

This fact sheet explores the rules for the design of A2 and A3 flammable-refrigerant-based stationary air conditioning and refrigeration systems. The content is based on the *Flammable Refrigerants Safety Guide* (the guide) as published in July 2013. Separate fact sheets cover system installation and system operation and maintenance.

Designing systems for flammable refrigerants

Refrigerant classification: Flammable refrigerants include A2 and A3 classes from AS/NZS 1677.1. Flammability group classification is based on the lower explosive limit (LEL). Different design rules apply to each type. Refrigerants classified as A2L should be treated as an A2. Unknown refrigerants should be treated as A3. See Section 3 of the guide.

System suitability: If the system is not specifically designed or converted for use with flammable refrigerants; the area is not well ventilated; or there are ignition sources in or close to the system, the application would be unsuitable for flammable refrigerants. For systems located below-ground, additional limitations apply. The overall safety objective is for any potential release of flammable refrigerant to be contained to a safe concentration. Risks are reduced by applying refrigerant charge limitations.

System conversions: Flammable A2 or A3 refrigerants are not a suitable “drop-in” replacement for non-flammable A1 refrigerants, system conversion is usually required. When converting an existing A1-refrigerant-based system to use an A2 or A3 refrigerant:

- the designer must be competent in the design rules (including to recognise when additional engineering controls are necessary)
- the converted system must comply with all applicable standards and regulations
- both the equipment and flammable refrigerant manufacturers should be contacted for their advice on the application, including on warranties. See Section 1 of the guide.

Applicable Standards: include the AS/NZS 60335 series for electrical product compliance, AS4343 for pressure equipment compliance; AS/NZS 1677.2 for system design safety compliance and AS/NZS 60079 for explosive atmospheres compliance. See Section 2 of the guide.

Refrigerant charge limitations: are the maximum amounts of flammable refrigerant allowed in a product or system. AS/NZS 60335 standards contain charge limitations for particular products and AS/NZS 1677.2 contains charge limitations for systems. Refrigerant charges are restricted according to the level of risk posed to the people in the area surrounding or using the equipment. There are two basic criteria described in AS/NZS 1677.2 to determine permissible refrigerant charge limitations:

1. The first is “allowable” charge size (in kg), which is based on the room net volume (in m³) multiplied by the practical limit (in kg/m³) for the refrigerant. Practical Limits for both A2 and A3 refrigerants are based on 20 per cent of the LEL and are listed in AS/NZS 1677.1.

2. The second is “maximum” charge size (in kg), and this refers to the absolute upper limit that the allowable charge can reach for the occupancy class. Maximum charge limits are applied to A3 refrigerants only.

It is the lower of these two values (in kg) that is the permissible refrigerant charge limit that can be contained within a system or product. It is the net volume of the space that is used when determining charge limitations.

For A2 refrigerants –
Allowable charge = room volume x practical limit

For A3 refrigerants –
Allowable charge = room volume x practical limit
≤ maximum charge

Where the refrigerant classification is in doubt, use the default A3 practical limit of 0.008kg/m³

For small consumer products (e.g. fridges and dryers) the maximum charge size is typically 150g in each separate circuit, you can have multiple systems of this type in the same area.

For air conditioners/heat pumps the maximum charge is from 1kg to 5kg depending on the application.

For motor compressors the maximum charge depends on the appliance it is installed in.

For AS/NZS 1677.2 systems the maximum charge is variable depending on the application.

For systems containing more than 0.150kg of flammable refrigerant specific conditions may apply such as:

- Charge limits related to the room occupancy and volume
- Protection by gas/leak detection
- The exclusion of all ignition sources in or around the system
- Minimum ventilation requirements.

Significant consequences may arise if you, as a designer, fail to properly address safety considerations. Further information can be found on all of these topics in the *Flammable Refrigerants Safety Guide*, available for free download from www.airah.org.au

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Occupancy category: The three categories of occupancy used to define maximum refrigerant charge are:

Category	General characteristics – rooms or parts of buildings	Typical examples
General occupancy I	Where people can sleep, or are restricted in their movement, or an uncontrolled number of people are present, or where people have access without being personally acquainted with the applicable safety precautions	Hospitals, courts, prisons, theatres, supermarkets, schools, lecture halls, public transport terminal, hotels, dwellings, restaurants
Supervised occupancy II	Where only a limited number of people can be assembled, some being necessarily acquainted with the general safety precautions of the establishment	Business or professional offices, laboratories, places for general manufacturing and where people work
Authorised occupancy III	Where only authorised persons have access, who are acquainted with general and special safety precautions of the establishment and where manufacturing, processing or storage of material or products takes place	Manufacturing facilities, (e.g. for chemicals, food, beverage, ice, ice cream), refineries, cold stores, dairies, abattoirs, non-public areas in supermarkets

Pooling risk: Some common flammable refrigerants are heavier than air and can tend to pool at floor level. This means that even with charge restrictions of 20 per cent of the LEL, flammable zones can still exist in poorly ventilated rooms. This is of special concern for installations which are occupied by sleeping or incapacitated people such as in bedrooms, nursing homes etc. For this reason, extra conditions on allowable charge limits are applied to air conditioners and heat pumps classified for use as for human comfort. Refer to Annex GG of AS/NZS 60335.2.40

Flammable atmospheres: Flammable refrigerant, when leaked to atmosphere, can form an explosive gas atmosphere. If the concentration of the flammable gas can exceed 5 per cent of the LEL then that work area must be deemed a hazardous atmosphere under the Work, Health and Safety (WHS) regulations. The requirements for hazardous areas from AS/NZS 60079.10.1 will apply and additional applicable design standards would include AS 1482 and AS/NZS 60079.14.

Sources of ignition: Where flammable refrigerants are used in a system there must be no potential sources of ignition, in or around the equipment, which could ignite any leaked refrigerant. Potential sources of ignition to consider include; a hot surface, a spark from an electrical source, a naked flame, static electricity, or even lightning. Ignition sources within and around the system need to be removed.

Pressure relief: AS/NZS 1677.2 specifies which specific types of pressure-relieving devices are permitted for different system types. Discharges must be directed into a safe place that is well ventilated.

WHS regulations: require risks to be managed where atmospheres can rise above 5 per cent of the LEL. Because the practical limit for refrigerant/system design is based on 20 per cent of the LEL the implication is that designers need to consider actioning this 5 per cent LEL criterion when designing a system for a specific occupancy within a jurisdiction that has adopted the model WHS regulations. This could include leak detection by odour or electronic sensor, or system refrigerant containment strategies. Under WHS regulations, pressure equipment categorised as hazard level A, B, C or D according to AS 4343 requires design registration.

Detection systems: AS/NZS 1677.2 Clause 4.8.2.1 requires detectors in machinery rooms where the Practical Limit of the refrigerant can be exceeded. A fixed gas detection system should be installed for any system with a maximum charge of 5kg or more. For any gas detection system, triggers to undertake specific actions should be specified. The accepted trigger criteria for action levels for gas detectors include:

- 19.5 per cent oxygen content (for human respiration)
- 5 per cent of the LEL; (for WHS regulations)
- National Exposure Standards (for community and occupational exposures)

Labelling: The attachment of class labels should be specified for both the units and the interconnecting pipework. See Section 9 of the guide.

Training: Designers should be competent in all safety aspects of flammable refrigerants. See Section 10 of the guide.

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