicing or replacement, in accordance with AS/NZS 1677.2:1998, clause 3.6.9.3: Isolating Valves.

2.3.9 Isolation/evacuation valves **must** be fitted to systems to assist in the servicing and maintenance of plant (see also 2.3.10 to 2.3.13 inclusive, 2.6.5 and 2.9.8).

2.3.10 Service valves **should** be fitted to both the suction and delivery sides of the compressor to minimise **refrigerant** discharge during service work, in all systems except those which are hermetically sealed (see 2.3.13 and also 2.6).

2.3.11 Pump out capability within a system with isolating valves **must** be provided for system servicing where compressor service valves are not installed.

2.3.12 Service access ports **must** be provided on all **transport refrigeration** systems to allow **refrigerant** removal and charging.

2.3.13 **Transport refrigeration** systems **must** have service valves located at the compressor and other locations (in accordance with AS/NZS 1677.2:1998).

2.3.14 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.

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 in large systems it is necessary to have a separate oil pump to lubricate the compressor bearings and shaft prior to start-up.

2.3.15 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 lines connected to the compressor will also minimise the potential for leaks.

2.3.16 Pipeline connections to the compressor **must** be supported in accordance with AS 4041:1998, section 3: Design to avoid unacceptable stresses which could lead to leakage or fracture (see also 2.5.6).

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

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

2.3.19 Replaceable dryers **should** be used on all systems, however, replaceable core dryers **should** be used on larger systems.

2.4 Refrigerant condensers and evaporators

Properly designed and manufactured condensers and evaporators have few leakage problems, however, the following points need to be considered and appropriate action taken.

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

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

2.4.3 Fluid velocity **must not** exceed the maximum safe working velocity of any material used.

2.4.4 Sacrificial anodes, cathodic protection systems or another anti-corrosion measure **must** be provided where it is necessary to reduce corrosion and protect against electrolytic action.

2.4.5 Anti-vibration mountings and mufflers are highly **recommended**, as excessive vibration from compressors or other equipment can cause heat exchanger tubing failure (see also 2.3.7).

2.4.6 Where cooling water quality is poor, for example with sea water or bore water, treatment and filtration methods **should** be designed to avoid corrosion or erosion failure.

2.4.7 The tube plate and tube materials appropriate to the type of water **must** be selected to minimise corrosion in the case of 2.4.6.

2.4.8 Facilities for flushing and/or drainage **must** be fitted since reduced or inactive water-flow may lead to serious corrosion problems, especially on sea water cooled systems.

2.5 Refrigerant pipelines & fittings

2.5.1 All pipelines **must** be designed so that the number of joints is kept to the practical minimum.

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

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

2.5.4 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.

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

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

2.5.7 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.

2.5.8 Provision **must** be made for thermal movements in the pipework, and loops/anchors incorporated.

2.5.9 Strainers, filters, and dryers sized for the system **must** be included to ensure all the **refrigerant** and oil circulated throughout the system stays clean and moisture free.

2.5.10 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.

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

2.5.12 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.

2.5.13 A moisture indicating liquid line sight glass installed with the dryer is strongly **recommended**.

2.5.14 Full flow filter dryers **should** be used in preference to bypass dryers .

2.5.15 **Refrigerant** flexible hose **should** comply with SAE Standard J51.

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

2.6 Valves

2.6.1 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.

2.6.2 The system **must** be designed to enable valves which use packing to retain leakage from the spindle gland and to remain capped at all times unless being opened or closed. For example; expansion valves, service valves and packed line valves.

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

2.6.4 Preference **should** be given to valves with welded or brazed connections in all instances (see also 2.5.2).

2.6.5 Isolation and service valves **must** be included in the system (excluding **transport refrigeration** systems) to enable the pump down and isolation of **major components** and equipment.

2.7 Relief device

This section should be read in conjunction with AS/NZS 1677.2:1998.

2.7.1 Systems **must** have relief devices selected for the **refrigerant** and operating conditions of the system.

2.7.2 Relief devices **must** be of the type that automatically reset after activation.

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

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

2.7.5 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.

2.7.6 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, or provisions are made so that the low side is equipped with a pressure relief valve of sufficient capacity to protect all connected vessels, compressors and pumps simultaneously subjected to excess pressure.
See also AS/NZS 1677.2:1998, clause 3.7.3.1: *Protection of the refrigerating system.*

High side relief to the low side has many attendant risks and the designer **must** ensure that the pressure does not exceed the maximum safe working pressure of the vessel, see AS/NZS 1677.2:1998, section 3.1: *Maximum operating pressure*, to section 3.4.

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

Installing a rupture disc between the equipment and the relief valve will protect the valve from corrosion and resetting problems.

2.7.8 An indicator system **must** be installed when the rupture disc is utilised in this manner to indicate that the disc has ruptured and permitted **refrigerant** to contact the relief valve.

2.7.9 Pipework **must** be designed so that liquid **refrigerant** cannot be trapped between isolation valves without pressure relief (see AS/NZS 1677.2:1998 section 3.7: *Protection against excess pressure).*

2.8 Air purgers (negative pressure systems)

A well designed and maintained **negative pressure system** will need to purge non-condensable gas for only a minimal amount of time.

2.8.1 A purge unit which **recovers refrigerant should** be fitted to all new commercial and industrial equipment and retro-fitted to existing systems.

2.8.2 The **refrigerant** loss due to non-condensable purging **must** **not** exceed 0.5 kg of **refrigerant** per 1 kg of air.

2.8.3 A purge monitor which indicates actual purging time **must** be fitted in all cases.

2.8.4 The performance of all air purgers **must** comply with ANSI/ARI 580-2001.

2.8.5 The purge unit **should** be capable of operating independently of the refrigeration system.

2.9 Pump down capability

2.9.1 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.

2.9.2 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 percent by volume full.

2.9.3 The vessels **must** be designed to contain the pressure at ambient conditions at pump down without the relief valve discharging (see AS 1210:1997).

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

2.9.5 Units 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).

2.9.6 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 1677.2:1998 Section 3.7: *Protection against excess pressure*. They may be exempted from 2.9.1, 2.9.4 and 2.9.5, provided the evaporator or liquid accumulator/separator or both can contain the entire charge.

2.9.7 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 1210:1997 for approved storage vessels and **refrigerants**.

2.9.8 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** prior to service or repair operations (see also 2.6).

2.9.9 Systems containing a one piece condenser/receiver need not comply with 2.9.1 if the condenser shell is large enough to contain the pumped down **refrigerant** charge, is fully isolated by shut off valves and is protected by a pressure relief valve in accordance with AS/NZS 1677.2:1998, Section 3.7: *Protection against excess pressure.*

2.10 Charge monitors and leak detectors

2.10.1 Where practical, a **refrigerant** charge monitoring or leak detection system **should** be used on new installations to alert equipment owners/operators of a **refrigerant** leak.

3 *Manufacture and assembly*

3.1 General

It is imperative that all supervisory personnel involved in the manufacturing process are conversant with **refrigerant** technology and familiar with all aspects of the manufacturing process.

3.1.1 Complete refrigeration and air conditioning systems **must** be clean, dry, leak tested, evacuated, pressurised, sealed and labelled with the **refrigerant** type before delivery.

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

3.1.3 Refrigeration and air conditioning system components **must** be pressure tested, clean, dry, capped and labelled such that the appropriate **refrigerants** and lubricants can be identified.

3.2 Leak testing

3.2.1 Except where used as a trace gas (see 3.2.2), **fluorocarbon refrigerant must not** be put into a system for the purposes of leak testing.

Acceptable leak test methods include (but are not limited to):

(a) liquid submersion testing

(b) foam enhancer leak detection

(c) positive pressure holding test / pressure drop off test (gross leaks only)

(d) vacuum degradation test (gross leaks only)

(e) fluorescent leak detection

(f) electronic leak testing

(g mass spectrometer

3.2.2 A **fluorocarbon** substance may be used as a trace gas for leak testing by manufacturers, however, they **must** comply with the following conditions:

(a) the trace gas **must** be pre-mixed with nitrogen as a homogenous mixture, with a **fluorocarbon** content not greater than 10% by volume in the nitrogen

(b) the trace gas mixture **must** be fully **recovered** after final leak testing and **must not** be dispatched with the unit as a holding charge

(c) the unit **must** be tested for gross leaks using one of the methods described in 3.2.1 prior to introducing the trace gas.

3.3 Charging of refrigerant

3.3.1 All charging **must** be carried out in accordance with AS/NZS 1677.2:1998 Section 6.1: *Charging and discharging refrigerant*, with the exception that manufacturers are **not** required to charge solely into the low side of the system.

4 Provision of information on installation, use and maintenance

4.1 Instructions **must** be furnished with each new system, detailing correct methods and recommended procedures for installation, use, and maintenance that prevent the deliberate emission, and minimise the potential for accidental emission, of **refrigerants**.

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

5 Installation procedures

Recommendations on the design of pipework and on the methods of connection can be found in Section 2.5 of this code. Some self-contained products are manufactured and sold as a complete package. Where connection of **refrigerant** piping is not required, installation is normally the responsibility of the purchaser.

Note that where such a system has a **refrigerant** charge of less than two kilograms, it is covered by the *Australia and New Zealand refrigerant handling code of practice 2007 Part 1 – self-contained low charge systems* and not the provisions of this code.

5.1 The manufacturer's instructions for installation **must** be followed if the system is **factory matched** and the manufacturer has supplied instructions with the system, except where the instructions specify a practice that will lead to emission of **refrigerant.**

Manufacturer's instructions **must not** specify a practice which will result in the avoidable emission of **refrigerant.**

Provided the instructions do not specify a practice that will lead to emission of **refrigerant,** if the manufacturer's instructions are followed then the installation is exempt from items 5.1.3 to 5.1.24.

The relevant parts of section 5 of this code **must** be complied with if there are any installation procedures not covered by the manufacturer's instructions.

Installation of all other systems, or systems where manufacturer's instructions are not supplied, **must** comply with section 5 of this code in its entirety.

5.2 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.

5.3 The installer **must** ensure that all piping used is selected in accordance with AS/NZS 1571:1995 - *Copper - Seamless tubes for air conditioning and refrigeration* and AS 4041:2006 – *Pressure piping*

5.4 All pipework and fittings **should** be thoroughly examined for cleanliness and suitability for the system and **refrigerant** prior to assembling.

5.5 All unsealed tubing **must** be thoroughly inspected and, if necessary, cleaned before assembly to remove any copper residue and/or scale particles such as dirt or metal.

5.6 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.

5.7 Pipes **must** be clean, burr free and not fallen in prior to assembly.

5.8 Condensing units **must** be secured to prevent any movement.

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

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

5.11 Compressor drive belts, when fitted, **should** never be over tensioned as this can lead to premature bearing wear and shaft seal failure.

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

5.13 For flare connections, a suitable lubricant **must** be used between the back of the flare and the nut to avoid tearing the flare when tightening the nut.

5.14 For flanged connections only the correct type and grade of gasket material, **should** be used (see also 2.5.2) that is suitable for the operating temperatures and pressures in the relevant part of the system and **compatible** with the relevant **refrigerant** and oil.

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

5.16 **Refrigerant** lines **should** be as short and direct as possible.

5.17 The copper tubing **must** be enclosed within a protective covering if it is not possible to place it in a location where it will not be exposed to possible damage.

5.18 If copper tubing runs along walls or rafters etc. it **must** be fixed at regular intervals according to the tube diameter and not exceeding the following intervals:

(a) 6.5mm diameter tube or less:	1m spacing
(b) 6.5mm to 20mm diameter tube:	1.5 m spacing
(c) 25mm diameter tube:	2m spacing
(d) 32mm to 40mm diameter tube:	2.5m spacing
(e) larger than 50mm diameter tube:	3m spacing.

Good support throughout the system means not only fewer problems, but better operation. Good piping and tubing support offers several advantages:

(a) no sagging and eventual cracking

(b) good oil-handling characteristics

(c) no bad effects from vibration

(d) longer service life for the piping

(e) less chance of liquid hammer damage.

5.19 Copper pipe **must** be protected from chafing and corrosion where galvanised clamps are used.

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

5.21 **Refrigerant** tubing exposure to direct sunlight **should** be minimised.

5.22 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 Building Code of Australia / New Zealand.

5.23 All **refrigerant** pipes **must** be evacuated prior to **refrigerant** charging (see also Section 6).

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

5.25 After pipework has been fixed in position, dry nitrogen **must** be passed through the system to remove oxygen prior to brazing or silver soldering joints.

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

5.27 The nitrogen **must** be at minimal gauge pressure during the brazing operation to eliminate the possibility of pin hole leaks.

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

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

Acceptable leak test methods include (but are not limited to):

(a) liquid submersion testing

(b) foam enhancer leak detection

(c) positive pressure holding test / pressure drop off test (gross leaks only)

(d) vacuum degradation test (gross leaks only)

(e) fluorescent leak detection

(f) electronic leak testing

(g) mass spectrometer

5.30 A **fluorocarbon** substance may be used as a trace gas for leak testing, however, its use **must** comply with the following conditions:

(a) the trace gas **must** be pre-mixed with nitrogen as a homogenous mixture, with a **fluorocarbon** content not greater than 10% by volume in the nitrogen

(b) the trace gas mixture **must** be fully **recovered** after final leak testing and **must not** be used as a holding charge

(c) the unit **must** be tested for gross leaks using one of the methods described in 5.1.29 prior to introducing the trace gas.

5.31 The system **must** be pressurised to a safe test pressure, having ensured there are no gross leaks as per 5.1.29 and 5.1.30.

5.32 All charging **must** be carried out in accordance with AS/NZS 1677.2:1998 Section 6.1: *Charging and discharging refrigerant.*

5.33 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.

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

5.35 Refrigeration and air conditioning systems and components **should** be commissioned with calibrated instruments and an established checklist (such as CIBSE Commissioning Code C (controls) 2001 and Code M (management) 2003, ASHRAE Guideline 1-1996 *The HVAC Commissioning Process* or NEBB standards), using experienced personnel. A copy of the completed checklist **should** be provided to the customer.

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

5.37 Service visits for the first year **should** be at the fixed price recommended in the quotation.

5.38 A service checklist (such as provided in AIRAH manual DA19 – *HVAC&R Maintenance*) **should** be utilised and a copy **should** be given to the customer after each service.

6 Evacuation

This section refers to evacuation in the field **only** – not evacuation during the manufacturing process.

6.1 The manufacturer's instructions for evacuation **must** be followed if the system is factory-matched (ie: the manufacturer has supplied a matched evaporator and condenser) and the manufacturer has supplied instructions with the system, except where the instructions specify a practice that will lead to emission of **refrigerant.** Provided the instructions do not specify a practice that will lead to emission of **refrigerant,** if the manufacturer's instructions are followed then the installation is exempt from items 6.1.2 to 6.1.5.

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

Installation of all other systems, or systems where manufacturer's instructions are not supplied, **must** comply with section 6 of this code in its entirety.

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

6.3 The system **must** be evacuated to remove moisture and non-condensables after determining that there are no **refrigerant** leaks when the system is pressurised,

6.4 Evacuation **must** be either the deep evacuation method, or triple evacuation using dry nitrogen only as the moisture absorber, following the procedures described below.

Deep vacuum method: Pull a deep vacuum to a pressure of less than 65 Pa absolute (500 microns of mercury). After isolating the vacuum pump, allow the system to stand for 60 minutes to ensure the vacuum is maintained at or below 78 Pa absolute (600 microns of mercury); OR

Triple evacuation method: Use a vacuum pump to pull a vacuum to a pressure of at least 65 Pa absolute (500 microns of mercury). Break the vacuum with dry nitrogen and allow the system to stand. Re-evacuate the system and repeat the procedure twice more, breaking the vacuum each time with dry nitrogen.

6.5 After the system has been evacuated the vacuum pump **should** be isolated from the system. As a guide, with constant ambient conditions, the vacuum **should** **not** rise more than 13 Pa (100 microns of mercury) in one hour. A greater rate of rise may indicate a leak or the presence of moisture (see also 8.1.17).

6.6 Absolute vacuums **must** be measured using accurate measuring equipment selected for the specific application.

7 *Commissioning*

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

7.1 The manufacturer's instructions for commissioning **must** be followed if the system is factory-matched (ie: the manufacturer has supplied a matched evaporator and condenser) and the manufacturer has supplied instructions with the system, except where the instructions specify a practice that will lead to emission of **refrigerant.** Provided the instructions do not specify a practice that will lead to emission of **refrigerant,** if the manufacturer's instructions are followed then the installation is exempt from items 7.2 to 7.5.

The relevant parts of section 7 of this code **must** be complied with if there are any commissioning procedures not covered by the manufacturer's instructions.

Installation of all other systems, or systems where manufacturer's instructions are not supplied, **must** comply with section 8 of this code in its entirety.

7.2 Condensing unit checks **must** involve the following procedures:

(a) ensuring that all travelling bolts and packaging have been removed and that the unit is correctly secured

(b) checking v-belts and pulleys for alignment and tightness

(c) cleaning condensers and ensuring a clear path for air movement

(d) evacuating and charging the unit

(e) ensuring the valves are in their correct operating position and valve caps are replaced.

7.3 Evaporator checks **must** involve:

(a) checking fan motor mountings and removal of transit packaging

(b) checking coil mounting.

7.4 Pipework checks **must** involve:

(a) ensuring that pipework has been correctly installed and secured

(b) checking proper insulation of suction line.

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

(a) gauges **must** be fitted to high and low sides of the compressor

(b) Pressures **must** be compared with the pressure for the prevailing ambient for that **refrigerant.** (Higher pressure indicates non-condensable gases or poorer than expected condenser performance.)

(c) high pressure/low pressure safety cutouts **must** be set

(d) the compressor oil level **must** be checked, even if this is normally carried out in the factory

(e) the system **refrigerant** charge **must** be checked

(f) operation **must** 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

(g) the compressor oil level **must** be re-checked and topped up if necessary, after first ensuring there are no other circumstances contributing to low oil level

(h) gauges **must** be removed, re-tests should be carried out for leaks, and belt tension should be adjusted if necessary.

8 Servicing of equipment

Many of the points in this section also need to be considered in Section 1.1 on Personnel and Section 14 on Recovery, Recycling and Disposal of Refrigerants.

Note: if the system is being **retrofitted** with a **refrigerant**, lubricant or components other than those for which it was originally designed, see Section 12 on Retrofitting.

Negative pressure systems can be pressurised using electric blankets or hot water to heat the vessel to a controlled positive pressure for leak detection purposes.

8.1 A service person **should** be aware of the possibility that the system may have been incorrectly charged or incorrectly labelled (See also Section 10).

8.2 The service person **must** therefore first establish the type of **refrigerant** contained in the system by checking the pressure/temperature relationship or by using other methods, and verify that the labelling is correct.

8.3 Only qualified persons with relevant experience **should** work on refrigeration and air conditioning systems which contain toxic or flammable **refrigerants** (ie: non-A1 safety class), since they demand special precautions (see Appendix 1).

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

8.5 **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.

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

8. 7 Controlled **refrigerants must not** be used to clean debris and dirt from air cooled condenser fins or any equipment parts.

8.8 The service person **must** check and repair as necessary all potential leak sites including:

(a) all hand valves used on service equipment

(b) process tubes and attachments

(c) valve stem glands

(d) sealing caps over gauge points (check flare face for wear)

(e) service valve caps (ensure a suitable washer is in place)

(f) pressure relief valves.

8.9 Access valves **must** have their caps refitted.

Various methods may be used for leak testing, eg. electronic leak detectors, ultrasonic leak detectors, proprietary bubble solution, halide lamp, and/or ultra violet lamp. Some leak test methods are specific to **refrigerant** types.

8.10 If work has been done on the refrigeration circuit, the system **must** be leak tested after service and any identified leaks **must** be repaired. **Refrigerant must not** be put into the system for the purpose of leak testing.

8.11 The service person **must** examine the following items for traces of **refrigerant** oil, which could indicate leaks, and repair where necessary;

(a) flare joints

(b) brazed joints

(c) catalyst cured joints

(d) compression fitting joints

(e) compressor gaskets

(f) control bellows

(g) shaft seals

(h) flanges

(i) every other potential leakage point.

8.12 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.

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

8.14 Having located a leak, that part of the system **must** be isolated to minimise the loss of **refrigerant**, after which the repair can then be undertaken.

8.15 The **refrigerant must** be pumped back into the system receiver or **recovered** to a separate **cylinder** if isolation is impractical, or if that part of the system cannot be held at atmospheric pressure accurately while the repair is being carried out. This **cylinder must** be suitable for the **refrigerant** being removed.

8.16 **Refrigerant must not** be wilfully discharged to atmosphere under any circumstances.

8.17 If the service person 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.

8. 18 An equivalent replacement `O' ring seal **must** be used each time an `O' ring connection is remade.

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

8.19 The test pressure **must** comply with AS/NZS 1677.2:1998, table 3.2: *Relationship between the various pressures and the maximum operating pressure (ps)* when leak testing on negative pressure systems.

8.20 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.

8.21 The service person **should** ensure that the condenser is clean and serviceable.

8.22 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.

8.23 Belts on open belt drive condensing units **should** be thoroughly checked for wear and damage in order to limit leaks. Worn or damaged belts, misalignment or over tensioning can cause failure of the compressor shaft seal and drive end bearing.

8.24 Compressor drive belts, when fitted, **should** never be over tensioned as this can lead to premature bearing wear and shaft seal failure.

8.25 The charging and/or temporary gauge lines and connecting lines and/or flexible hose **should** be evacuated using a vacuum pump to less than 5000 microns to eliminate air intake.

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

8.27 A regular inspection and maintenance program **should** be adopted. This **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 Cleaning and flushing

Cleaning and flushing a contaminated system after a hermetic or semi-hermetic compressor failure or motor burnout.

9.1 **Contaminated refrigerant must** be fully r**ecovered.**

9.2 The **cylinder must not** be over-filled, as per AS 2030.1:1999.

9.3 **Refrigerants must not** be mixed in the same **cylinder** as clean / reusable **refrigerant.**

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

9.5 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.

9.6 **Fluorocarbon refrigerant must not** be used for flushing components.

9.7 Occupational Health and Safety standards **must** be observed when handling solvents.

9.8 Relevant material safety data sheets (safety data sheets in New Zealand) **must** be obtained and made available to the technician handling solvents.

9.9 The cleaning solvent **should** be pumped throughout the system until only clean solvent emerges.

9.10 After ensuring the system has been thoroughly cleaned, caution **should** be taken to ensure no solvent residue remains in the system after purging.

9.11 All spent solvents **must** be disposed of in accordance with New Zealand *Hazardous Substances (Disposal) Regulations 2001* and / or Australian state and territory hazardous substance disposal regulations.

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

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

9.14 The system **must** be pressurised and leak tested using one of the methods in 3.2.1, and then **must** be evacuated by the deep evacuation method, except if because of the nature of the **plant** (eg. blood bank, plasma freezing, operating theatre equipment) the major consideration is bringing the **plant** back into service without delay, in which case triple evacuation may be used. Refer to section 6.

9.15 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 is done at the end of the process.

9.16 The system **must** then be pressurised then leak tested, re-evacuated and recharged with **refrigerant.**

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 9.1.5 and 9.1.6, then cleaning of the system by using purpose selected suction and liquid line filter dryers is an acceptable alternative.

9.17 All filters fitted **must** be capable of being replaced with a minimal loss of **refrigerant** to the atmosphere, using the procedure outlined in 9.1.15 if cleaning of the system by using purpose selected suction and liquid line filter dryers is undertaken.

10 Labelling

10.1 Whenever the type of **refrigerant** and/or lubricant in a system is changed, the service person **must** clearly label the system with:

(a) the **refrigerant** type,

(b) name of service person, license number (Australia only) and service organisation,

(c) date of service,

(d) any ultraviolet dye that has been added.

Wherever 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 service person **must** also clearly label the system with:

(e) the lubricant type

10.2 **Refrigerating systems** modified on site **must** be labelled as per Clause 10.1.1.

10.3 Compressors, unit systems and liquid **refrigerant** pumps **must** be labelled in accordance with AS/NZS 1677.2:1998 Clause 5.4.2: *Marking of compressors, unit systems and liquid refrigerant pumps.*

10.4 The service organisation **<u>must</u>** check with New Zealand authorities or Australian State and Territory authorities as to their particular labelling requirements.

11 Maintenance

11.1 General maintenance

11.1.1 All **plants** **<u>must</u>** be regularly inspected in accordance with AIRAH manual DA19 – *HVAC&R maintenance*.

11.1.2 For systems with separate oil pumps, these pumps **should** be run at least once a month for 2 hours during shut-down periods longer than a month.

11.1.3 On compressors where a separate oil pump is not fitted, the shaft **should** be rotated at least once a month to ensure the seal is kept lubricated (see also 11.1.1, 11.1.2, and 11.1.7).

11.1.4 If a system equipped with an open type compressor is to be shut down for more than one month, the equipment **should** be pumped down, all necessary valves closed to prevent the escape of r**efrigerant**, and suitably labelled.

11.1.5 The shaft seal **<u>must</u>** be thoroughly inspected , lubricated and leak tested before starting any maintenance if, after any shut down period of more than one month;

(a) the oil pump has not been run, or

(b) on compressors with no oil pump, if the shaft has not been rotated periodically.

11.1.6 Compressor drive belts, when fitted, **should** never be over tensioned as this can lead to premature bearing wear and shaft seal failure.

11.1.7 The shaft **should** be rolled at least once per month to minimise leakage at the shaft seal on open drive machines.

11.1.8 If the procedure in 11.1.5 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.

Such a procedure could prevent seal failure occurring over a long period of shutdown.

11.1.9 The general operating conditions **should** be checked once a week, including system pressures, **refrigerant** sight glass, etc.

11.1.10 The condition of condensing equipment **should** be checked once a week. For air cooled equipment, the condition or the condenser coil **should** be observed.

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

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

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

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

11.1.14 The seal **must** be checked with a **refrigerant** leak detector if 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, in the case of the open compressor, **refrigerant** that might leak through the shaft seal.

11.1.15 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.

11.1.16 For all systems, the condenser and liquid receiver (if used) **must** be checked for **refrigerant** leaks using a **refrigerant** leak detector.

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

11.1.18 The system temperature controller **should** be readjusted to the proper temperature setting if 11.1.17 is completed satisfactorily.

11.2 Advice to equipment users

11.2.1 The owner of the unit **should** be held responsible for its use and care.

11.2.2 A malfunctioning unit **should** be attended to by a licensed service organisation as soon as the condition occurs to ensure that any leakage of **refrigerant** is minimised. See also AS/NZS 1677.2:1998 Appendix F: *Guide to the Operation and Maintenance of Commercial and Industrial Refrigerating Appliances and Systems in Relation to Safety (Informative).*

Users are advised that persons who service refrigeration and air conditioning equipment are required by legislation to observe this code of practice and not to "top up" systems known to be leaking or to service equipment unless it can be returned into service in a leak free condition. Some modification to **plant** or equipment may be necessary to achieve the aim of the code of practice to minimise loss of **refrigerant.**

11.2.3 It is **recommended** that a routine maintenance agreement for their **plant** be undertaken with a licensed service person or organisation if a user does not have trained staff to undertake service or maintenance work.

11.2.4 All users **should** monitor the operation of their installation weekly and call the service person immediately if any abnormal condition is found. (Apart from the likelihood of minimising loss of **refrigerants** to the atmosphere this may also save the cost of an expensive repair or replacement.)

11.2.5 When a system contains in excess of 50kg of **refrigerant,** the service person **must** recommend to the owner that the system be leaked tested at least on a quarterly basis (see also 8.1.8).

11.2.6 The installation of a suitable sensing and alarm system to detect a loss of **refrigerant** charge or the presence of leaked **refrigerant**, as well as an oxygen monitoring system for installations in enclosed spaces, is highly **recommended.**

11.2.7 All **refrigerants _must_** be **recovered** and either recycled, **reclaimed** or held for **destruction** in an approved manner.

12 Retrofitting

12.1 Any procedures recommended by the system manufacturer or their distributor **_must_** be followed when **retrofitting** is to be carried out.

12.2 **Retrofitting** a system with an **alternative refrigerant** and/or lubricant **_must_** only be carried out based on written advice from the equipment and/or component manufacturers.

12.3 If the equipment and/or component manufacturers cannot be contacted and written advice from them is not available, written advice from a suitably qualified refrigeration or air conditioning engineer **_must_** be obtained prior to the **retrofit.**

12.4 High pressure, flammable or toxic **refrigerants _must_ _not_** be used in systems where they will pose a safety risk.

12.5 **Alternative refrigerants _must_** be **compatible** with all parts of the system.

12.6 Correct lubricants **_must_** be used with **alternative refrigerants** (check with the **refrigerant** supplier if in doubt).

12.7 When an **alternative refrigerant** has been **retrofitted** to a system, the system's labelling, colour coding (if applicable) and nameplates **_must_** be changed to permanently identify the **refrigerant** contained and the type of lubricant.

12.8 A new filter drier appropriate for the new **refrigerant _must_** be fitted.

12.9 Where it is technically and economically feasible, **alternative refrigerants** with a lower **ozone depletion** and **global warming potential** than the original **refrigerant should** be used.

13 Decommissioning

13.1 All **refrigerant _must_** be **reclaimed** from all parts of the system at the time of **decommissioning**, unless the system is being **decommissioned** for service or immediate recommissioning.

14 Recovery, recycling and disposal of refrigerants

14.1 DURING MANUFACTURE, INSTALLATION AND SERVICING

Note: 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.

In Australia, **recovery** and recycling of **refrigerant** at the end of its useful life using **recovery** and/or recycling equipment is mandatory. In New Zealand it is an offence under the Ozone Layer Protection Act to wilfully release an ozone depleting substance.

To avoid mixing **refrigerants** that can be recycled or reused and to ensure that no **recovery cylinder** is over-filled, it is necessary to either use dedicated **recovery** equipment for each **refrigerant** or to ensure that only **cylinders** marked with the correct filling ratio are used, and that this filling ratio is not exceeded for the **refrigerant** being **reclaimed.**

The provision of receivers or dump tanks on larger capacity refrigeration and air conditioning systems facilitates re-using the **refrigerant** charge following servicing operations or **decommissioning** of equipment.

In smaller capacity systems using capillary expansion devices, or critical charge systems where pump down facilities are not provided, **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 following two provisions apply:

14.1.1 The designed maximum safe working pressure of a **refrigerant cylinder** **must** **not** be exceeded in any filling operation, as per AS 2030.1:1999, no matter how temporary.

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.**

14.1.2 **Refrigerant** **must** **not** be **recovered** into a flexible bag.

14.1.3 **Cylinders** **must** only be used within the application for which they are designed.

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

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

14.1.5 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.

14.1.6 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.

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

14.1.8 **Cylinders** **must** conform with AS 4484:2004, AS 2030:1999 and AS/NZS 1200:2000 *Appendix G: Organisation of Australian, New Zealand and other pressure equipment standards.*

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

14.1.9 **Refrigerant recovery** units **must** be appropriate for the **refrigerant** being **recovered**.

See Appendix 1 for further information if the presence of flammable **refrigerant** is suspected.

14.1.10 Special care **must** be taken to ensure cross contamination of **refrigerants** and lubricants does not occur within the equipment if the **refrigerant** is to be recycled or reused.

14.1.11 Proprietary equipment **must** be used in accordance with the manufacturer's instructions.

14.1.12 Hoses, fittings and procedures used during service, installation and **decommissioning must** be those which minimise the loss of **refrigerant.**

14.1.13 **Refrigerant must** be either disposed of or tested when it is suspected to be contaminated or is to be re-used in a system other than that from which it was removed. If necessary, it may be recycled or reprocessed to ensure it complies with the provisions of ARI 700-2004.

14.1.14 **Refrigerant recovery** equipment and/or recycle equipment **must** conform to AS 4211.3:1996.

14.1.15 **Refrigerant** vapour as well as **refrigerant** liquid **must** be **recovered** when a system is repaired.

As many systems have a large internal volume it is important that all **refrigerant** vapour be **recovered**. A system at atmospheric pressure can still hold many kilograms of **refrigerant** vapour after the liquid has been removed.

14.1.16 When **recovering refrigerant** from a chiller, the **refrigerant should** be **recovered** until the internal system pressure is reduced to 3kPa absolute for low pressure systems (eg. R11) and 70kPa absolute for positive pressure systems, eg. (R134a, R12 and R22). The internal system pressure **should** then be taken up to atmospheric pressure with dry nitrogen if the chiller is to be opened. This will prevent moisture-laden air entering the system which could lead to contamination and corrosion.

14.2 Disposal of refrigerants

If **refrigerant** is to be recycled or reprocessed, mixing different types of **refrigerants** may render large quantities of **refrigerant** unusable as separation may be impossible.

14.2.1 Unusable or unrequired **fluorocarbon refrigerant must not** be discharged to the atmosphere and **must** be **returned** to a supplier or collection agent for disposal.

In Australia, **reclaimed refrigerant** can be **returned** to the supplier for disposal. See www.refrigerantreclaim.com.au for more information.

For locations that accept **returned refrigerant** in New Zealand, visit www.opc.co.nz

The importation and use of **fluorocarbon refrigerant** in **disposable refrigerant containers** is prohibited by law in Australia. Clauses 14.2.2 through 14.2.5 apply to New Zealand only.

14.2.2 Any residual **refrigerant** in a **disposable container must** be **recovered.**

14.2.3 A **disposable container must not** be refilled or used as a temporary receiver during service.

14.2.4 A **disposable container must not** be repaired or modified in any way.

14.2.5 Empty **disposable containers must** be disposed of at a recycling centre.

14.2.6 Refrigerators and freezer cabinets **must** have any locks removed or rendered inoperative upon removal from service. Doors, drawers and/or lids **must** 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.

14.2.7 **The refrigerant must** be **recovered** before disposal if the refrigeration system contains **refrigerant.**

15 Handling and storage of refrigerants

15.1 Handling and storage

Losses of **refrigerant** to the atmosphere can occur during the handling and storage of **refrigerant cylinders**. Service persons have a duty of care to avoid such losses.

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

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

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

15.1.3 **Refrigerant cylinders must not** be directly heated by flame, radiant heat or uncontrolled direct contact heat. Warming of the discharging **cylinder** is permissible under controlled conditions to increase the rate of discharge of **refrigerant** during transfer.

15.1.4 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.

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

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.

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

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

15.1.8 Service personnel **should** make reference to **refrigerant** manufacturers' Material Safety Data Sheets (safety data sheets in New Zealand) when handling **refrigerants.**

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

15.1.10 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.

15.1.11 **Cylinders** **must** be leak tested every three months and leaking **cylinders** **must** be returned to the supplier.

15.2 Charging

15.2.1 Except where charging is being carried out by the manufacturer on an assembly line, the pipework connecting a **cylinder** to a refrigeration 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 pipework.

15.2.2 **Refrigerant** being transferred **must** be accurately measured into the system with due reference to temperature as per AS 4211.3:1996.

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

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

15.2.5 **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.**

15.2.6 **Refrigerant cylinders must not** be connected to systems or other **cylinders** at a high 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.**

15.3 Refrigerant transfer between cylinders

Note that the provisions of section 15.1 also apply to **refrigerant** transfer between **cylinders.**

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

15.3.1 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 maximum gross weight is a function of the internal volume of the **cylinder, refrigerant** composition and oil content and temperature. The **cylinder** supplier should determine the maximum gross weight in accordance with AS 2030.1:1999.

15.3.2 **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** (see also 15.2.5).

15.3.3 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**.

15.3.4 When **cylinders** are manifolded together it is **highly recommended** that single direction flow or check valves be installed at each **cylinder.**

16 Appendices

16.1 Appendix 1 — dealing with the recovery of fluorocarbons mixed with other refrigerants

Over the past few years a number of different refrigerants and refrigerant mixtures have been used as replacements for CFCs and HCFCs. In some cases hydrocarbons and hydrocarbon mixtures have been used for this purpose.

In many instances the equipment in question may not be labelled to indicate the refrigerant used and as the operating pressures of these replacements are usually similar to those of the original refrigerant, identification in the field is extremely difficult.

Hydrocarbons or other refrigerants may have been used to 'top up' fluorocarbon refrigerant in some refrigeration or air conditioning systems.

If the presence of flammable refrigerant is suspected in a system, proper care should be taken to recover the flammable refrigerant. Only properly trained personnel using equipment designed for recovering flammable refrigerant should perform this task.

Refrigerant containing a fluorocarbon **must not** be vented to the atmosphere.

16.2 Appendix 2 – Fluorocarbon Refrigerants

A long term replacement refrigerant should have a zero Ozone Depleting Potential (ODP), and a low Global Warming Potential (GWP).

The ODP and GWP figures listed below for refrigerant blends must not be used for the purposes of reporting on the import, export and manufacture of bulk Ozone Depleting Substances and Synthetic Greenhouse Gases, or imports of pre-charged equipment under Part VII of the *Ozone Protection and Synthetic Greenhouse Gas Management Act*. For further information on these reporting requirements, please contact the Ozone and Synthetic Gas Team in the Australian Department of the Environment and Water Resources.

No:	Name:	Chemical Formula or % Mass Mixture:	O.D.P.:	G.W.P.: 100 yrs	Safety
CFCs and CFC blends:					
R11	Trichlorofluoromethane	$C.Cl_3.F$	1.00	4,600	A1
R12	Dichlorodifluoromethane	$C.Cl_2.F_2$	1.00	10,600	A1
R113	Trichlorotrifluoroethane	$C.Cl_2.F.C.Cl.F_2$	0.80	6,000	A1
R114	Dichlorotetrafluoroethane	$C.Cl.F_2.C.Cl.F_2$	1.00	9,800	A1
R500	CFC Blend	CFC-12 (74%) HFC-152a (26%)	0.60	7,900	A1
R502	CFC Blend	CFC-115 (51%) HCFC-22 (49%)	0.22	4,500	A1
HCFCs and HCFC blends:					
R22	Chlorodifluoromethane	$C.H.Cl.F_2$	0.055	1,700	A1
R123	Dichlorotrifluoroethane	$C.H.Cl_2.C.F_3$	0.020	120	A1
R124	Chlorotetrafluoroethane	$CH.F.Cl.C.F_3$	0.022	620	A1
R401A	HCFC Blend	HCFC-22 (53%) HCFC-124 (34%) HFC-152a (13%)	0.027	1,100	A1/A1
R401B	HCFC Blend	HCFC-22 (61%) HFC-124 (28%) HFC-152a (11%)	0.028	1,200	A1/A1
R401C	HCFC Blend	HCFC-22 (33%) HFC-124 (52%) HFC-152a (15%)	0.025	900	A1/A1
R402A	HCFC Blend	HCFC-22 (38%) HFC-125 (60%) HC-290(Propane) (2%)	0.013	2,700	A1/A1
R402B	HCFC Blend	HCFC-22 (60%) HFC-125 (38%) HC-290(Propane) (2%)	0.020	2,300	A1/A1
R403A	HCFC Blend	HCFC-22 (75%) HFC-218 (20%) HC-290(Propane) (5%)	0.026	3,000	A1/A1

No:	Name:	Chemical Formula or % Mass Mixture:	O.D.P.:	G.W.P.: 100 yrs	Safety
R403B	HCFC Blend	HCFC-22 (56%) HFC-218 (39%) HC-290(Propane) (5%)	0.019	4,300	A1/A1
R405A	HCFC Blend	HCFC-22 (45%) HFC-142b (5.5%) HFC-152a (7%) HFC-318 (42.5%)	0.018	5,200	A1/A1
R406A	HCFC Blend	HCFC-22 (55%) HCFC-142b (41%) HC-600a (Isobutane) (4%)	0.036	1,900	A1/A2
R408A	HCFC Blend	HCFC-22 (47%) HFC-125 (7%) HFC-143a (46%)	0.016	3,000	A1/A1
R409A	HCFC Blend	HCFC-22 (60%) HCFC-124 (25%) HCFC-142b (15%)	0.039	1,500	A1/A1
R409B	HCFC Blend	HCFC-22 (65%) HCFC-124 (25%) HCFC-142b (10%)	0.039	1,500	A1/A1
R411A	HCFC Blend	HCFC-22 (87.5%) HCFC-152a (11%) HCFC-1270 (1.5%)	0.030	1,500	A1/A2
R411B	HCFC Blend	HCFC-22 (94%) HCFC-152a (3%) HCFC-1270 (3%)	0.032	1,600	A1/A2
R412A	HCFC Blend	HCFC-22 (70%) HCFC-142b (25%) HFC-218 (5%)	0.035	2,200	A1/A2
R416A	HCFC Blend	HCFC-124 (39.5%) HCFC-134a (59%) HFC-600 (1.5%)	0.009	1,000	A1/A1
R509A	HCFC Blend	HCFC-22 (44%) HFC-218 (56%)	0.015	5,600	A1

No:	Name:	Chemical Formula or % Mass Mixture:	O.D.P.:	G.W.P.: 100 yrs	Safety
HFCs and HFC blends:					
R125	Pentafluoroethane	$C_2.H.F_5$	0.0	2,800	A1
R134a	Tetrafluoroethane	$C.F_3.C.H_2.F$	0.0	1,300	A1
R143a	Trifluoroethane	$C.F_3.C.H_3$	0.0	4,300	A2
R404A	HFC Blend	HFC-125 (44%) HFC-134a (4%) HFC-143a (52%)	0.0	3,800	A1/A1
R407A	HFC Blend	HFC-32 (20%) HFC-125 (40%) HFC-134a (40%)	0.0	2,000	A1/A1
R407B	HFC Blend	HFC-32 (10%) HFC-125 (70%) HFC-134a (20%)	0.0	2,700	A1/A1
R407C	HFC Blend	HFC-32 (23%) HFC-125 (25%) HFC-134a (52%)	0.0	1,700	A1/A1
R410A	HFC Blend	HFC-32 (50%) HFC-125 (50%)	0.0	2,000	A1/A1
R507A	HFC Blend	HFC-125 (50%) HFC-143a (50%)	0.0	3,900	A1/A1

16.3 Appendix 3 – Safety Group Classifications

Introduction

Refrigerants have been classified into safety groups according to the following criteria:

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

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

Class A signifies refrigerants with an LC50 ≥ 10,000 ppm.

Class B signifies refrigerants with an LC50 < 10,000 ppm..

Flammability Classification: Refrigerants are assigned to one of three classes, 1, 2 or 3, based on flammability. Tests have been conducted in accordance with ASTM E681-04 Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases) except that the ignition source must be an electrically activated kitchen match head for halocarbon refrigerants.

Class 1 refrigerants are non-flammable.

Class 2 refrigerants have a lower explosive limit (LEL) ≥ 3.5% volume.

Class 3 refrigerants have a lower explosive limit (LEL) < 3.5% volume.

All flammability classes are as tested in air at 101 kPa (standard atmospheric pressure) and 21°C ambient temperature.

Definitions of flammability differ depending on the purpose. For example, ammonia is classified for transportation purposes as a non-flammable gas by the U.S. Department of Transportation, but it is a Class 2 refrigerant.

Safety Classification of Refrigerant Blends: Blends whose flammability and/or toxicity characteristic may change as the composition changes during fractionation must be 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 TLV-TWA is less than 400 ppm. The TLV-TWA for a specified blend composition has been calculated from the TLV-TWA of the individual components.

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