THE AUSTRALIAN INSTITUTE OF
REFRIGERATION, AIR CONDITIONING AND HEATING

SAFETY GUIDE

Flammable Refrigerants

Update 1 2018

AIRAH

Preface

This update to the 2013 Flammable Refrigerants Safety Guide (FRSG) has been produced by the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) in association with the Department of Environment and Energy.

The FRSG provides an overview of the key elements of safe design, installation and operation of flammable refrigerant-based systems.

This FRSG Update 1 2018 provides a summary of the main changes affecting the Flammable Refrigerant Safety Guide (FRSG), as a result of updates to Australian Standards (AS/NZS 1677 being superseded by AS/NZS ISO 817 and AS/NZS 5149 series) and changes to Regulations that impact the application of flammable refrigerants. The main technical change is the introduction of new Australian Standards AS/NZS ISO 817 and AS/NZS 5149 parts 1 to 4 in 2016 which supersede AS/NZS 1677 parts 1 and 2. The main regulation changes include the Australian HFC import phase-down commencing in 2018 and the application of the GHS classification scheme commencing in 2017 through WHS regulations.

This FRSG update 1 2018 has been produced as part of an FRSG Online awareness package, an online resource intended to improve awareness of how to best manage the health and safety risks associated with the use and management of flammable refrigerants in refrigeration and air conditioning equipment.

The FRSG online resource is designed to raise awareness and refresh and complement existing knowledge. It does NOT replace technical training on flammable refrigerants and does NOT substitute for the detailed nationally endorsed technical training (discussed in Module 8) offered by Registered Training Organisations.

All refrigeration technicians that handle flammable refrigerants must be trained to be competent in their use. Refrigeration technicians must have access to refrigeration classification standard AS/NZS ISO 817 and design standards AS/NZS 5149 (parts 1 to 4). The online resource will help refrigeration technicians and apprentices and other stakeholders understand the range of skills and knowledge required to work safely with flammable refrigerants.

Designers, installers and service providers should access the AS/NZS 5149 *Refrigerating systems and heat pumps – Safety and environmental requirements series* in order to understand the precise requirements for an individual installation.

Warning: The FRSG online resource does not substitute for the detailed nationally endorsed technical training required to safely and productively work with flammable refrigerants. Significant consequences may arise if you fail to follow appropriate design, installation or operating practices. Further information can be found on all of these topics in the *Flammable Refrigerants Safety Guide,* and a range of supporting information products, available for free download from *www.airah.org.au.*

Disclaimer

The information or advice contained in this update is intended for use only by persons who have had adequate technical training in the field. This information has been compiled as an aid only and the information or advice should be verified before it is put to use by any person. Reasonable efforts have been taken to ensure that the information or advice is accurate, reliable and accords with current standards as at the date of publication. To the maximum extent permitted by law, the Australian Institute of Refrigeration Air Conditioning and Heating Inc., its officers, employees and project partners:

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Flammable Refrigerants Safety Guide – Update 1 2018

Introduction

This update highlights the changes that have been made to flammable refrigerant safety standards and regulations since 2013. The main change is the introduction of new Australian Standards AS/NZS ISO 817 and AS/NZS 5149 parts 1 to 4 in 2016 which supersede AS/NZS 1677 parts 1 and 2. The main regulation changes include the Australian HFC import phase-down commencing in 2018 and the adoption of the GHS classification scheme in 2017.

Regulations

The *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* was amended in June 2017 to introduce a phase-down of hydrofluorocarbon (HFC) imports from 1 January 2018. The phase-down targets refrigerant global warming potential (GWP or CO_2-e) and applies to all HFCs covered by the Montreal Protocol, including refrigerant blends containing those HFCs. Hydrofluoroolefins (HFOs) are not included in the phase-down unless a HFC is part of a HFO blend, in which case the HFC component will count towards the import quota.

Australian Standards

AS/NZS ISO 817 classification contains a new 2L 'lower flammability' safety group. Flammable refrigerants now include A2L, A2, A3, B2L, B2 and B3 classes from AS/NZS ISO 817.

	Safety Group	
Higher Flammability	**A3**	**B3**
Flammable	**A2**	**B2**
Lower Flammability	**A2L**	**B2L**
No Flame Propagation	**A1**	**B1**
	Lower Toxicity	**Higher Toxicity**

The terminology of the lower flammability limit (LFL) has been adopted to replace lower explosive limit (LEL). AS/NZS 5149.1 and AS/NZS 60335.2.40 set maximum charge limits based on refrigerant charge limitation (RCL) and practical limit.

Refrigerant charge limitation (RCL) is the maximum amount of refrigerant allowed in a product or system to reduce the flammability hazards. AS/NZS 60335 annex GG contains charge limitations for appliances (e.g. heat pumps and air conditioners) and AS/NZS 5149.1 Table A.2 contains charge limits for systems. Refrigerant charges are restricted according to the level of risk posed; based on the flammability class (e.g. A2L, A2, B2L or A3), the occupancy category, the application (human comfort or other) and whether the system is above or below ground. **Practical limits**, used for simple calculations, are based on the RCL or historically established charge limitations. **Charge cap factors** m_1, m_2 and m_3 are based on the LFL.

Occupancy category

The three categories of occupancy used to define maximum refrigerant charge remain the same, but are renamed as follows:

- General occupancy a
- Supervised occupancy b
- Authorised occupancy c

Machinery rooms are considered as an *Authorised Occupancy c* in Australia.

Location Classifications

The four system location categories used to define maximum refrigerant charge are:

Class I: Refrigerant containing parts located in occupied space. (e.g. self-contained drinks cabinet)

Class II: Compressors and pressure vessels in machinery room or open air. (e.g. split system)

Class III: Refrigerant containing parts located in machinery room or open air

Class IV: Refrigerant containing parts located in ventilated enclosure

For refrigerating systems not in scope of AS/NZS 60335.2.40 or AS/NZS 60335.2.89 the flammable refrigerant charge limits must be in accordance with AS/NZS 5149.1 Table A.2.

Human comfort applications

Some common flammable refrigerants are heavier than air and can tend to pool at floor level. This means that even with charge restrictions of 20 per cent of the LFL, flammable zones can still exist in poorly ventilated rooms. This is of special concern for installations which are occupied by sleeping or incapacitated people such as in bedrooms, nursing homes etc. For this reason, extra conditions on allowable charge limits are applied to air-conditioners and heat pumps classified for use as for 'Human Comfort'. AS/NZS 5149.1 introduces the concept of a "Charge Cap Factor" m_1, m_2 or m_3 based on the LFL; for A2L - no restrictions for charges ≤ $m_1 \times 1.5$, for A2/A3 - no restrictions for charges ≤ to m_1. Otherwise

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

Where AS/NZS 5149.1 allows the use of alternative provisions for A2L refrigerants the designer can calculate allowable refrigerant charge based on the RCL and the ventilation provided. A range of system-specific conditions apply to this approach.

Odourant for refrigerants

Previously AS/NZS 1677.1 required class A3 refrigerants to be odorised, similar to the way fuel gas such as LPG is odourised. AS/NZS ISO 817 does **not require** Class A3 (or any) refrigerant to be odourised. EN and ASHRAE refrigerant standards similarly do not require addition of odorant. Manufacturers and suppliers can add an odourant to a refrigerant, but this is not a mandatory requirement. Most imported flammable refrigerant, and equipment using flammable refrigerant, do not have odourant added. Queensland legislation requires the addition of odorant to A3 refrigerant in some circumstances.

Labelling

An identification plate must show the manufacturer/installer name, model number, manufacture year, refrigerant designation/type, refrigerant charge and maximum allowable pressures for high- and low- pressure sides of the refrigerant circuit. The installing contractor who charges the system must ensure that all units containing flammable refrigerant are marked with a visible and clearly identifiable international symbol ISO 7010 W021 label. Interconnecting refrigerant pipework should be marked with a GHS Flammable Gas Symbol near valves and where walls are penetrated and every two metres where the pipework is visible or in a ceiling space or void which a person may access for maintenance or repair work.

GHS Flammable Gas symbol

ISO 7010 W021 symbol

Machinery rooms must have warning notices that unauthorized persons must not enter, and that naked lights or flames are prohibited.

Pipe work

Joints should be minimised where possible and installers should generally use brazed or permanent mechanical joints. Serviceable type joints such as flare nuts can be used for the final connection to the unit but must not otherwise be used in the occupied space or in any area where leaked refrigerant could 'pool'. Refrigerant piping must be enclosed or protected to avoid mechanical damage.

Installation checklists

The installation checklists of the FRSG are included in this update (see Appendix A). These checklists have been updated to provide the correct reference to the new safety standards as appropriate.

WHS Regulations

Require risks to be managed where atmospheres can rise above 5 per cent of the LFL in normal use. The RCL for refrigerant/system design is based on 20 per cent of the LFL however the implication is that technicians and contractors need to action this 5 per cent LFL criterion when charging or recovering refrigerant during installation or maintenance procedures. This should include creation of a temporary flammable zone and leak detection by electronic sensor prior to, during and after the work.

Detection systems

AS/NZS 5149.3 Clause 9 requires detectors where the Practical Limit of the refrigerant can be exceeded. Detectors must be refrigerant specific and located where a refrigerant leak will concentrate. Triggers to actuate alarms, shutoff valves and emergency ventilation systems in machinery rooms are specified, including:

- 19.5 per cent oxygen content (for human respiration).
- 25 per cent of the LFL of the refrigerant.
- half or less of the AS/NZS ISO 817 RCL concentration of the refrigerant.
- specific concentrations for ammonia R717.

Cylinders

Cylinders should be marked in accordance with the GHS for storage, and ADG for transport, although GHS pictograms can be substituted with ADG Class Labels where both represent the same hazard.

Safe operation and maintenance

For compliance with the AS/NZS 5149.4 standard to be claimed the people operating the system must be competent and instructed in the correct system operation procedures. Each system must have an operation logbook and be the subject of preventative maintenance procedures as specified in the system operating instructions.

Licensing

An ARCTick licence is required for any person to work with HCFC or HFC refrigerants. Specific licensing requirements for A3 refrigerants apply in Queensland.

Training

The ARC Green Scheme Accreditation recognises those refrigeration and air conditioning technicians who have up-skilled to facilitate the safe use of flammable refrigerants and technologies into the industry. Voluntary accreditations last for 2 years and are based on those refrigerants not covered by the ARCTick scheme including A3 hydrocarbons, B2L Ammonia (R717) and A2L R1234yf (for automotive air conditioning).

Summary of changes

A summary of the main changes affecting the Flammable Refrigerant Safety Guide (FRSG), as a result of updates to Australian Standards (AS/NZS 1677 being superseded by AS/NZS ISO 817 and AS/NZS 5149 series) and Regulations relating to the application of flammable refrigerants, is provided in the following Table. The clause from the FRSG is listed along with the change and an explanation or commentary.

Designers, installers and service providers should access the relevant Australian Standards in order to understand the precise requirements for an individual installation. These include:

AS/NZS ISO 817:2016 *Refrigerants—Designation and safety classification*

AS/NZS 5149 *Refrigerating systems and heat pumps—Safety and environmental requirements*

AS/NZS 5149.1:2016 Part 1: *Definitions, classification and selection criteria*
AS/NZS 5149.2:2016 Part 2: *Design, construction, testing, marking and documentation*
AS/NZS 5149.3:2016 Part 3: *Installation site*
AS/NZS 5149.4:2016 Part 4: *Operation, maintenance, repair and recovery*

AS/NZS 60335.2.40:2015 *Household and similar electrical appliances – Safety - Part 2.40 Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers*

FRSG Update 1 – Main changes summary

Summary of main standards/regulatory changes affecting the FRSG

FRSG Clause	Change	Comment
1.4 The meaning of key terms	Practical limit, Refrigerant Concentration Limit (RCL) and Refrigerant classification are now based on AS/NZS ISO 817: 2016.	**Practical limits**, used for simple calculations, are based on the RCL or historically established charge limitations.
1.4 The meaning of key terms	The terms LFL and UFL are now used to replace LEL and UEL.	**Charge cap factors** m_1, m_2 and m_3 are based on the LFL.
2.2 Acts and Regulations	The *Ozone Protection and Synthetic Greenhouse Gas Management Legislation Amendment Bill* was passed by parliament in 2017.	This amendment enabled the introduction of a **phase-down of hydrofluorocarbon (HFC)** imports from 1 January 2018.
2.6.1 Refrigeration related standards	AS/NZS 1677.1 is superseded by AS/NZS ISO 817: 2016. AS/NZS 1677.2 is superseded by AS/NZS 5149 parts 1 to 4: 2016.	**AS/NZS 5149** parts 1 and 2 cover system design and construction, part 3 covers sites and plantrooms and part 4 covers operation and maintenance.
3.1 Refrigerant classification	Refrigerant classification now based on AS/NZS ISO 817: 2016 This introduces flammability Class 2L – Lower Flammability.	Refrigerants are now classified into four **flammability groups** in AS/NZS ISO 817: 2016: Groups 1, 2L, 2 and 3. 2L is the new **lower flammability** group.
3.2 Flammability of refrigerants	AS/NZS ISO 817 now includes A2L and B2L refrigerant classifications.	**A2L** – R32, R143a, R444A, R1234yf, R1234ze(E) **B2L** - Ammonia
3.4 Odourised flammable refrigerants	AS/NZS ISO 817 does not require flammable refrigerants to be odourised.	Odourisation of A3 refrigerants may be **required in Queensland**. Most imported flammable refrigerants will not be odourised.
3.5 Safe application of flammable refrigerants	Hazardous area assessments are required for all flammable refrigerants.	In accordance with **AS/NZS 60079.10.1, AS/NZS 60079.14 and AS/NZS 1482**. AS/NZS 60079.10.1 does not apply to domestic premises.
4.2 Electrical appliance charge limitations	AS/NZS 5149 compliance is not required if the requirement is covered in the relevant AS/NZS 60335 appliance standard.	Where a requirement is different between the two standards, **the appliance standard takes precedence**.
4.3 Charge limits based on flammability classification	Charge limits for flammable refrigerants are calculated in accordance with AS/NZS 5149.1 Table A.2 or AS/NZS 60335.2.40 Annex GG, as applicable.	**For air conditioning** - a "Charge Cap Factor" m_1, m_2 or m_3 is applied; it is based on the refrigerant LFL. For A2L - no charge restrictions ≤ $m_1 \times 1.5$, for A2/A3 - no charge restrictions ≤ to m_1.
4.4 Hazardous areas – explosive gas atmosphere	Hazardous area assessments are required for all flammable refrigerants. WHS Regulations require risks to be managed where atmospheres can rise above 5 per cent of the LFL in normal use.	Technicians and contractors need to action this when charging or recovering refrigerant during installation or maintenance procedures, including the creation of a **temporary flammable zone** and leak detection prior to, during and after the work.
4.6 Maximum charge limits based on occupancy classification	The three categories of occupancy are renamed as General occupancy a, Supervised occupancy b and Authorised occupancy c. There are now four system location categories Class I, II, III, IV.	Maximum charge limits are defined in AS/NZS 5149.1 **Table A.2** places caps on A3, A2 and A2L refrigerants.
4.8 System jointing and construction standards	Apart from the final connection to the indoor unit AS/NZS 5149.2 does not allow the use of serviceable type joints such as flare nuts.	AS/NZS 60335.2.40 **does allow** the use of flare nuts where equipment is pre-charged with flammable refrigerant.
4.10 Protection against excess pressure	Protection against pressure is now covered in detail in AS/NZS 5149.2, Clause 5.2.	Refer to the **flowcharts** in Figures 1a), 1b), 1c), and 1d).
5.2 Risk Assessment	Hazardous area assessments are required for all flammable refrigerants.	Assessments should be in accordance with **AS/NZS 60079.10.1**, AS/NZS 60079.14 and AS/NZS 1482.

5.4 Fixed detection systems	Requirements for fixed refrigerant detection in plantrooms are now covered by AS/NZS 5149.3.	Detectors can activate **alarms, emergency ventilation and isolate electrical plant**, all as required by the standard.
6.1 General	Service and maintenance is covered in AS/NZS 5149.4 or the applicable AS/NZS 60335 appliance standard.	AS/NZS 5149.4 covers **refrigerating systems**; AS/NZS 60335.2.40 covers **air conditioners and heat pumps.**
6.2 AS/NZS1677.2 maintenance requirements	AS/NZS 5149.4 contains the maintenance requirements for systems (not appliances). AS/NZS 60335.2.40 specifies that the maintenance instructions should be included in the appliance manual.	Each AS/NZS 5149.4 system must have an operation logbook and be the subject of **preventative maintenance procedures** as specified in the system operating instructions.
8.3 Protective clothing	Guidance for the provision of Personal Protective Equipment (PPE) is not provided in AS/NZS 5149.4.	Guidance for the provision of Personal Protective Equipment (PPE) is provided by your **state or territory** work health and safety authority.
9.3 Marking and labelling of pipework	AS/NZS 5149.2 also requires hazard identification labels to be attached "near valves and where walls are penetrated".	Labels should be attached to the pipe and indicate the contents of the pipe, e.g. the **flammable gas symbol.**
10.2 Competent person training	The AS/NZS 5149.2 standard refers to EN 13313 *Refrigerating systems and heat pumps competence of personnel* for the competency of service personnel. The AS/NZS 5149.4 standard also requires that **companies** working in the refrigeration field shall be certified by a recognised national organization.	In Australia WHS regulations define a **competent person** as "someone who has acquired the knowledge and skills to carry out the task, through training, qualification or experience".
10.4 Flammable refrigerant training	The ARC Green Scheme Accreditation recognises those refrigeration and air conditioning technicians who have formally up-skilled to facilitate the safe use of flammable refrigerants and technologies into the industry.	Voluntary ARC Green Scheme accreditations last for 2 years and are based on qualifications with those refrigerants not covered by the ARCTick licensing scheme including; A3 hydrocarbons, B2L Ammonia (R717) and A2L R1234yf, **which are all flammable refrigerants**.
11.2 Flammable refrigerant gas cylinders	Cylinders should be marked with the United Nations Globally Harmonised System (GHS) Flammable Gas Symbol **or** the ADG Flammable Gas 2.1 Class Label (red diamond).	Under WHS regulations, the required GHS pictograms may be **substituted with the correct ADG class labels**, where both the GHS pictogram and ADG class label represent the same hazard.
Table 11.1 Gas cylinder sizes and water capacity	The GHS Flammable Gas Symbol replaces the ADG Flammable Gas 2.1 Class Label (red diamond) symbol in Table 11.1.	Australia has adopted the GHS, which commenced from **01 January 2017.** This change also applies to Table 11.2 and 11.3 and throughout the FRSG**.**
12.3 ADG gas cylinder marking and labelling	Cylinders for transport should be marked with the ADG Flammable Gas 2.1 Class Label (red diamond). Note that WHS regulations allow GHS pictograms to be substituted by the correct ADG class labels (for the same hazard)	ADG relates to vehicle placarding only (**external signage**) and it is OK to transport the contents of a goods vehicle with GHS labels and still meet ADG (once the external signage complies).

SAFETY GUIDE

Appendix A. Checklists

These checklists have been updated to provide the correct reference to the new safety standards as appropriate.

A1 High wall split system check list (updated 2018)

The following is a check list of issues that need to be addressed by the installer to install or convert a typical high wall split system air conditioner using a flammable A2L, A2 or A3 refrigerant in a domestic dwelling or in light commercial application such as a restaurant, café or small office:

High wall split system check list	Yes? No? or N/A
1. Have you received the appropriate training and are you **competent** to install or convert a high wall split system? – Refer Section 10.	
2. Conduct a **Risk Assessment** – Refer Clause 5.2: a. If the installation is to be a 'conversion' is the current system in good condition and leak tight? b. Is the owner of the system aware that it will be charged with flammable refrigerant and has the owner given permission to convert? – Refer Clause 1.3.	
3. Have you prepared an **Emergency Plan** for the work area? – Refer Section 7.	
4. Determine the **refrigerant charge limit (RCL)**: a. Refer to the appliance instruction manual which will list the minimum floor area of the room that can be served by the unit. The area of the smallest room served is used. b. Alternatively calculate the maximum mass of refrigerant charge limit in accordance with Annex GG of AS/NZS 60335.2.40 based on i. the amount of refrigerant used in the appliance, ii. the installation location, and iii. the type of ventilation of the location or of the appliance. c. Calculate m_1, m_2 and m_3 and compare these quantities with the maximum mass of refrigerant M as per Table GG.1. d. Is the system located above ground or below ground? If below ground special consideration must be given to the risk of pooling of leaked refrigerant. e. Measure the smallest room that is to be air conditioned by the system. Calculate the allowable charge (maximum mass of refrigerant) using the formula in Annex GG.	

5. Identify **potential sources of ignition** (SOI) -– Refer Clause 4.7: a. Is the split system designed and approved for flammable refrigerants? b. If the system is to be converted from non-flammable to a flammable refrigerant, can all of the SOI within the system be eliminated? c. Check for SOI in the location the system is to be installed. Do not locate the system near open fire places, gas heaters or other SOI.	
6. Does the system have any **serviceable joints** within the occupied space, excepting the final connection to the unit? These must be removed and replaced by brazed or permanent mechanical joints.	
7. Does the system have the appropriate pressure equipment **ratings and approvals** for flammable refrigerants? – Refer Clause 4.9. a. If the system is to be converted, does it have a pressure relief valve? Refer Clause 4.10.	
8. Installation of a **new** system or conversion of an **existing** system: a. Check the work area is safe and setup a '**temporary flammable zone'**, refer Clauses 6.3 and 6.4. b. Ensure you have the appropriate tools and equipment, refer Clause 6.8. c. Do you have the appropriate Personal Protective Equipment? Refer Section 8. d. If the system is a conversion, recover controlled CFC, HCFC and HFC refrigerant. Note: An ARCtick licence is required for this work. e. Apart from final connections to the unit, remove all serviceable type joints (e.g. flare joints) from the occupied space and replace with either a permanent mechanical joint or braze – refer AS/NZS 60335.2.40. f. Eliminate all potential SOI – refer Clause 4.7. g. Pressure and leak test the system. h. Commission the system and provide written operating and maintenance instructions – refer AS/NZS 60335.2.40. i. Instruct the operator on the correct operation and maintenance of the system.	
9. Marking and labelling of the system: a. Ensure that both the indoor and outdoor units are labelled with an **ISO 7010 W021 flame symbol**, refer Section 9. b. The Name Plate or Serial Plate must also be appropriately marked, refer AS/NZS 60355.2.40. c. Interconnecting pipework should also be labelled with the **GHS Flammable Gas symbol**, near valves and where walls are penetrated**,** refer Clause 9.3.	

A2 Coolroom refrigeration system check list (updated 2018)

The following is a check list of issues that need to be addressed by the installer, to install or convert a typical coolroom refrigeration system using a flammable A2L, A2 or A3 refrigerant, with a condensing unit mounted inside the occupied space of the building and a ceiling mounted evaporator, in a light commercial application such as a restaurant, fast food outlet, butchers shop or convenience store:

Coolroom refrigeration system check list	Yes? No? or N/A
1. Have you received the appropriate training and are you **competent** to install or convert a commercial refrigeration system with this refrigerant? – Refer Section 10.	
2. Conduct a **Risk Assessment** – Refer Clause 5.2: a. If the installation is to be a 'conversion' is the current system in good condition and leak tight? b. Is the owner of the system aware that it will be charged with flammable refrigerant and has the owner given permission to convert? – Refer Clause 1.3. c. Conduct a hazardous area assessment in accordance with AS/NZS 60079.10.1.	
3. Have you prepared an **Emergency Plan** for the work area as the contractor working on a flammable system? The 'sites emergency plan' will have to also be updated if it does not account for a refrigeration system that has flammable refrigerant – Refer Section 7.	
4. Determine the **refrigerant charge limit (RCL)**: a. Refer Clause 4.5, the allowable charge limit is calculated by the RCL limit for the refrigerant multiplied by the room net volume, where RCL is 20% of the LFL. This is then compared to the maximum charge limit restrictions of Table A.2 which are capped based on the LFL of refrigerant. b. Identify the 'occupancy category' a or b or c; see AS/NZS 5149.1. In this example it will be '*General Occupancy a'*, (note the inside of the coolroom is not considered as occupied space if only used for storage). c. Identify where the refrigerant containing parts will be located and determine the 'Location Classification'; I, II, III, or IV; see AS/NZS 5149.1. In this example the system is Class I: *Refrigerant containing parts located in occupied space*. d. Determine charge cap factors m_1, m_2 and m_3 and the appropriate multiplier for the refrigerant class in use (e.g. 1.5 for 2L refrigerants). e. Determine charge limits from AS/NZS 5149.1 Table A.2 using the flammability class A2L, A2 or A3 as appropriate, the occupancy category a, and the location classification I. f. For A2L there are no room volume restrictions for refrigerant charges below or equal to m_1 x 1.5, for A2 and A3 refrigerants there are no restrictions for refrigerant charges below m_1. g. If the system is using A3 refrigerant, is it located above ground or below ground? If above ground the maximum charge is 1.5 kg for 'Other applications' in General Occupancy a. If below ground, the maximum charge is 1kg and special consideration must be given to the risk of pooling of leaked refrigerant. h. Measure smallest room that has refrigerant containing parts of the system. Calculate the allowable charge using the formula – 20% x LFL x room net volume. The 'allowable' charge must not exceed the charge limits calculated above. Note: the smallest room with refrigerant containing parts may not be the coolroom. Check the volume of the space that the condensing unit is located in, unless it is mounted outdoors.	

5. Identify potential **sources of ignition** (SOI) – Refer Clause 4.7: a. Is the refrigeration system designed and approved for flammable refrigerants? b. If the system is to be converted from non-flammable to a flammable refrigerant, can all of the SOI within the system be eliminated? c. Check the location the system is to be installed in for SOI. Do not locate the system near open fire places, gas heaters or other SOI.	
6. Does the system have any **serviceable joints** within the occupied space (apart from final connections to the units) – both inside the coolroom and the condensing unit if it is located indoors? These must be removed and replaced by brazed or permanent mechanical joints – Refer Clause 4.8.	
7. Does the system have the appropriate pressure equipment **ratings and approvals** for flammable refrigerants? – Refer Clause 4.9: a. If the system is to be converted, does it have a pressure relief valve? Refer Clause 4.10.	
8. Installation of a **new** system or conversion of an **existing** system: a. Check the work area is safe and setup a '**temporary flammable zone'**, refer Clauses 6.3 and 6.4. b. Ensure you have the appropriate tools and equipment, refer Clause 6.8. c. Do you have the appropriate Personal Protective Equipment? Refer Section 8. d. If the system is a conversion, recover controlled CFC, HCFC and HFC refrigerant. • Note: An ARCtick licence is required for this work. e. Remove all serviceable type joints (e.g.: flare joints) from the occupied space (excluding final connections) and replace with either a permanent mechanical joint or braze, refer AS/NZS 5149.2. f. Eliminate all potential SOI – refer Clause 4.7. g. Pressure and leak test the system. h. Commission the system and provide written operating and maintenance instructions – refer AS/NZS 5149.4 i. Instruct the operator on the correct operation and maintenance of the system.	
9. Marking and labelling of the system: a. Ensure that both the condensing unit, the evaporator and all service access points are labelled with a '**ISO 7010:2011, W021 flame symbol**. b. The Identification Plate must also be appropriately marked, refer AS/NZS 5149.2. c. Interconnecting pipework should also be labelled with the '**GHS Flammable Gas symbol',** near valves and where walls are penetrated**,** refer Clause 9.3.	

A3 Plantroom-based refrigeration system check list (updated 2018)

The following is a check list of issues that need to be addressed by the installer, to install or convert a typical plantroom-based refrigeration system to use flammable A2L, A2 or A3 refrigerant in a commercial application:

Plantroom-based refrigeration system check list	Yes? No? or N/A
1. Have you received the appropriate training and are you **competent** to install or convert a plantroom-based refrigeration system? – Refer Section 10.	
2. Conduct a **Risk Assessment** – Refer Clause 5.2: a. If the installation is to be a 'conversion' is the current system in good condition and leak tight? b. Is the owner of the system aware that it will be charged with flammable refrigerant and has the owner given permission to convert? – Refer Clause 1.3. c. Conduct a hazardous area assessment in accordance with AS/NZS 60079.10.1.	
3. Have you prepared an **Emergency Plan** for the work area as the contractor working on a flammable system? The 'site emergency plan' will have to also be updated if it does not account for a refrigeration system that has flammable refrigerant – Refer Section 7.	
4. Determine the **refrigerant charge limit**: a. Refer Clause 4.5, the allowable charge limit is calculated by the RCL limit for the refrigerant multiplied by the room net volume, where RCL is 20% of the LFL. This is then compared to the maximum charge limit restrictions of Table A.2 which can be capped, based on the LFL or practical limit of the refrigerant. b. Identify the 'occupancy category' a or b or c; see AS/NZS 5149.1. In this example it will be *Authorised Occupancy c*. c. Identify where the refrigerant containing parts will be located and determine the 'Location Classification'; I, II, III, or IV; see AS/NZS 5149.1. In this example the system is a direct system with compressors and pressure vessels in a plantroom, and only evaporators as refrigerant containing parts located in the coolroom. (Note that neither plantroom nor coolroom is considered a "*General occupancy a*" in AS/NZS 5149.1.) d. Determine charge limits from AS/NZS 5149.1 Table A.2 using the *flammability class* A2L, A2 or A3 as appropriate, *other* applications, the *occupancy category c,* the *location classification III* and *above or below* ground, all as applicable to your installation. e. For A2L and A2 refrigerants there are no charge restrictions. For A3 refrigerants there are no restrictions for above ground plantrooms and a maximum charge limit of 1 kg for below ground plantrooms. f. Measure the smallest plantroom that has refrigerant containing parts of the system in it. g. In all cases if the practical limit for the refrigerant can be reached or exceeded in the plantroom, then the requirements of AS/NZS 5149.3 for *special machinery rooms*, including ventilation and refrigerant detection and alarm apply. h. Any piping containing flammable refrigerant passing through any areas of Occupancy Category I or II must be appropriately protected. – Refer AS/NZS 5149.2.	

5. Identify **potential sources of ignition** (SOI) – Refer Clause 4.7: a. Is the refrigeration system designed and approved for flammable refrigerants? b. If the system is to be converted from a non-flammable to a flammable refrigerant, can all of the SOI within the system be eliminated? (Including electrical equipment not verified as suitable for operation in a flammable atmosphere). c. Confirm that both the plantroom and coolroom are fitted with flammable gas detectors that will raise an alarm, initiate emergency ventilation, and cause isolation of power (apart from emergency lighting and ventilation etc). d. Confirm that any electrical equipment intended to continue operating after detection of flammable gas is suitable for operation in a flammable atmosphere. Notes: 1. Gas detectors should detect gas with the highest possible sensitivity and well before the atmosphere becomes flammable (e.g. 5% of the LFL). 2. Isolation of power includes all sources, including control systems, and must take place at a point before the power enters the room. e. Check the plantroom for SOI. Do not locate the system near gas-fired boilers or other SOI.	
6. Does the system have any **serviceable joints**, both inside the coolroom and the plantroom? If so, can they be replaced? Apart from for the final connection to the unit, the use of serviceable joints/flare joints in the internal space for flammable refrigerants is not allowed by AS/NZS 5149.2.	
7. Does the system have the appropriate pressure equipment **ratings and approvals** for flammable refrigerants? – Refer Clause 4.9: a. If the system is to be converted, does it have a pressure relief valve? – Refer Clause 4.10.	
8. Does the installation have the **appropriate ventilation** for flammable refrigerants? – Refer AS/NZS 5149.3 Clause 5. a. Does the plantroom ventilation system draw from an appropriate location? For heavier-than-air refrigerants, the extraction ventilation system should draw in at low level in the plantroom and coolroom. b. Do the ventilation system and relief valves discharge to outdoors at high level, well away from potential SOI and well away from fresh air intakes to air conditioning or ventilation systems? c. Does the ventilation system include alarms and/or cause isolation of power on loss of air flow according to the requirements of the hazardous area classification of the room? d. If the plantroom contains switchboards with ventilation fans, the switchboard ventilation air intakes should draw in fresh air from outside the plantroom.	
9. Installation of a **new** system or conversion of an **existing** system: a. Check the work area is safe and setup a '**temporary flammable zone'**, refer Clauses 6.3 and 6.4. b. Ensure you have the appropriate tools and equipment, refer Clause 6.8. c. Do you have the appropriate Personal Protective Equipment? Refer Section 8. d. If the system is a conversion, recover controlled CFC, HCFC and HFC refrigerant. Note: An ARCtick licence is required for this work. e. Remove serviceable type joints (e.g.: flare joints) as far as practical from the plantroom, coolroom and interconnecting piping, (excluding final connections) and replace with either a permanent mechanical joint, weld or braze, refer AS/NZS 5149.2. f. Eliminate all potential SOI – refer Clause 4.7. g. Pressure and leak test the system. h. Commission the system and provide written operating, maintenance and safety instructions – refer AS/NZS 5149.4. Note: Instructions include those relevant to the safeguarding systems such as the ventilation and gas detection systems, (e.g. the applicable testing and calibration protocols for the gas detection system).	

10. Marking and labelling of the system: a. Ensure that both the condensing unit and the evaporator and all service access points are labelled with an **ISO 7010:2011, W021 flame symbol**. b. The Identification Plate must also be appropriately marked, refer AS/NZS 5149.2. c. Interconnecting pipework should also be labelled with the '**GHS Flammable Gas symbol',** near valves and where walls are penetrated, refer Clause 9.3.	

A4 Checklist for emergency plans

This checklist for Emergency Plans has been reproduced from the SafeWork Australia Emergency Plans factsheet (February 2012).

http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/emergency-plans-fact-sheet

CHECKLIST—EMERGENCY PLANS	Yes	No
Responsibilities • Has someone with appropriate skills been made responsible for specific actions in an emergency, for example managing an evacuation or assigning area wardens? • Is someone responsible for making sure all workers and others in the workplace, for example contractors, customers and visitors are accounted for in an evacuation? • Do workers working alone know what to do in an emergency? • Are specific procedures in place for critical functions, for example power shut-downs?		
Emergency contact details • Are emergency contact details relevant to the types of possible threats, for example fire brigade, police and poison information centre? • Are the emergency contact details displayed at the workplace in an easily accessible location? • Are contact details updated regularly?		
Evacuations • Have all emergencies requiring an evacuation at the workplace been identified? • Has an evacuation procedure been prepared (if applicable)? • Does the procedure: - address all types of situations and hazards which may arise at the workplace - cover everyone who may be present at the workplace - allow for quick and safe evacuation when needed - clearly identify routes to safe assembly areas (consider special assistance for hearing, vision or mobility-impaired people), and - include a process for accounting for persons?		
Evacuations for a fixed workplace • Is the evacuation procedure clearly and prominently displayed at the workplace, where practicable? • Is there a mechanism, for example a siren or bell alarm for alerting staff of an emergency? If yes, is it regularly tested to ensure its effectiveness? • Is there a documented site plan that illustrates the location of fire protection equipment, emergency exits and assembly points? If yes, is it posted in key locations throughout the workplace? • Are all exits, corridors and aisles readily accessible and kept clear of obstructions? • Does the workplace have illuminated exit signs?		
Fire protection equipment • Does the workplace have appropriate fire protection equipment? Is it suitable for the types of risks at the workplace, for example foam or dry powder type extinguishers for fires that involve flammable liquids? • Is it properly maintained and regularly checked and tested by the local fire authority or fire equipment supplier? • Is the area where the equipment is stored kept clear of obstructions? • Are adequate numbers of workers trained to use fire extinguishers? Do they know what type of extinguisher to use for different types of fires?		

Extreme weather conditions • If there is a risk of extreme or dangerous weather conditions, for example bushfire, floods or storms, will the control measures be effective in these conditions? • Do emergency procedures accommodate declarations of extreme weather warnings? Examples of extreme weather warnings may include warnings such as a code red in the case of extreme bushfires or categories 3, 4 or 5 for cyclone warnings. Do declarations of extreme weather warnings in the emergency plan include matters such as: safe exit routes, for example the process for identifying and communicating roads that may be closed? • Do procedures identify the closest designated 'safe place'? • Do procedures accommodate evacuation procedures of the relevant local authorities for example the fire services, SES and police? • Do workers have access to reliable communications equipment? • Are workers trained in emergency evacuation and related procedures? • If workers travel into areas where extreme weather warnings may be declared, have appropriate policies and procedures been developed for when such declarations are made?		
Chemical safety • Are current safety data sheets available for all hazardous chemicals on site? • Are all hazardous chemicals labelled and stored in a safe manner? • Is appropriate equipment available to initially respond to a chemical incident, for example absorbent material to contain a liquid spill? • Is appropriate personal protective equipment and training provided to protect workers who are called on to deal with an unplanned chemical release?		
First aid • Has a first aid assessment been conducted? • Does the workplace have trained first aiders and suitable first aid facilities? • Are workers aware of where first aid facilities are kept and who first aiders are?		
Neighbouring businesses • Have neighbouring businesses been considered if an emergency occurs? How would they be advised of an emergency situation arises (if applicable)? • Should they be consulted about the preparation and coordination of emergency plans? • Have the risks from neighbouring businesses been considered, for example fire from restaurant/takeaway food outlets, Q fever from cattle yards or vehicle accidents on major roads?		
Post incident follow-up • Are there procedures in place to notify the relevant regulator about a notifiable incident where necessary? • Are there procedures in place to ensure the cause of the emergency is determined and action is taken to prevent a similar incident occurring again? • Are there procedures in place to ensure the welfare of workers after an emergency or an incident, for example medical treatment or trauma counselling?		
Review • Are emergency plan practice runs undertaken to assess the effectiveness of the emergency plan, for example evacuation drills? • Is someone responsible for documenting and retaining the results of emergency plan practice runs? • Is someone responsible for reviewing the emergency plan and informing workers of any revisions?		

End of FRSG Update 1 2018