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Designing
with Flammable Refrigerants
FACT FILE

This FACT FILE is based on AIRAH's Flammable Refrigerants Safety Guide 2026

Designers, manufacturers, importers, and suppliers, must ensure, so far as is reasonably practicable, that systems they design or supply, eliminate or minimise the health and safety risks associated with flammable refrigerants. This fact file explores the design rules to avoid safety risks for flammable refrigerant-based systems.

Safety objectives

The safety objectives for flammable refrigerants include:

- Minimise the possibility of any refrigerant leaks
- Minimise the possibility of air entering the refrigerant circuit
- Minimise the possibility of ignition of any refrigerant leaks
- Minimise the severity of the consequences of any ignition
- Integrate mitigation measures to minimise the formation of flammable mixtures
- Provide marking and information to warn of flammability hazards.

Minimising leak potential

Best practice principles to reduce the potential for refrigerant leakage include:

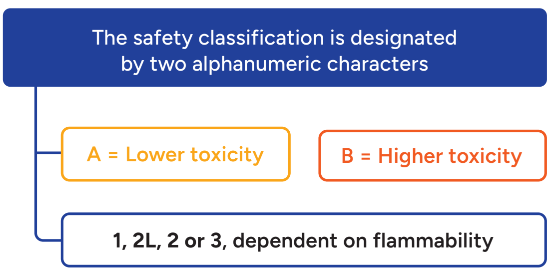
- Keep the system simple and minimise the number of joints
- Minimise the number of components
- Close-couple the system where possible
- Minimise the operating pressure
- Minimise the number of access points and locate them where they are most useful
- Ensure the system can be easily accessed for maintenance, including leak detection.

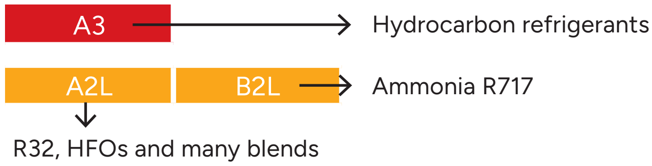
Safety standards

Standards support designers to discharge their safety duties under environmental, electrical safety and WHS/OHS legislation. AS/NZS 5149 and AS/NZS 60335 (particularly AS/NZS 60335.2.40 and AS/NZS 60335.2.89) contain detailed design guidance.

Design classifications

The AS/NZS ISO 817 system classifies refrigerants into safety groups according to health and safety risks based on flammability and toxicity. The safety group classification system is used when designing equipment, determining maximum refrigerant charge sizes and defining the applications and locations in which they can be used. The three most encountered flammable refrigerant safety groups are A3, A2L and B2L.





As part of the classification process, the refrigerant concentration limit (RCL) for each refrigerant is established by testing for toxicity, oxygen deprivation and flammability. The RCL feeds into the safety standards for systems and appliances to determine practical limits for refrigerant charge.

AS/NZS 5149 design rules

AS/NZS 5149.1 specifies system safety and environmental requirements for different refrigerant classifications based on the **occupancy classification**, the **system classification** and the **location classification**.

There are three classifications for occupation:

- **General occupancy:** Examples include public buildings such as hospitals, schools, supermarkets and restaurants
- **Supervised occupancy:** Examples include offices, laboratories and other workplaces
- **Authorised occupancy:** Examples include cold stores, dairies and non-public areas in supermarkets

There are two classifications for systems:

- **Direct releasable:** Systems where there is a direct pathway for leaked refrigerant to enter an occupied space
- **Indirect:** Systems where there is no direct pathway for leaked refrigerant to enter an occupied space

There are four location classifications:

- **Class I:** Within the occupied space
- **Class II:** Partially within the occupied space
- **Class III:** Machinery room or open air
- **Class IV:** Ventilated enclosures

Flammable refrigerant charge limits

Table A.2 of AS/NZS 5149.1 Appendix ZZ shows the flammable refrigerant charge limit for different flammability classes, as well as different occupations, systems and locations.

The charge limits of Table A.2 are capped based upon the lower flammability limit (LFL) of the refrigerant. There are three cap factors: m_1, m_2, and m_3.

$m_1 = 4m^3 \times$ LFL	$m_2 = 26m^3 \times$ LFL	$m_3 = 130m^3 \times$ LFL

Refrigerant	LFL (kg/m³)		m_1 (kg) =	m_2 (kg) =	m_3 (kg) =
R32	0.307	1.5	1.84	11.97	59.87
R1234yf	0.289	1.5	1.73	11.27	56.36
R1234ze	0.303	1.5	1.82	11.82	59.09
R717	0.116	1.5	0.70	4.52	22.62
R290	0.038	1	0.15	0.99	4.94
R600a	0.043	1	0.17	1.12	5.59

There are no room volume restrictions for systems with class 2L refrigerant charges less than or equal to $\mathbf{m_1 \times 1.5}$ or for class 2 and 3 refrigerant charges less than or equal to $\mathbf{m_1}$. For larger charges, calculate the allowable maximum charge in accordance with Formula A.4. To calculate the required minimum floor area to install a system with refrigerant charge m, in kilograms, use Formula A.5.

$$m_{max} = 2.5 \text{ x } LFL^{5/4} \text{ x } h_0 \text{ x } A^{1/2}$$

AS/NZS 5149.1 Formula A.4

$$A_{min} = \left(\frac{m}{2.5 \text{ x } LFL^{5/4} \text{ x } h_0} \right)^2$$

AS/NZS 5149.1 Formula A.5

Alternative provisions for A2L refrigerants

Where design charge limits for A2L refrigerants are exceeded for a space, the system can still comply with safety standards if special alternative provisions are made. These include ventilation (natural or mechanical), safety shut-off valves and safety alarms.

The designer can choose to calculate the "allowable refrigerant charge" using the QLMV (quantity limit with minimum ventilation) or QLAV (quantity limit with additional ventilation) values given instead of the practical limit values. Where the value is more than the QLMV but less than or equal to the QLAV value, at least one of the measures is required. Where the value exceeds the QLAV, at least two of the specified measures are required.

AS/NZS 60335.2.40 maximum allowable charge

Installation instructions for air conditioners must clearly show the minimum floor area into which the air conditioner can be installed, as per AS/NZS 60335.2.40.

The AS/NZS 60335.2.40 maximum allowable charge calculations consider variables such as the room floor area, height of the air conditioner, type of air conditioner, characteristics of the refrigerant, the level of ventilation and the application of risk mitigation devices (e.g. valves, detectors, sensors, alarms etc). These complex calculations are done by the manufacturer.

Sources of ignition

Where flammable refrigerants are used in a system, there must be no potential sources of ignition associated with or in the vicinity of the equipment. Examples include a hot surface, a spark from an electrical source, an open or naked flame, static electricity or mechanical equipment.

AS/NZS 60335.2.40 specifies how to identify and treat sources of ignition.

Materials

All materials used should be compatible with the refrigerant, lubricant and equipment, as indicated by the specifications of the refrigerant and equipment manufacturer. Designers should check the manufacturer's documentation of the system components.

AS 4343 hazard levels

AS 4343 defines five separate hazard levels: A, B, C, D and E. These are based on:

- The type of equipment
- The design pressure of the vessel
- The volume of the vessel
- Characteristics of the equipment and installation
- The contents of the vessel or system (whether it is a flammable substance or not affects the hazard level).

WHS design registration is required for hazard level A, B, C or D vessels (not for level E). WHS plant item registration is only required for hazard level A, B and C vessels (not for levels D and E). If a system is converted from an A1 refrigerant to a flammable 2L, 2 or 3 refrigerant, the hazard level classification of the pressure equipment should be checked to see if it will change to a higher level because of the conversion. This would require registering an altered plant design with the WHS regulator. It may also require plant item registration.

Pressure equipment

Under the *Work Health and Safety Regulations 2011*, pressure equipment categorised as hazard level A, B, C or D according to AS 4343 requires design registration.

An AS/NZS 5149 refrigerating system must contain a means for safely preventing or relieving over-pressure at pressures at or below the design pressure of the system. AS/NZS 5149.2 specifies which types of pressure relieving devices are permitted for particular system types. To determine which specific requirements apply, categorise the assembly into one of four AS/NZS 5149.2 risk categories I, II, III, or IV depending on:

- The GHS classification of the refrigerant
- The phase of refrigerant in the assembly (gas/liquid)
- The maximum allowable pressure (PS)
- The volume of the vessel or diameter of pipe/fitting.

Maximum allowable pressure (PS)

The system designer determines the maximum allowable pressure (PS) in the different parts of the system by calculation and/or testing, considering the maximum ambient temperature for the installation site, the potential for build-up of non-condensable gases in the system, the system application characteristics and the method used for defrosting. PS is equivalent to the saturated refrigerant pressure at the specified temperature. PS can be determined either by calculation verified by testing or by calculation using the default minimum temperatures from AS/NZS 5149.2 Table 2.

The maximum allowable pressure (PS) for the high- and low-pressure sides of the system must be stated on the system or appliance identification plate.

Refrigerant gas detection

When the allowable charge specified in AS/NZS 5149.1 can be exceeded for the installation, appropriate refrigerant detectors must be provided. This can commonly occur in plantrooms. Detectors must at least actuate an alarm and start emergency mechanical ventilation. They must be protected to prevent tampering and located to allow access for checking, repair, or replacement. Refrigerant detection systems can be used to automatically:

- Initiate mechanical emergency ventilation
- Actuate audible and visual alarms
- Isolate electricity supply
- Shut down any combustion processes in the area
- Shut down the refrigerating system components such as chillers, pumps etc.

Alarms can be set at levels to provide a sequence of operation.

Minimising leak potential

Consider the following factors to minimise the leak potential of systems:

System type: Large central plant systems inherently leak more than close-coupled distributed systems. This is partly due to the onsite installation conditions and the increased number of joints in a central system.

Operating and standstill pressures: Higher pressures require even greater care in component selection, jointing, installation and leak detection.

Components specification: Components must be appropriate for the pressure, temperature, refrigerant and oil. This includes everything from Schrader valve cores to brazed plate heat exchangers and compressors. Pipe thickness must be adequate for the pressures involved.

Compressor selection: Avoid open-drive compressors where possible. If they must be used, ensure that they have shaft seals.

Accurate drawings: These should show the location of all joints and access points.

Ease of service: Joints should be accessible to enable leak detection. Access must be provided to all components that require ongoing inspection, maintenance and repair.

Jointing method: Brazed or welded joints have a lower leak potential than any type of mechanical joint. The correct jointing materials should be specified.

Pipework design and installation: Routing should minimise pipe run length and number of joints. Pipe should be clamped and supported to minimise vibration and pipe chafing.

Component installation: Many components should be wet ragged during hot works to prevent damage. Schrader valve cores should be removed during hot works. Compressors should be mounted in accordance with the manufacturer's instructions, to prevent vibration.

Pressure testing: Systems must be pressure tested for leak tightness before going into service. Allow time for tightness testing, repairs and re-testing.

High-pressure switch setting: This should be no more than 90% of the pressure relief valve (PRV) vent pressure (PS) to prevent the PRV from venting on rapid rise of pressure because the high-pressure switch does not switch the system off in time.

Maintenance: The maintenance regime specified should be appropriate for the plant type. Many systems will benefit from frequent leak inspections. Any leaks found should be repaired immediately and the system re-tested.

Appropriate operation: Cap valves, clean condensers to minimise pressure, and inspect controller set points regularly. Document service inspections in the operation and maintenance manual.

Design and application engineer training

A person that is responsible for the design of a refrigeration or air conditioning system carries a duty of care. They should be aware of the safety risks, standards and regulations involved with the design, installation and operation of any equipment intended to operate with flammable refrigerants.

Design and application engineers should complete a recognised Bachelor of Mechanical or Electrical Engineering or Diploma in Refrigeration and Air Conditioning and the appropriate units of competency (or equivalent) available through registered training organisations.

This is an extract from the ***Flammable Refrigerants Safety Guide***, 2026 edition. Developed by AIRAH, Refrigerants Australia and Refrigerant Reclaim Australia.

The *Flammable Refrigerants Safety Guide* update project is supported by the ARBS Foundation, an ARBS organisation dedicated to funding research and education initiatives that advance learning and understanding across Australia's HVAC&R and building services industries.

SCAN TO VIEW

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