THE AUSTRALIAN INSTITUTE OF
REFRIGERATION, AIR CONDITIONING AND HEATING

SAFETY GUIDE

# Flammable Refrigerants

INDUSTRY GUIDE 2013

AIRAH

SAFETY GUIDE

# Flammable Refrigerants – Safety Guide

## Preface

This is an industry guide on managing the health and safety risks associated with the safe design, manufacture, supply, installation, conversion, commissioning, operation, maintenance, decommissioning, dismantling and disposal of refrigeration and air conditioning equipment and systems that use a flammable refrigerant. This industry guide is required because of the increasing demand for flammable refrigerants due to their low-GWP characteristics. Hydrocarbon refrigerants are broadly available in Australia and various flammable synthetic fluorocarbon refrigerants are available, or are expected to be available, in the near future.

This industry guide applies to anyone who has a duty of care in the circumstances described. Like regulations, industry guides deal with particular issues and do not cover all hazards or risks which may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations, codes of practice, and industry guides exist.

## About AIRAH

The Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) is an independent, specialist, not-for-profit technical organisation providing leadership in the HVAC&R sector through collaboration, engagement and professional development.

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- Australian Institute of Refrigeration, Air conditioning and Heating (AIRAH)
- Australian Refrigeration Wholesalers Association (ARWA)
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- Climate Control Companies Association New Zealand (CCCA)
- Department of Natural Resources and Mines Qld (DNRM)
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)
- E-OZ Energy Skills Australia
- Electrical Regulatory Authorities Council (ERAC)
- Fire and Rescue NSW
- Gas Technical Regulators Committee (GTRC)
- Institute of Refrigeration Heating and Air Conditioning Engineers (IRHACE) New Zealand
- Queensland Fire and Rescue Service (QFRS)
- Road Transport and Warehouse Association (RWTA)
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## How to use this industry guide

In providing guidance, the word "should" is used in this guide to indicate a recommended course of action, while "may" is used to indicate an optional course of action. The words "shall", "must", "requires" or "mandatory" indicate a mandatory requirement that exists, through standards or regulations, and must be complied with if compliance with the guide is to be claimed.

## Acronyms used in this guide

| | |
|---|---|
| **CFC** | Chlorofluorocarbon |
| **CoP** | Code of practice |
| **DG** | Dangerous goods |
| **GWP** | Global warming potential |
| **HC** | Hydrocarbon |
| **HCFC** | Hydrochlorofluorocarbon |
| **HFC** | Hydrofluorocarbon |
| **HFO** | Hydrofluoroolefin |
| **HVAC&R** | Heating, ventilation, air conditioning and refrigeration |
| **LEL** | Lower explosive limit |
| **LFL** | Lower flammability limit |
| **OH&S** | Occupational health and safety |
| **PCBU** | Person conducting a business or undertaking |
| **SGG** | Synthetic greenhouse gas |
| **SME** | Small or medium enterprise |
| **SOI** | Source of ignition |
| **WHS** | Work health and safety |

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# 1. Scope and application

## 1.1 Introduction

Many of the refrigerants traditionally used in refrigeration and air conditioning systems in Australia have been non-flammable, non-toxic, synthetic greenhouse gases (SGGs) that have a high global warming potential (GWP). These were typically synthetic refrigerants including CFCs, HCFCs and HFCs. Due to the growing national and international concern regarding the resulting atmospheric effects of SGGs, the use of alternative low GWP refrigerants is increasing. Most of these low GWP alternative refrigerants are flammable.

The use of flammable refrigerants has increased in Australia and they are now widely used in domestic refrigerators, small integral commercial cabinets, fluid chillers and industrial refrigeration. Their use is expected to continue to grow in commercial and industrial refrigeration applications as well as commercial and residential air conditioning. This increased use of flammable refrigerants represents a significant change for the refrigeration and air conditioning industry. It is therefore critical that the flammability of alternative refrigerants be addressed by an industry guide that recognises their flammability and provides guidance on their safe use. That is the purpose of this guide.

All refrigerants are dangerous if misused or applied incorrectly. While having less impact on the environment, flammable refrigerants are significantly more easily combusted than the refrigerants traditionally used. Because of the increased flammability risk, significant consequences may arise if you, as a person conducting a business or undertaking (PCBU):

- fail to follow appropriate servicing and maintenance practices, and
- fail to follow appropriate installation or decommissioning practices, and
- fail to properly address safety considerations if converting or modifying a system where a flammable refrigerant is involved.

These failures could result in fires, damage to persons, damage to property, and legal action that is otherwise avoidable. In order for these risks to be kept as low as is reasonably practical, equipment and systems designed for use with flammable refrigerants require additional safety features, beyond that normally required when using non-flammable refrigerants.

**Flammable refrigerants (i.e. A2 or A3) are not usually a suitable drop-in replacement for non-flammable (A1) refrigerants. Conversion is usually required and any conversion that is not implemented in the correct way is deemed to be unsafe, (refer to Clause 1.3).**

Mandatory charge restrictions apply to the use of flammable refrigerants in many applications. Designers, manufacturers, importers and suppliers must ensure, so far as is reasonably practicable, that the equipment they design, manufacture, import or supply is safe, before it is introduced to the market place. Installing contractors and service technicians must ensure, so far as is reasonably practicable, that the equipment they install and service is safe.

## 1.2 Application

This guide provides practical guidance for PCBUs on how to manage health and safety risks associated with the design, manufacture, installation, commission, service, use, decommission, dismantle and disposal of refrigeration and air conditioning equipment utilising flammable refrigerants that is used, or could reasonably be expected to be used, at a workplace, in a public building, or in a residential/domestic setting.

This guide specifically applies to all stationary (while in use) refrigerating systems of all sizes, including air conditioners and heat pumps that are to be charged with flammable refrigerants with a refrigerant classification of A2 or A3 or any other refrigerant that meets the criteria to be classified as an A2 or A3 refrigerant. This guide does not cover non-stationary (while in use) applications of flammable refrigerants such as in vehicle air conditioning (cars, trucks, buses, trains, boats, aircraft) or transport refrigeration (road, rail, air, marine).

This guide does not cover the use of ammonia (NH3, R717) as a refrigerant, which is covered in a separate document, the *Victorian Code of Practice – Ammonia Refrigeration (2010)*.

This guide is not applicable to major hazard facilities, large chemical storage facilities, and large industrial plants such as natural gas liquids (NGL) extraction and liquid natural gas (LNG) processing plants. These facilities can contain large inventories of flammable hydrocarbons as refrigerants and are already covered by existing legislation and national/international standards for major hazard facilities (refer to **www.safeworkaustralia.gov.au**).

## 1.3 Converting systems and equipment

This guide applies to the use of all flammable refrigerants with an A2 or A3 classification. This guide applies to the use of flammable refrigerants in systems specifically designed for their use and to the "conversion" of equipment and systems not specifically designed for their use, including chillers and plant-room equipment.

Refrigeration and air conditioning equipment designed for use with CFCs, HCFCs or HFCs will most likely not have been designed to be used with flammable refrigerants.

These systems and equipment should not be converted to flammable refrigerants unless all of the following criteria are met:

- The technician or contractor undertaking the conversion is specifically trained to safely handle and use flammable refrigerants, in accordance with the requirements of Clause 10.6.
- The converted system complies with all current applicable standards, regulations, and this industry guide.
- The flammable refrigerant manufacturer is contacted and requested to advise on whether conversion of this kind of system is endorsed by them and with what limitations/caveats.
- The equipment manufacturer is contacted and requested to advise on whether conversion of this kind of system is endorsed by them and with what limitations/caveats, as well as any known issues with the use of flammable refrigerant in the specific model(s).

Electrical safety regulators advice on converting systems and equipment is:

1. If equipment has not been confirmed as being designed, manufactured and tested to be compliant to relevant electrical safety standards for use with the proposed refrigerant then conversion of the equipment or use of the proposed refrigerant should not occur.
2. All domestic electrical appliances must be shown to comply with the relevant electrical safety product standard for use with the proposed refrigerant.
3. For commercial and industrial situations all the equipment used, and the complete installation, shall have appropriate certification, assessment, and evidence of compliance with the applicable electrical safety standards, (refer Clause 2.4).

Common types of domestic and light commercial refrigeration and air conditioning equipment, including domestic air conditioners and refrigerators, are subject to mandatory design requirements via legally mandated standards such as the AS/NZS 60335 series for electrical compliance, and AS 4343 for pressure equipment compliance where design and plant registration is required. Compliance with these standards is mandatory for the sale, installation, modification or repair of the equipment. In practice, this means that a legal conversion of some systems from a non-flammable to a flammable refrigerant may not be technically or economically feasible (particularly domestic refrigerators and freezers).

Conversion of a system to flammable refrigerants should not be carried out unless the modifier possesses:

a) competence in the design of refrigerating equipment (competence to carry out routine service and maintenance alone is usually insufficient), and
b) knowledge of the additional or changed legal requirements which may be engaged as a result of using flammable refrigerants in the particular application, and
c) the competence to recognise when additional engineering controls are necessary and how to implement them.
d) detailed knowledge of the electrical safety standards applicable to the system.

As with any modification that deviates from the original manufacturer's instructions, the modifier is responsible for continued compliance with legislation and is obliged to inform the end user and/or owner of the system of any considerations (e.g. health and safety, changes to operating procedures) that should be considered.

NATA-accredited facilities exist for the independent testing of new or modified refrigeration and air conditioning equipment, and this is one pathway for demonstrating compliance to the relevant standards and legislation. Depending on the system other specialists may also be needed, e.g. for large systems and hazardous areas.

## 1.4 The meaning of key terms

Many alternative terms with alternative definitions are in use in different sectors of industry. For the purposes of this guide the following definitions of terms applies:

**A person conducting a business or undertaking (PCBU)** may be a PCBU whether they are in business

alone or with others (e.g. partnerships, joint ventures and unincorporated associations) and whether the business is for profit or not for profit. Persons include individuals and bodies corporate, it is a broad concept used to capture all types of modern working arrangements.

The phrase 'business or undertaking' is intended to be read broadly and covers businesses or undertakings conducted by persons including employers, principal contractors, head contractors, franchisors and the Crown.

Under the terms of the WHS Act and Regulations, and in the context of a refrigeration and air conditioning system, a PCBU with a duty of care could include the following:

- The person responsible for operating the system
- The person responsible for servicing or maintaining a system
- A person installing a system or part of a system
- A person supplying a system or part of a system
- A person designing or manufacturing a system or part of a system.

**Competent person** is a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task.

**Conversion** is the term used when changing a system from one refrigerant to another, where the new refrigerant has a higher flammability or toxicity safety group refrigerant classification than the original refrigerant, and where modifications to the system and/or the surroundings are necessary to achieve regulatory compliance (e.g. change of electrical contacts, thermal overloads and similar).

**Drop-in** is the term used when changing from one refrigerant to another, where the new refrigerant has the same flammability and toxicity safety group refrigerant classification as the original refrigerant, and only minor adjustments to the system are necessary to achieve the required performance (e.g. adjustment of the thermostatic expansion valve superheat).

**Flammable refrigerant** is any refrigerant with a refrigerant classification of A2 or A3 or any other refrigerant that meets the criteria to be classified as an A2 or A3 refrigerant.

**Lower explosive limit (LEL) [lower flammability limit (LFL)]** is the minimum concentration of the refrigerant that is capable of propagating a flame through a homogeneous mixture of refrigerant and air measured at 21°C and 101kPa.

**Practical limit** for any refrigerant is the limit of refrigerant charge in kilograms per $m^3$ of the space served and as specified by AS/NZS 1677.1. For Group A2 refrigerants, the practical limit is less than half the concentration that can lead to suffocation due to oxygen displacement, or which has narcotic or cardiac sensitisation effects after a short time, or is about 1/5 of the lower explosive limit, whichever is smaller. For Group A3 refrigerants, the practical limit is about 1/5 of the lower explosive limit.

**Primary duty of care** is a legal obligation imposed on an individual or company requiring that they exercise a reasonable standard of care while performing any acts that could foreseeably harm others.

Duty of care may be considered a formalisation of the implicit responsibilities held by an individual towards another individual within society. Duty of care statements can be found in each jurisdiction's (Commonwealth/State/Territory) current Work Health and Safety or Occupational Health and Safety Acts.

The Model Work Health and Safety Act can be found at **www.safeworkaustralia.gov.au**

These documents may also provide additional statements on the duties of employers and employees.

**Qualification** means evidence of a certain level of training, professional knowledge, skill and experience. Nationally recognised vocational education and training Australian Qualifications Framework (AQF) qualifications are provided through endorsed training packages and accredited courses containing units of competency.

**Refrigerant classification** is the AS/NZS 1677 system of classifying refrigerants into safety groups according to health and safety risks assessed on the basis of flammability and toxicity (refer Clause 3.1). The safety classification system is used when designing equipment, determining maximum refrigerant charge sizes and defining the applications and locations that they can be used in.

**Units of competency** are nationally agreed statements of the skills and knowledge required for effective performance in a particular job or job function.

**Upper explosive limit (UEL) [upper flammability limit (UFL)]** is the maximum concentration of the refrigerant that is capable of propagating a flame through a homogeneous mixture of refrigerant and air measured at 21°C and 101kPa.

## 1.5 Who has flammable refrigerant health and safety duties?

A PCBU has the primary duty to ensure, so far as is reasonably practicable, that workers and other people are not exposed to health and safety risks arising from the business or undertaking.

This duty requires the person to manage risks by eliminating health and safety risks so far as is reasonably practicable, and if it is not reasonably practicable to eliminate the risks, by minimising those risks so far as is reasonably practicable.

The WHS Act places duties on PCBUs who carry out the following activities associated with work or workplaces:

- Section 20 – management or control of a workplace
- Section 21 – management or control of fixtures, fittings or plant at a workplace
- Sections 22-25 – design, manufacture, import or supply of plant, structures or substances that are, or could be used at a workplace
- Section 26 – install, construct or commission plant or structures that are, or could be used at a workplace

A PCBU who manages or controls refrigeration or air conditioning plant at a workplace must ensure, so far as is reasonably practicable, that flammable refrigerant-based systems eliminate or minimise the risks, to the health and safety of a person, associated with flammable refrigerants.

**Designers, manufacturers, importers, suppliers and installers of plant** must ensure, so far as is reasonably practicable, that flammable refrigerant-based systems or plant they design, manufacture, import, or supply, eliminate or minimise the risks, to the health and safety of a person, associated with flammable refrigerants. This duty includes meeting the relevant standards, carrying out testing and analysis as well as providing specific information about the plant.

**Designers, manufacturers, importers, suppliers, and installers of flammable refrigerants** must ensure, so far as is reasonably practicable, that flammable refrigerants they design, manufacture, import, supply, or install, eliminate or minimise the risks, to the health and safety of a person, associated with flammable refrigerants. This duty includes carrying out testing and analysis as well as providing specific information about the refrigerant.

**Suppliers of flammable refrigerants** must ensure that the purchaser(s) have received adequate information to ensure that the product is without risks to health and safety when used for the purpose for which it was manufactured. This will include information necessary to enable them to store, transport, handle and use the refrigerant safely during installation and in its intended end use. It is highly recommended that suppliers make purchaser(s) aware of the existence of training courses and educational material. In the case of R-32, an ARCtick licence is required to purchase that refrigerant.

**Officers**, such as company directors, have a duty to exercise due diligence to ensure the business or undertaking complies with the WHS Act and Regulations. This includes taking reasonable steps to ensure the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks associated with flammable refrigerants.

**Workers** have a duty to take reasonable care for their own health and safety and to not adversely affect other people's health and safety. Workers must co-operate with reasonable policies or procedures relating to health and safety at the workplace and comply, so far as they are reasonably able, with reasonable instructions.

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# 2. Legislative framework

## 2.1 General

This section provides a list of regulations, codes and standards that apply to flammable refrigerants.

Laws and regulations, Standards, codes, guidelines and certification schemes are continuously under review, and are revised and updated from time to time. For example, Australian Standards are amended and revised over time, and interpretations or amendments are occasionally issued by Standards Australia. It is essential that users of this guide have the latest updates available and are aware of all relevant changes contained in the latest update. New and amended regulations also often have a "bedding in" period so the date of enforcement of a regulation is an important aspect to consider.

At the time of publication, the information contained in this section was believed to be current and correct. Users of this guide must ensure that they check all of the information provided, particularly in regard to regulations and Australian Standards for any updates, changes or amendments that may have occurred since that time.

## 2.2 Acts and regulations

An act sets out general duties of care applying to employers, employees, self-employed persons, occupiers, designers, manufacturers, importers and suppliers. The act enables regulations to be made in relation to the safety, health and welfare of people at work.

Regulations set out specific duties of care applying to employers, employees, self-employed persons, occupiers, designers, manufacturers, importers and suppliers.

Some states have adopted national model WHS legislation and some have retained their own legislation. For the states and territories who now use or will use harmonised Work Health and Safety (WHS) legislation instead of their previous OH&S laws and the states who have retained their own legislation, refer to Table 2.1.

### Table 2.1 WHS legislation or OH&S laws by jurisdiction

| State or Territory | Applicable Legislation |
|---|---|
| Australian Capital Territory | Work Health and Safety Act |
| Commonwealth of Australia | Work Health and Safety Act |
| New South Wales | Work Health and Safety Act |
| Northern Territory | Work Health and Safety Act |
| Queensland | Work Health and Safety Act |
| South Australia | Work Health and Safety Act<br>Note: Still to be passed by Parliament |
| Tasmania | Work Health and Safety Act |
| Victoria | Occupational Health & Safety Act (2004) and Regulations (2007) |
| Western Australia | Occupational Safety & Health Act (1984) and Regulations (1996) |

The acts and regulations that must be complied with are set out below for each state and territory of Australia.

### 2.2.1 ACT legislation

*Work Health and Safety Act 2011 (WHS Act)*

*Work Health and Safety Regulation 2011 (WHS Regulation)*

**www.legislation.act.gov.au**

### 2.2.2 NSW legislation

*Work Health and Safety Act 2011 (WHS Act)*

*Work Health and Safety Regulation 2011 (WHS Regulation)*

*Electricity (Consumer Safety) Regulation 2006*

**www.legislation.nsw.gov.au**

### 2.2.3 NT legislation

*Work Health and Safety Act 2011 (WHS Act)*

*Work Health and Safety Regulation 2011 (WHS Regulation)*

**dcm.nt.gov.au**

### 2.2.4 QLD legislation

*Work Health and Safety Act 2011 (WHS Act)*

*Work Health and Safety Regulation 2011 (WHS Regulation)*

*Petroleum and Gas (Production and Safety) Act 2004*

*Petroleum and Gas (Production and Safety) Regulations 2004*

*Hydrocarbon Refrigerant Licensing*

*Electrical Safety Act 2002*

*Electrical Safety Regulation 2002*

**www.legislation.qld.gov.au**

### 2.2.5 SA legislation

*Work Health and Safety Act 2012 (WHS Act)*

*Work Health and Safety Regulations 2012 (WHS Regulation)*

*Electricity Act 1996*

*Energy Products (Safety and Efficiency) Act 2000*

**www.legislation.sa.gov.au**

### 2.2.6 TAS legislation

*Work Health and Safety Act 2012 (WHS Act)*

*Work Health and Safety Regulations 2012 (WHS Regulation)*

**www.thelaw.tas.gov.au**

### 2.2.7 VIC legislation

*Occupational Health & Safety Act 2004*

*Occupational Health & Safety Regulations 2007*

*Dangerous Goods Act 1985*

*Dangerous Goods (Storage & Handling) Regulations 2012*

*Dangerous Goods (Transport by Road or Rail) Regulations 2008*

*Electricity Safety (Equipment) Regulations 2009, S.R. No 36/2009*

**www.legislation.vic.gov.au**

### 2.2.8 WA legislation

*Occupational Safety and Health Act 1984*

*Occupational Safety and Health Regulations 1996*

*Dangerous Goods Safety Act 2004*

*Dangerous Goods Safety Regulations 2007*

*Electricity Act 1945*

**www.slp.wa.gov.au**

## 2.3 Queensland regulations for hydrocarbon refrigerants

### 2.3.1 Licensing and approvals

In Queensland, the use of hydrocarbon refrigerants is regulated under the *Petroleum and Gas (Production and Safety) Act 2004* **www.legislation.qld.gov.au.** This includes approval of the refrigerating device and licence to undertake gas work on the refrigeration device.

- A device that uses hydrocarbon refrigerants is a Type B gas device and is required to be approved before it is sold, installed or used. An appliance such as a refrigerator or an air conditioner that uses hydrocarbon refrigerants, e.g. R600, must be approved by a recognised Type B approving authority **www.mines.industry.qld.gov.au** or the Chief Inspector Petroleum and Gas, before it is sold, installed or used in Queensland.
- Anyone installing, removing, altering, repairing, servicing, testing or certifying the gas system of a device (i.e. charging, discharging or breaking into the refrigeration system that uses hydrocarbon refrigerants) must hold a gas work licence (hydrocarbon refrigerants) to do so.

Full details of how to make an application for a licence are provided in the gas work licence notes 2011 **www.mines.industry.qld.gov.au**, part two. The application must be made on the approved gas work licence (hydrocarbon refrigerants) application form **www.mines.industry.qld.gov.au**

### 2.3.2 Unodourised flammable refrigerants

*Section 628 of the Petroleum and Gas (Production and Safety) Act 2004* requires that fuel gas must be odourised unless the supply is to an industrial installation with appropriate gas detectors and shut-down systems, and a risk analysis has been carried out by an appropriately qualified person showing the supply is safe. The term "appropriately qualified person" is defined in Section 628 as being a person who:

(a) is independent of the person supplying the fuel gas; and

(b) the chief inspector considers:

(i) is appropriately qualified; and

(ii) has access to information to carry out the risk analysis.

A number of organisations have submitted evidence to the Chief Inspector and are currently considered by the Chief Inspector to be appropriately qualified persons **www.mines.industry.qld.gov.au**. Other persons who wish to qualify as an appropriately qualified person should submit relevant evidence for the Chief Inspector's consideration.

**Note:** The Chief Inspector Petroleum and Gas has determined that Queensland regulations will require hydrocarbon refrigerant to be odourised in any system that contains more than a 150g of refrigerant charge.

Guidelines for the use of unodourised gas (guidelines **www.mines.industry.qld.gov.au**) are provided to assist those conducting risk analyses or organisations wishing to use unodourised gas in meeting risk criteria.

## 2.4 Electrical safety regulations

Current state electrical safety regulations prescribe the minimum standards of safety for electrical equipment. The Australian and New Zealand Standard AS/NZS 3820 is called up in all of the state electrical regulations, and this Standard defines the essential safety requirements for low-voltage electrical equipment. Compliance to this Standard is mandatory under the regulations, and can be demonstrated by compliance to the relevant product standards. The AS/NZS 60335 series of Standards is listed in Appendix B of AS/NZS 3820 as being representative of suitable product safety standards.

In addition to the product safety standards, the requirements of AS/NZS 3000 apply to all installations and to the detail design of all systems built on site. AS/NZS 3000 also requires compliance with AS/NZS 60079.10.1 and AS/NZS 60079.14 for any installations involving the use of a flammable gas that may require Hazardous Area Classification.

There is a new Electrical Equipment Safety System (EESS) that is being adopted by all states and territories except NSW. This means that all suppliers of "in-scope" electrical equipment mentioned in this guide will have to register as a responsible suppliers on the EESS database and make a declaration that the electrical equipment offered for supply is electrically safe and complies with the relevant electrical safety standards.

It is important to note that if a modification is made to an electrical product, such as the use of a different refrigerant during the recharging process, it is the person that makes the modification that then must take responsibility for the electrical safety of the appliance. For example, if a flammable refrigerant (A2 or A3) is used in an electrical product designed for a non-flammable refrigerant (A1) then the electrical product may become non-compliant with the product standard. As with any modification, the modifier is responsible for this non-compliance.

Electrical safety regulators would treat this level of modification as creating a new electrical appliance, which would require, for "in-scope" electrical equipment, the modifier to be a registered responsible supplier; if it is Level two or Level 3 equipment, to register the equipment; to have certification, if Level 3 equipment; compliance folder if Level 2 equipment; or evidence of compliance to the relevant electrical safety standard if Level 1 equipment (i.e. the modifier has become the equipment manufacturer).

Further information on electrical safety regulations and product compliance can be found at the ERAC website: **www.erac.gov.au**

## 2.5 Codes of practice

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS Act, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks that may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS Act and Regulations. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

Compliance with the WHS Act and Regulations may be achieved by following another method, such as a technical or an industry standard, if it provides an equivalent or higher standard of work health and safety than the code.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice.

For further information on the codes of practice that have been approved by SafeWork Australia visit **www.safeworkaustralia.gov.au**

## 2.6 Australian Standards

Standards Australia develops Australian Standards through an open process of consultation and consensus. Committees of experts from industry, government, consumers and other interests prepare standards that reflect the latest scientific and industry experience.

Australian Standards are kept under continuous review after publication and are updated regularly.

Standards (and this guide) play an important role in helping PCBUs, as well as designers, manufacturers, and installers of plant, to discharge their safety duties under the various WHS/OH&S Acts and regulations. While this guide is limited to fundamental safety requirements and does not purport to provide detailed design guidance, such detailed design guidance can be found in relevant Australian Standards. Referring to Australian Standards will further assist duty holders to gain knowledge about a hazard or risk, and any ways to eliminate or control the risks of flammable refrigerants so far as is reasonably practicable.

This section provides a list of the main Australian Standards that apply to flammable refrigerants, including standards on refrigeration, handling, storage, electrical safety and explosive atmospheres. In all cases it is the latest edition of the standard (including any amendments) that shall be applied.

### 2.6.1 Refrigeration related standards

- AS/NZS 1677.1 – Refrigeration systems, part 1: Refrigerant classification
- AS/NZS 1677.2 – Refrigeration systems, part 2: Safety requirements
- AS 4211.3 – Gas recovery or combined recovery and recycling equipment – Fluorocarbon refrigerants from commercial/domestic refrigeration and air conditioning systems (Note that this standard does not cover equipment for use with flammable refrigerants).

### 2.6.2 Handling and storage standards

- AS 1216 – Class labels for dangerous goods
- AS/NZS 1596 – The storage and handling of LP gas
- AS 2030.1 – Gas cylinders – General requirements
- AS 2931 – Selection and use of emergency procedure guides for the transport of dangerous goods
- AS 4332 – The storage and handling of gases in cylinders
- AS 4484 – Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour coding.

### 2.6.3 Product safety standards

- AS/NZS 60335.1 – Household and Similar Electrical Appliances – Safety – General requirements
- AS/NZS 60335.2.11 – Particular requirements for tumble dryers
- AS/NZS 60335.2.24 – Particular requirements for refrigerating appliances, ice cream appliances and ice makers
- AS/NZS 60335.2.34 – Particular requirements for motor compressors
- AS/NZS 60335.2.40 – Particular requirements for electrical heat pumps, air conditioners and dehumidifiers
- AS/NZS 60335.2.75 – Particular requirements for commercial dispensing appliances and vending machines
- AS/NZS 60335.2.89 – Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor

### 2.6.4 Pressure equipment standards

- AS 4343 – Pressure equipment – Hazard levels

### 2.6.5 Electrical installation and related safety standards

- AS 1482 – Electrical equipment for explosive atmospheres – Protection by ventilation – Type of protection v
- AS/NZS 3000 – Electrical installations (known as the Australian/New Zealand Wiring Rules)
- AS/NZS 4761.1 – Competencies for working with electrical equipment for hazardous areas (EEHA) – Competency standards
- AS/NZS 60079.10.1 – Explosive atmospheres – Classification of areas – Explosive gas atmospheres
- AS/NZS 60079.14 – Explosive atmospheres – Electrical installations design, selection and erection
- AS/NZS 60079.17 – Explosive atmospheres – Electrical installations inspection and maintenance
- AS/NZS 60079.29.2 – Explosive Atmospheres – Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen.

For further information on Australian Standards visit Standards Australia website: **www.standards.com.au** or **SAI Global**.

## 2.7 ARCtick licensing

Under the *Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995*, a "refrigerant trading authorisation" is required when a business or individual wishes to acquire, possess or dispose of CFC, HCFC and HFC refrigerant. A refrigerant trading authorisation is subject to conditions and auditing processes designed to minimise the risk of emissions while the refrigerant is in the business or individual's possession.

Also, anyone wanting to install, service, or repair an air conditioner, or any other piece of refrigeration and air conditioning equipment containing refrigerants covered by the *Ozone Protection and Synthetic Greenhouse Gas Management legislation*, must be a licensed technician under the regulations. The holder of a refrigerant handling licence is an individual who is qualified in their field of activity and has met the licensing requirements under the regulations.

This licensing regime applies for systems designed to operate on CFC, HCFC and HFC refrigerants. Therefore, a current refrigerant handling licence is required when converting a system containing CFC, HCFC and HFC refrigerants to a flammable refrigerant.

For further information on ARCtick licensing visit the Australian Refrigeration Council: **www.arctick.org**

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# 3. Classification and application of flammable refrigerants

## 3.1 Refrigerant classification

Refrigerants are classified based on their flammability (1, 2 or 3) and toxicity (A or B) characteristics in accordance with AS/NZS 1677.1. This Standard designates refrigerant numbers and is based on and technically equivalent to ISO 817. The method and parameters of classification are determined on the basis of health and safety, consistent with international, USA and European practice, primarily based on flammability and toxicity.

Refrigerants are classified into three flammability groups in AS/NZS 1677.1:

- **Group 1** Non flammable.
- **Group 2** LEL ≥ 3.5% volume.
- **Group 3** LEL < 3.5% volume.

LEL is the lower explosive limit, the minimum concentration of the refrigerant that is capable of propagating a flame through a homogeneous mixture of refrigerant and air measured at 21°C and 101kPa.

**Note:** ASHRAE standards have included an optional 2L subclass to the existing Class 2 flammability classification, signifying class 2 refrigerants with a burning velocity less than or equal to 10 cm/s. For the purposes of this guide a refrigerant with an A2L classification should be treated as an A2 classification.

Refrigerants are also classified into two toxicity groups in AS/NZS 1677.1:

- **Group A** LC50 ≥ 10 000 parts per million.
- **Group B** LC50 < 10 000 parts per million.

LC50 is the lethal concentration expected to cause the death of 50% of the entire defined experimental (rat) population. It is the calculated concentration of the substance in air for an exposure time of four hours.

Using this system, refrigerant classifications consist of two alphanumeric characters (e.g. A2 or B1). The capital letter indicates the toxicity and the numeral denotes the flammability. The refrigerant classification system is used when designing equipment, determining maximum charge sizes and identifying the applications and locations that they can be used in.

**Note:** Irrespective of the classification, all refrigerants should be treated as potentially toxic at low concentrations, and are a powerful asphyxiant as they can displace oxygen.

AS/NZS 1677.1 does not include some refrigerants that have come to market after its publication. As the classification methodology is very similar, the ASHRAE 34 Standard can be consulted to assist with determining the classification and designation of refrigerants that are not listed in AS/NZS 1677.1. Where there is doubt under which group a refrigerant is required to be classified, it must be classified in the group requiring the most stringent precautions.

**Note:** For transport and storage a different classification system is applied, according to the Australian Dangerous Goods Code, see additional explanation in Section 12 of this guide.

## Table 3.1 Flammability properties for Group A refrigerants

| Refrigerant classification | Lower flammability level, % in air by volume | Heat of combustion, kJ/kg | Flame propagation |
|---|---|---|---|
| **A1** Non-flammable | N/A | N/A | No flame propagation when tested at 60° and 101.3kPa |
| **A2** Lower flammability | ≥ 3.5 | < 19,000 | Exhibit flame propagation when tested at 60°C and 101.3kPa |
| **A3** Higher flammability | < 3.5 | ≥ 19,000 | Exhibit flame propagation when tested at 60°C and 101.3kPa |

**Note:** The heat of combustion and flame propagation data provided in Table 3.1 is reproduced from ASHRAE 34.

# 3.2 Flammability of refrigerants

For the purposes of this guide, Table 3.1 defines the properties for assigning refrigerant flammability in accordance with AS/NZS 1677.1. Any refrigerant that does not have a refrigerant classification assigned to it and that meets the criteria to be classified as a flammable refrigerant (Group 2 or 3), shall be treated as such.

**Note:** An additional sub-group within the A2 classification is currently proposed for a future revision to ISO 817. This sub-group is referred to as A2L and would include the new hydrofluoroolefins (HFO) refrigerants under development such as R1234yf. R32 would also be placed in this new sub-group. Until such time as this sub-group is recognised in Australian Standards, refrigerants found bearing the A2L classification should be treated as an A2 refrigerant.

**If there is any doubt as to the classification to apply to a refrigerant not listed in AS/NZS 1677.1, is it recommended to treat the refrigerant as though it were an A3 refrigerant.**

# 3.3 Limit on flammable refrigerant charges

The charge limits for flammable refrigerants are restricted according to the level of risk they pose to the occupants or people using the refrigeration equipment or in the surrounding area, see Section 4 of this guide. This level of risk increases when the occupants:

- Are unskilled or untrained on the safety aspects of the equipment
- Are sleeping or incapacitated
- Might introduce an ignition source into an area which has potentially leaked flammable refrigerant.

# 3.4 Odourised flammable refrigerants

Fuel gases such as LPG (hydrocarbon gas) used in barbeques and the natural gas used in cooking and heating equipment must have an "odourant" added so that it can be smelled in the event of a leak and the area evacuated. AS/NZS 1677.1 requires all A3 refrigerants to be odourised in a manner functionally equivalent to LPG, i.e. an odour which is distinctive and of an intensity which indicates the presence of gas down to 20% of the lower flammability limit.

Not all flammable refrigerants may have odourant added or, if they do, materials and components used in the refrigeration or air conditioning system may react with the odourant over time, causing odourant fade. This means that in the advent of a leak, the flammable refrigerant may not be smelled by people in the vicinity. This is one of the reasons why maximum charge limits are applied to flammable refrigerants, to minimise the risks according to the application.

Some jurisdictions may not accept the use of unodourised flammable refrigerant for service personnel. The use of unodourised gas imposes a considerable risk to the safety of personnel and public during transport to the site, during system installation and during ongoing maintenance interventions. It is noted that refrigerant odourant may fade over time but the initial refrigerant charge and any refrigerant used for recharging should be odourised. Special arrangements need to be made for the handling, storage and transport of recovered refrigerant that has lost its odourant.

**Note:** Refer to Clause 2.3.2 for specific requirements relating to the use of unodourised hydrocarbon refrigerant in Queensland.

## 3.5 Safe application of flammable refrigerants

Not all refrigeration and air conditioning system types and applications are suitable for flammable refrigerants. For some system types flammable refrigerants are acceptable, whereas for other system types, they should never be used. In all cases, prevention of ignition sources and provision of adequate ventilation to disperse any gas leaks are critical safety factors. Appropriate attention to these factors must be paid in and around any system.

Any system may be unsuitable for flammable refrigerants where any of the following apply:

- The system was not specifically designed or modified for use with flammable refrigerants;
- The area is not well ventilated; or
- There are ignition sources or hot surfaces close to the system (i.e. within a region where any gas leak has not had sufficient opportunity to safely disperse).

For systems located below ground level or in poorly ventilated spaces, additional requirements and limitations apply due to the increased risk of pooling of the refrigerant in below-ground applications.

The requirements for the safe use of flammable refrigerants contained in this guide are based primarily on those detailed in the applicable Part 2 Standards of the AS/NZS 60335 series and AS/NZS 1677.2. These requirements outline – by a combination of permissible charge limitations, control of potential ignition sources and/or the provision of mechanical ventilation where applicable – the objective for any potential release of flammable refrigerant to be contained to a safe concentration.

However, system standard AS/NZS 1677.2 has been superseded in the application of these controls by other more recent Standards. Current requirements for the application of these principles can be found in these other Standards, including AS/NZS 60079.10.1, AS/NZS 60079.14 and AS/NZS 1482.

In order to guide technicians and installers, conversion/installation checklists have been provided in Appendix A to outline the issues that need to be addressed when applying flammable refrigerant based systems. Checklists are provided for the following typical applications:

- High-wall split system
- Cool room refrigeration system
- Plant-room-based refrigeration system

**Note:** The checklists in Appendix A can be used as a basic guide for system designers and manufacturers; however, access to, and a thorough working knowledge of, the Standards covered in this guide sre also required to ensure full compliance is achieved.

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# 4. Safety requirements for design and manufacture

## 4.1 The role of designers and manufacturers

This section provides information about flammable refrigerants, sources of ignition and charge-size limits with respect to the location of the refrigerating equipment. It provides a guide for the design and manufacture of refrigeration systems, plant rooms and installation sites where flammable refrigerants are to be used.

**Notes:**

1. This guide is limited to fundamental safety requirements and does not purport to provide detailed design guidance.
2. This guide is based on the assumption that refrigeration systems are designed, constructed, installed, inspected, and maintained by competent personnel.

## 4.2 Electrical appliance charge limitations

All electrical appliances in Australia and New Zealand must comply with the fundamental safety requirements and any applicable standards under state, territory and national electrical safety legislation. Many of these applicable standards contain charge limitations for flammable refrigerants. A list of the flammable refrigerant charge limits imposed by these applicable standards is provided in Table 4.1.

The product standards in Table 4.1 deal with the electrical safety of appliances. Compliance with these product standards is mandatory under the various state electrical regulations. Compliance is shown via a safety test report from an accredited testing laboratory. These product specific standards take precedence over horizontal and generic system standards covering the same subjects such as AS/NZS 1677.2.

The electrical compliance requirements of these product standards must not be confused with the electrical installation requirements of the Australian Wiring Rules as detailed in AS/NZS 3000. The Wiring Rules only apply up to the isolator or main contactor located within the appliance; they do not apply to the internal wiring or components of the appliance itself.

**Note:** The use of hydrocarbon refrigerants is regulated in Queensland, see Clause 2.3.

## 4.3 Charge limits based on flammability classification

The charge limits, or maximum amounts, of flammable refrigerants that can be included within a system are restricted according to the level of risk posed to the occupants or people in the area surrounding or using the refrigeration equipment.

In terms of permissible refrigerant charge limits that can be contained within a system, there are two basic criteria described in AS/NZS 1677.2 as follows:

1. The first is "allowable" charge size (in kg) which is based on the room size or volume (in $m^3$) and practical limit (based on the 20% of the LEL and in $kg/m^3$) for the refrigerant. Practical limits for both A2 and A3 refrigerants 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.

## Table 4.1 Charge limits from applicable standards

| Standard | Title | Application | A2/A3 Charge limits* |
|---|---|---|---|
| **Product standards** | | | |
| AS/NZS 60335.2.11 | Particular requirements for tumble dryers | Tumble dryers that use a refrigerating system incorporating sealed motor compressors for carrying out the drying process | Up to 150g of flammable refrigerant in each separate refrigerant circuit |
| AS/NZS 60335.2.24 | Particular requirements for refrigerating appliances. Ice-cream appliances and ice-makers | Domestic and similar uses. **Note:** includes caravans, camping, boating | Up to 150g of flammable refrigerant in each separate refrigerant circuit |
| AS/NZS 60335.2.40 | Particular requirements for electrical heat pumps, air conditioners and dehumidifiers | Any air conditioning and heat pump application for normal household, or used by layman in shops, light industry and farms | Up to 1kg and 5kg depending on the application |
| AS/NZS 60335.2.34 | Particular requirements for motor compressors | Motor compressors which are intended for use in household and similar appliances, excluding industrial uses | Charge limit depends on which appliance it is fitted in. |
| AS/NZS 60335.2.75 | Particular requirements for commercial dispensing appliances and vending machines | Commercial dispensing or vending machines such as cold beverage vending, ice cream and whipped cream dispensers, ice dispensers, and refrigerated merchandisers | Up to 150g of flammable refrigerant in each separate refrigerant circuit |
| AS/NZS 60335.2.89 | Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor | Refrigeration appliances used for commercial situations, e.g. refrigerated display cabinets, storage cabinets, service counters, water coolers | Up to 150g of flammable refrigerant in each separate refrigerant circuit |
| **System standards** | | | |
| AS/NZS 1677.2 | Refrigerating systems Part 2: Safety requirements for fixed applications | All refrigeration, air conditioning and heat pumps, domestic, commercial, industrial | *Variable depending on application |

***Note:** Currently A2 refrigerant charge limitations in AS/NZS1677.2 are based on practical limits with no maximum charge limits. The AS/NZS 60335 series of Standards treat A2 and A3 charge limits the same.

Flammability information is shown in Table 4.2 for some common Group A2 and A3 refrigerants. When the concentration of the flammable refrigerant in air is between the LEL/LFL and UEL/UFL, the refrigerant can be ignited. Sources of ignition include unsealed (sparking) electrical switches and naked flames. More information on ignition sources is provided in 4.6.

## Table 4.2 Flammability information for some A2 and A3 refrigerants

| R No. | Safety group | Name | Practical limit (kg/m³) | Flammability | | | | Auto ignition temperature °C |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower limit LEL/LFL | | Upper limit UEL/UFL | | |
| | | | | kg/m³ | % v/v | kg/m³ | % v/v | |
| R32 | A2 | Difluoro-methane | 0.061 | 0.306 | 14.4 | 0.710 | 33.4 | 648 |
| R600a | A3 | Isobutane | 0.008 | 0.043 | 1.7 | 0.202 | 9.7 | 530 |
| R290 | A3 | Propane | 0.008 | 0.038 | 2.1 | 0.171 | 9.6 | 450 |
| R170 | A3 | Ethane | 0.008 | 0.037 | 3.3 | 0.190 | 10.6 | 515 |
| R1270 | A3 | Propylene | 0.008 | 0.043 | 2.5 | 0.174 | 10.1 | 455 |

**Note:** The information in this table is reproduced from Table 3.1 of AS/NZS 1677.1 (1998) except for the LEL/LFL of R32, which is taken from AS/NZS 60335.2.40 (2006). The practical limit for R32 has also been recalculated using this LEL/LFL data.

When determining refrigerant charge limitations ensure that it is the "net" volume of the space that is used. For cooler/freezer rooms, net volume means the room volume after deduction of the stock volume. For example, in a cool room with a total volume of 50m³ that can be stocked up to 60% of the room volume; the maximum charge for R-290 (propane) is 20m³ x 0.008 = 0.16kg. For air conditioner units that are zoned, ensure that the smallest volume that is connected to the system is used. For example, where an air conditioner serves 300m³, but can be zoned down to 125m³, the maximum charge for R-600 (butane) is 125 x 0.008 = 1.0kg. If systems cannot be made or installed to conform to these limits then indirect systems or non-flammable refrigerants shall be used.

Blended refrigerants that have flammable constituents are being used to mimic the performance of common HCFC and HFC refrigerants such as R22, R134a and R404A. These blends are marketed under various trade names and may have flammable constituents, or be themselves classified as flammable. Refrigerant blends that do not have an ASHRAE 'R' number assigned to them should be treated as having an A3 refrigerant classification with an LEL of 0.038 kg/m³ and a practical limit value of 0.008 kg/m3.

It should be noted that there is a potential conflict between the WHS regulations requirement to manage risks where atmospheres can rise above 5% LEL and the long-term refrigeration and air conditioning industry acceptance of using 20% LEL as the basis for the Practical Limit for system design. The implication of this conflict is that PCBUs now need to consider this 5% LEL criteria when designing or installing a system for a specific occupancy within a jurisdiction that has adopted the WHS regulations.

# 4.4 Hazardous areas – explosive gas atmosphere

WHS regulations state that an atmosphere is a hazardous atmosphere if:

- *the atmosphere does not have a safe oxygen level; or*
- *the concentration of oxygen in the atmosphere increases the fire risk; or*
- *the concentration of flammable gas, vapour, mist or fumes exceeds 5% of the LEL for the gas, vapour, mist or fumes; or*
- *combustible dust is present in a quantity and form that would result in a hazardous area.*

A PCBU at a workplace must manage risks to health and safety associated with an ignition source in a hazardous atmosphere at the workplace.

Flammable gas, when leaked to atmosphere, can form an explosive gas atmosphere. If the concentration of the flammable gas can exceed 5% of the LEL then that work area must be deemed a hazardous atmosphere under the WHS regulations. In this case, the requirements for hazardous areas will apply.

The classification of hazardous areas for explosive gas atmospheres is defined under AS/NZS 60079.10.1 A hazardous area is defined as an area in which an explosive atmosphere is present, or may be expected to be present. The Standard defines three levels of hazardous area classifications – Zone 0, Zone 1 and Zone 2 – as follows:

- **Zone 0** An area in which an explosive gas atmosphere is present continuously or for long periods or frequently.
- **Zone 1** An area in which an explosive gas atmosphere is likely to occur in normal operation occasionally.
- **Zone 2** An area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, it will exists for a short period only.

Should the proposed installation result in a hazardous area classification, then additional applicable Standards would include AS 1482 and AS/NZS 60079.14.

In this guide, reference is made to a "temporary flammable zone" that arises during system installation and maintenance activities. A temporary flammable zone can be equated to a hazardous area classification of Zone 2. These are areas where at least some emission of refrigerant is anticipated to occur during the normal working procedures, such as refrigerant charging, recovery, and the like; typically where hoses may be connected or disconnected. In this case, the requirements for Zone 2 in AS/NZS 60079.14 apply.

## 4.5 Allowable charge of a flammable refrigerant

The allowable charge of a flammable refrigerant in a system represents the maximum amount that could discharge into an occupied space due to a leak, and is determined by the practical limit (in kg/m$^3$) multiplied by the net room volume (in m$^3$). The practical limit is 1/5 or 20% of the LEL of the flammable refrigerant concerned and assumes uniform dispersion. Therefore, where a room is not well ventilated or where collection of heavier-than-air gases could occur, flammable refrigerants should not be used.

When considering allowable charge limits, system designers and manufacturers should take into account both the high-pressure side and low-pressure side of the system, and their respective locations. Charge limits should be based on the net volume of the smallest room or space into which the refrigerant could escape in the event of a leak. For example, packaged systems are quite often located in small, poorly ventilated rooms. For rooms with a large part of the volume taken up by stock storage and the like, the charge limits should be based on the net volume; i.e. the volume reduced to compensate for the lost volume due to stored product, and not the gross volume (i.e. the product of the room dimensions).

When determining the allowable charge, consideration should also be given to whether a leak would result in a change of hazardous area classification around the equipment.

Small factory-sealed appliances can have a flammable refrigerant charge of up to 150g in each separate refrigerant circuit, and can be located anywhere without restriction. It is permissible to have numerous systems, with charges less than 150g, located in the same area. The basic safety premise is that in the advent of a leak of the flammable refrigerant, the probability of ignition from an external ignition source in the surrounding vicinity is very low. However, it is still prudent to locate the systems or appliances away from any known ignition sources. These small systems cannot have any potential ignition sources located within the appliance itself. Refer to the applicable specific product standards AS/NZS 60335.2.11, AS/NZS 60335.2.24, AS/NZS 60335.2.40 and AS/NZS 60335.2.89.

For individual systems with flammable refrigerant charges above 150g other specific conditions apply, such as charge limits related to the occupancy, the room volume, the requirement that no sources of ignition are within or in close proximity to the system, and/or minimum ventilation requirements. The flammable refrigerants in common use are heavier than air and can tend to pool at floor level. This means that even with charge restrictions of 20% of the LEL, flammable zones can still exist in poorly ventilated rooms. This is of special concern for installations that are occupied by humans who may be sleeping or incapacitated, such as in bedrooms and nursing homes. For this reason, extra conditions on allowable charge limits are applied to air conditioners and heat pumps that are applied for "human comfort". Refer to Annex GG of AS/NZS 60335.2.40 and Table 4.4 of this guide.

The pooling risk from leaked refrigerant in refrigerated cool rooms is lessened by the usual practice of running the evaporator fans continuously, even on the refrigeration system off-cycle. The risk can be further reduced by the system automatically doing a "pump-down cycle" whenever the refrigeration system is off or, in the case of freezer rooms, when the evaporator is in defrost mode. The liquid-line solenoid valve that controls the pump-down cycle should not be located at the evaporator inlet but outside the cool room, to minimise the risk further.

# 4.6 Maximum charge limits based on occupancy classification

The maximum charge for any refrigerant depends on the location of the refrigerant-containing parts and the occupancy category of the location. Refer to Table 4.3 for an explanation of the three occupancy categories and Table 4.4 for the maximum charge of A3 refrigerant that is allowed in each occupancy category. For A2 refrigerants the maximum charge is the practical limit multiplied by the room net volume.

**Note:** AS/NZS 1677.2 does not place any caps on the maximum charge limits for A2 refrigerants. This creates the possibility for systems to contain very large A2 refrigerant charges and still comply with that standard. Designers should be aware that large A2 charges, whether compliant with AS/NZS 1667.2 or not, may create unacceptably high risk.

## Table 4.3 AS/NZS 1677.2 Occupancy categories

| Category | General Characteristics | Examples [1] |
|---|---|---|
| General occupancy I | Rooms, parts of buildings, building where:<br>• people can sleep; or<br>• people are restricted in their movement; or<br>• an uncontrolled number of people are present or to which any person has access without being personally acquainted with the necessary safety precautions | Hospitals, courts or prisons, theatres, supermarkets, schools, lecture halls, public transport terminal, hotels, dwellings, restaurants |
| Supervised occupancy II | Rooms, parts of buildings 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 | Rooms, parts of buildings, building 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 |

***Note 1:** The list of examples is not exhaustive but shows the general characteristics for the area

## Table 4.4 AS/NZS 1677.2 and AS/NZS60335.2.40 – Maximum charge limits for A3 refrigerants

| Occupancy category | | Location classification | | | |
|---|---|---|---|---|---|
| | | Direct [1] | | Indirect [1] | |
| | | Refrigeration system or refrigerant containing parts located in occupied space | Compressors and pressure vessels in machinery room or open-air | All refrigerant containing parts located in a machinery room or open air | |
| | | | | Special machinery room | Open-air |
| I | Human comfort | According to Annex GG of AS/NZS 60335.2.40 | | 5kg Clause 2.6.2(a) | 10kg [2] Clause 2.6.2 (b) |
| | Other systems [3] | 1.5kg Clause 2.6.2 | 1.5kg Clause 2.6.2 | | |
| II | Human comfort | According to Annex GG of AS/NZS 60335.2.40 | | 10kg Clause 2.6.3 (a) | 10kg [2] Clause 2.6.3 (b) |
| | Other systems [3] | 2.5kg Clause 2.6.3 | 2.5kg Clause 2.6.3 | | |
| III | Human comfort | According to Annex GG of AS/NZS 60335.2.40 | | Unrestricted Clause 2.6.4 (c)(i) | |
| | Other systems [3] | 10kg Clause 2.6.4 (a) (i) | 25kg Clause 2.6.4 (b) (i) | | |

**Notes:**

1. For a full description of system types refer to AS/NZS 1677.2.
2. AS/NZS 1677.2 does not clearly specify whether or not areas containing refrigerating components that will not leak refrigerant (e.g. indirect vented closed "chiller" secondary loops) should be included when determining maximum charge limits. Consequently, there may be scope for such systems to contain higher charges if it can be shown that the only areas where refrigerant can leak, to generate a hazard, are occupancy Category III areas. Naturally, other requirements such as local planning and building regulations may also limit the quantities of flammable gases that can be used.
3. For "Other systems" located below ground, the maximum charge of flammable refrigerant shall be restricted to 1kg, (Clause 2.6.1 of AS/NZS 1677.2).

# 4.7 Sources of ignition

## 4.7.1 General

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 that could ignite any refrigerant that leaks from the system.

Note: Flammable materials should not be stored near or around a refrigeration system containing flammable refrigerants.

Potential sources of ignition can include:

- A hot surface
- A spark from an electrical source
- An open or naked flame
- Static electricity
- Lightning
- Mechanical equipment.

## 4.7.2 Hot surfaces

All parts of equipment should be checked to ensure that the temperature of any surface that may be exposed to leaked refrigerant cannot exceed the auto-ignition temperature of the flammable refrigerant, reduced by 100K. This temperature equates to about 350°C for many hydrocarbon refrigerants.

Condensate tray heaters and defrost heaters are prime candidates for hot surfaces within refrigeration and air conditioning equipment. Unless a maximum surface temperature is stated by the manufacturer, the temperature should be checked by testing as specified in ISO 5149 and/or the applicable AS/NZS 60335 Part 2 product safety standard.

**Note:** Some refrigerants and lubricants decompose when heated and emit toxic compounds. This means that a toxicity hazard can develop (even if ignition does not occur) as a result of refrigerant escape due to a leak or servicing procedure. Thermal decomposition usually occurs at temperatures near to the auto-ignition temperature. Consult safety data sheets (SDS) to determine the thermal decomposition characteristics and level of risk in the context of nearby surfaces that may reach these temperatures. With fluorinated refrigerants, be particularly aware of the potential for hydrogen fluoride and carbonyl halide generation.

## 4.7.3 Electrical sources of ignition

Refrigeration and air conditioning equipment using flammable refrigerant must be designed and constructed so that any leaked refrigerant will not flow or stagnate where electrical components, which could be a source of ignition, are fitted. Typical electrical components, which form part of the refrigeration system, and could be a source of ignition include:

- On/off, isolator switches or contactors
- Start relays and potential relays
- Switches – pressure, defrost, flow, oil differential, liquid level, fan delay or time
- Thermal overloads
- Fan motors
- Thermostats
- Condensate pumps
- Miniature circuit breakers
- Defrost heaters
- Condensate tray heaters
- Fan speed controller
- Programmable controllers.

Electrical equipment such as fans, heaters, electrical sockets, power outlets, motors and any other electrical equipment installed or likely to be used near systems containing flammable refrigerant should also be considered, particularly equipment mounted below the refrigeration system and at or near floor level.

According to AS/NZS 3000 all electrical equipment that could act as a source of ignition must be both selected and installed in accordance with the requirements of AS/NZS 60079.14. The classification of hazardous areas is defined in AS/NZS 60079.10.1.

Options for dealing with sources of ignition within a potentially flammable zone/hazardous area classification include the following:

1. Move the source of ignition outside the hazardous area (potentially flammable zone); or
2. Replace the source of ignition with a suitable device as noted above; or
3. Increase the uncontaminated air flow and/or maintain a permanent airflow to reduce the potentially flammable zone by applying AS 1482.

**Note:** The application of AS 1482 may also require the use of fixed gas detection equipment. Where there is a "jet" release, the use of ventilation will not eliminate a hazardous area close to any potential source of a jet. Uncontaminated air is typically drawn in from high level and discharged at low level.

## 4.7.4 Naked flame ignition sources

Refrigeration and air conditioning equipment charged with flammable refrigerant should not be installed or located in areas that have naked flames present. This can include areas with gas cook tops and ranges, gas water heaters and gas or wood-fired room or space heaters.

### 4.7.5 Static electricity and lightning

In order to avoid static electricity or lightning introducing a potential ignition source, metal structures around a system should be electrically earthed.

### 4.7.6 Mechanical equipment

Mechanical equipment may introduce other sources of ignition (e.g. sparks) that should be considered in the design of the system. Examples include:

- Static electricity from belts.
- Frictional sparking risks from different metals, including any rotating parts.

Guidance on these factors can be found in standards such as AS/NZS 60079.0, AS/NZS 60079.14 and AS 1020.

## 4.8 System jointing and construction standards

The joining of refrigerant piping and components should, where possible, use permanent mechanical joints or be brazed. The use of serviceable-type joints such as flare nuts must not be used in the occupied space or in any area where leaked refrigerant could "pool".

**Note:** Serviceable-type joints are permissible on the outside of outdoor units as long as they are in an area with good ventilation and no risk of leaked refrigerant pooling.

Refrigerant piping should be enclosed or protected to avoid mechanical damage during transport, installation and use.

## 4.9 Pressure equipment design registration and plant registration

Under WHS regulations, pressure equipment categorised as hazard level A, B, C or D according to AS 4343 require design registration. This means, in a conversion from an A1 to A2 or A3 refrigerant, it should be determined if the hazard level classification of the pressure equipment will change to a higher level as a result of the conversion, necessitating the registration of an "altered plant design". If the pressure equipment is categorised as hazard level A, B or C it may also require plant registration.

## 4.10 Protection against excess pressure

Exposure to heat (including fire) and various fault conditions may give rise to elevated pressures inside a refrigeration or air conditioning system. Therefore, the system must contain a means for safely relieving over-pressure at pressures at or below the design pressure of the system.

A pressure-relief device refers to any device designed to protect a system from overpressure, including pressure-relief valves, bursting discs and fusible plugs. AS/NZS 1677.2 specifies which types of pressure-relieving devices are permitted for particular system types.

Pressure-relief devices must be mounted on, or in proximity to, a pressure vessel or other parts of the system which require protection. They must be easily accessible and be connected above the level of liquid refrigerant.

As detailed in AS/NZS 1677.2, discharges must be directed into a safe place which is well-ventilated. Discharge vents or piping can be employed to direct discharges appropriately, taking care not to restrict the discharge flow rate. Flammable refrigerants need special considerations and they should never be discharged into an occupied or enclosed space where the allowable charge size, for the room volume, could be exceeded.

Careful consideration must be given to potential hazards which may arise in the event of a discharge. In the case of flammable refrigerants, this requires particular attention to the location of any potential sources of ignition in the area surrounding the discharge release point. A flammable concentration can occur around the relief point before the release disperses to below the LEL. Wherever practical, discharges should be directed upwards and discharge points are clearly identifiable from a safe distance, alerting persons to the potential release of flammable gases. Special care should be taken to ensure that the vented refrigerant cannot re-enter an occupied or enclosed space, pool in low areas, or enter drainage systems. Consideration should be given to the potential for accumulation of ice, dirt or debris collecting in discharge pipes and inhibiting proper functioning.

In designs where fusible plugs are permitted, the fusible plugs must not be insulated. Shut-off valves must not be fitted between the apparatus being protected and the pressure relief device. Never bypass or in any other way hinder a pressure-relief device from performing its function.

If a system is being converted from a non-flammable refrigerant to a flammable refrigerant, consideration of the pressure vessel approvals and the provision of pressure-relief valves need to be made. The hazard level classification of the pressures vessels and relief devices may not be appropriate; also the location of the pressure-relieving devices outlets may also need to be changed.

Special care also needs to be taken in the case of the conversion of small systems with vessels less than 230mm diameter that are converted from non-flammable to flammable refrigerants. These small systems designed for group A1 refrigerants typically do not have pressure-relief devices but rely on the failure of a soldered joint in case of fire. This is not acceptable for a flammable refrigerant as it could result in the sudden release of the refrigerant at an elevated pressure, potentially resulting in a vapour cloud explosion (VCE). For these small systems, the use of a suitable pressure-relief device will ensure a more controlled release of the refrigerant at a lower pressure that greatly reduces the risk of a VCE event.

**Note:** It is recommended that service providers carry their own calibrated pressure gauges because the pressure gauges fixed to the refrigerating system may become inaccurate over time (i.e. accuracy drift due wear and tear).

## 4.11 Fire service notification

It is highly recommended that the local fire service is notified of any system in their local area that is charged with 5kg or more of a flammable refrigerant. A notification form should be filled in by the installer and sent to the appropriate fire service. If the flammable refrigerant is changed, a new notification form should be sent. Similarly, if a flammable refrigerant system is decommissioned or removed, notification should be provided to the fire service advising of the change.

A typical template of a fire service notification form is provided in Appendix C.

**Note:** This recommendation may not be applicable in all jurisdictions.

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# 5. Risk assessment, controls and detection systems

## 5.1 General

This section provides some basic information on risk management and gas detection, for use by technicians, contractors and SMEs.

## 5.2 Risk assessment

Hazard identification and risk assessment enables a site to control risks associated with any product, process or plant that has the ability to cause injury or harm to people on the site.

This process can be either simple or complex, depending on the number of hazards and the association of those hazards present on the site. In some instances, a hazard identification and risk assessment flow diagram may be used. Alternatively, more complex hazards may require a WHS specialist with specific knowledge to provide assistance.

Risk assessment determines whether there is a direct risk of injury or damage to property from the identified hazards. The purpose of the risk assessment is to:

- Determine those risks that need to be controlled; and
- Assist in making decisions about the order in which risks should be controlled.

Risk management is the process of determining and implementing appropriate measures to control the risks associated with hazards and risks identified for a site. PCBUs have a duty to ensure that any risk/s associated with their premises or activities is controlled. The primary duty is to eliminate these risks. If this is not possible, the risk must be reduced as far as is practicable.

The risk management process involves the following steps:

- Establish the context – this helps to define the scope and identify key stakeholders.
- Identify hazards – find out what could cause harm.
- Assess the hazards – understand the nature of the harm that could be caused by the hazard, identify the risk factors.
- Evaluate the risks – how serious the harm could be and the likelihood of it happening, and if risk can be controlled (avoided, reduced or transferred).
- Control risks – implement the most effective control measure(s) that is reasonably practicable in the circumstances, and monitor performance.
- Review control measures to ensure they are working as planned.

The consistent, auditable recording of the reasons for decisions on risk should help in the long-term development of more effective decisions on risk.

Some of the hazards that need to be considered include:

- Chemical hazards: Safety Data Sheet (SDS) information such as flammability characteristics, toxicity, asphyxiation, for refrigerants and oils.
- Plant hazards: component failures, over-pressurisation and releases, corrosion, confinement and enclosed areas, collateral damage or impacts, thermal hazards (burns or frostbite).
- Task hazards: monitoring tasks such as visual inspections and pressure readings, maintenance tasks such as "breaking in" to a system.

- Work environment hazards: indoor versus outdoor work, enclosed areas and confined spaces, ventilation, gas transferring.

Some of the controls that could be applied to individual hazards include:

- Elimination or substitution – of the hazard for a non-hazardous alternative.
- Enclosure – of the hazard to contain the risk.
- Ignition sources – remove potential ignition sources.
- Ventilation – reduces contaminant by dilution or exhaust.
- Detection – odourisation of refrigerant, installation of fixed gas detection, use of portable gas detection.
- Information and administration – education and awareness, emergency procedures alarms.
- Charge minimisation – reducing the quantity of refrigerant required.
- Charge retention – the use of valves, receivers and automatic controls, to minimise potential leak quantities.
- Personal protective equipment – lowest on the risk control hierarchy.

A recommended assessment procedure for the use of A3 refrigerants is provided in Appendix E of AS/NZS 1677.2. A guide to the selection of electrical apparatus for hazardous (potentially explosive) areas is also provided in AS/NZS 1677.2 as Appendix D. If a more appropriate risk assessment procedure is not available, it is recommended that appendices D and E of AS/NZ S1677 be used. However, the standards and details found in appendices D and E of AS/NZS 1677 may have been superseded by subsequent versions of AS/NZS 60079.14 and AS/NZS 60079.10.1, and the details for any risk assessment of control measures should follow the later standards where they are applicable.

Further specific information and guidance relating to hazard identification, risk assessment and control processes may be obtained from the following resource documents:

- AS/NZS ISO 31000 – Risk management – Principles and guidelines
- HB 158 – Delivering assurance based on ISO 31000:2009 Risk management – Principles and guidelines
- Managing risks of hazardous chemicals in the workplace code of practice (SafeWork Australia)
- Managing the risks of plant in the workplace code of practice (Safe Work Australia)

## 5.3 Gas detection systems

Gas detection is the act of locating a gas hazard and characterising the nature of the hazard during a leak condition which may be either a toxic, asphyxiant or flammable condition. It is an activity that shows the nature of the atmosphere that workers and the public may be exposed to and supports the selection of other risk-control measures such as respiratory protection. In the context of this guide there are two common situations when detection is considered. They are:

- Under normal working conditions
- In an emergency response.

During normal working conditions, detection is intended to provide information about the presence and concentration of airborne hazards to ensure a safe environment. In particular, it provides warning in the event of a leak from the refrigeration or air conditioning system or some other change to the nature of the atmosphere.

During emergency conditions, detection is intended to identify the nature of the airborne contaminant and the extent of the hazard so the safety of any on-site response team or emergency responders (police, fire, and ambulance officers) and the community can be assured. This activity plays a crucial role during the emergency response.

Detecting gas levels over time, i.e. monitoring, is necessary to check the state of the hazard and hazardous area over time. With 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% oxygen content (for human respiration)
- 5% of the LEL; (for WHS Regulations) and
- National exposure standards (for community and occupational exposures).

For all applications, any level of gas detection should be taken as an indicator of likely dangerous conditions or situations that could quickly escalate to dangerous. Therefore, any gas level should be taken seriously and be treated with appropriate caution.

It is the workplace's obligation to ensure the detection equipment is serviceable and functioning, given its vital importance to warn workers and the community. Matters to be addressed include:

- selection and assessment
- policy and procedures
- calibration
- maintenance and servicing

- use – criteria and action levels
- review and audits.

There are two categories of gas detection systems; fixed systems and portable systems. Regardless of the system category there are basic selection factors to consider, these include:

- intrinsic safety or appropriately certified for hazardous area use
- robustness, design and construction
- operating range, selectivity, and sensitivity
- calibration, maintenance (such as mean time between failures (MTBF)) and servicing
- alarms, power requirements, and data logging
- operation.

Further detailed information on gas detection system selection, use, training and maintenance is available in AS/NZS 60079.29.2.

## 5.4 Fixed detection systems

Fixed detection systems are intended to monitor the atmosphere and provide warning about a leak or change to the composition of the atmosphere. Such systems may include oxygen detectors, flammable gas detectors and toxic gas sensors. All systems require regular servicing and operator training so that the system is maintained to ensure ongoing operability.

AS1677.2 Clause 4.8.2.1 requires detectors in machinery rooms where the practical limit can be exceeded.

It is recommended that a fixed gas detection system is installed for any system with a maximum charge of 5kg or more, and the emergency plan is reviewed accordingly. This includes any systems installed in areas such as open-air where the practical limit can be exceeded in the vicinity or where there is risk of pooling occurring in low-lying areas. A risk assessment should be undertaken for systems with a maximum charge of less than 5kg to determine if a fixed gas detection system is required.

Fixed detection systems should be installed at suitable locations that take into account the types of activities and vulnerable points of the system where leaks might be expected to occur (and affect the workforce or the public), such as around the installation or loading areas and public spaces. The ideal detector locations are also influenced by the physical and chemical properties of the airborne contaminant (the refrigerant) and the application, for example:

- The density – Is the refrigerant heavier than air?
- Any effect of ventilation on gas movement?
- The safety characteristics – Is the refrigerant toxic and/or flammable or an asphyxiant?
- The likely operating and release temperature of any leaked refrigerant?

Procedures relating to responding to an alarm from a fixed detection system, including the systems shut down procedure and occupant evacuation procedure, should be explicitly detailed in the site's emergency plan (refer Section 7).

**Note:** Some types of gas detection are of limited value in cool rooms and freezer rooms due to the condensing nature of the thermal environment. In addition, detection equipment may be based on electrochemical processes that necessitate ongoing maintenance and verification requirements, to ensure correct operation.

## 5.5 Hand-held or portable detection systems

Hand-held or portable gas detection systems are intended to be used by workers during everyday activities such as repairs, confined space entry, and also in emergency response scenarios. They are also used to inform workers of the selection of appropriate personal protective equipment (PPE) required to undertake a task.

Hand held or portable systems require regular servicing and operator training. If the facility intends to use hand-held or portable gas detectors during emergency response activities it should consider the following:

- Are there enough instruments available within the facility?
- Are staff trained and resourced to use them?
- Will the instrument detect the airborne contaminant over the entire range of measurement interest?
- Do testing procedures adequately address the range of conditions and site-specific issues associated with a release (e.g. gas layering, topographical issues, confinement, etc)?

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# 6. Service and maintenance

## 6.1 General

The section covers the maintenance and associated requirements for flammable refrigerant based refrigeration systems. This section also includes information on pre-service safety, temporary flammable zones, refrigerant recovery, refrigerant venting, refrigerant top-up, and tools and equipment.

Regular service and maintenance is essential to the safe and reliable operation of a flammable refrigerant based refrigeration system. Service and maintenance is covered in AS/NZS 1677.2 and the relevant sections of the Standard, relating to service and maintenance of stationary flammable refrigerant systems, are detailed below for reference. Specific guidance for system components may also be found in other guides, codes or Standards and such guidance should also be followed where relevant, e.g. the requirements for inspection and maintenance of electrical equipment in hazardous areas can be found in AS/NZS 60079.17.

It is generally recognised that the risk of fire or explosions is higher when systems are being worked on, compared to when they are operating normally. This is due to the fact that the possibility of a release of refrigerant and the presence of potential sources of ignition is greater during service and repair activities. The risk of ignition has been quoted as typically 100 to 1,000 times greater in these circumstances than when the equipment is not subject to human interference (Proklima, 2012). Persons working on such systems must be competent, which will include meeting specified training and licensing requirements if the jurisdiction requires it (e.g. Queensland state regulations).

Warning: All fluorinated refrigerants, when heated or combusted, release highly toxic gases including hydrofluoric acid and carbonyl halides. These compounds are toxic even at very low levels and can lead to permanent injury or death. A flammable fluorinated refrigerant fire may self-propagate, thereby resulting in higher local concentrations of these toxic compounds compared to non-flammable fluorinated refrigerants. For further information, consult Safety Data Sheets for the refrigerant, hydrogen fluoride and carbonyl halides.

## 6.2 AS/NZS1677.2 maintenance requirements

AS/NZS1677.2 includes maintenance requirements pertaining to the maintenance of systems containing flammable refrigerants. Please note the following section numbers and clauses referenced from the standard:

AS/NZS1677.2 Section 5 – Testing, inspection, documentation and marking, p38

- *Clause 5.2 – Inspection*
- *Clause 5.3 – Documentation*
- *Clause 5.4 – Marking*

AS/NZS1677.2 Section 6 – Operation and maintenance, p41

- *Clause 6.1 – Charging and discharging refrigerant*
- *Clause 6.2 – Operation and maintenance manual*
- *Clause 6.3 – Pressure equipment*

## 6.3 Pre-service safety

Before carrying out any work on a refrigerating system or associated equipment, it is essential to ensure that the immediate area is suitable for working safely – as it is deemed a temporary flammable zone – and the appropriate precautions are in place. In particular, prior to beginning work on systems containing flammable refrigerants, safety checks are necessary to ensure that the risk of ignition is minimised.

An assessment should be completed prior to any service, maintenance, or repair of the system to confirm the type and classification of the installed refrigerant. In the event that the system uses a flammable refrigerant, or the refrigerant is unknown, the following precautions should be taken before working on the refrigerant circuit:

- Identify the refrigerant being worked with. If identification is not possible treat it as an A3 refrigerant.
- All staff and others working in the local area must be instructed on the nature of the work being carried out.
- The area around the workspace must be sectioned off.
- Obtain permit for hot work (if required).
- Working within restrictive spaces should be avoided. When this cannot be avoided, additional safe working practices should be employed including working with a buddy and appropriate PPE.
- No flammable materials are stored in the work area.
- No ignition sources are present anywhere in the work area.
- Suitable fire extinguishing equipment ($CO_2$ or dry-powder type) is available within the immediate area.
- The work area is properly ventilated before working on the refrigerant circuit or before brazing or handling electrics.
- Ventilation should safely disperse any released refrigerant and preferably expel it externally to the outside.
- Suitable flammable gas detectors are present and operating to warn workers of a dangerous concentration of refrigerants.
- The gas detection equipment being used is suitable for use in hazardous areas.
- Erect appropriate signage, including "no smoking" and "do not enter the area" signs, see Figure 6.1.
- All appropriate and necessary tools, PPE and equipment are available (these are covered in this guide in Clause 6.8 and Section 8 respectively).

Figure 6.1 Appropriate signage

## 6.4 Temporary flammable zones

When working on systems using flammable refrigerants, the technician should consider certain locations as "temporary flammable zones" (refer Clause 4.4). These are normally regions where at least some emission of refrigerant is anticipated to occur during the normal working procedures, such as recovery, charging, and so on; typically where hoses may be connected or disconnected. These areas may be classified as Zone 2 Hazardous Areas under AS/NZS 60079.10.1.

For such zones, procedural controls including isolation of all electrical equipment, may be accepted in accordance with AS/NZS 60079.14, rather than requiring all electrical equipment in the temporary flammable zone to be installed as suitable for a hazardous area.

In anticipation of the maximum quantity of refrigerant that may be released during such a procedure (such as disconnecting a hose whilst it is full of liquid refrigerant), the distance from this point that should be considered as a temporary flammable zone is a minimum of two metres in all directions, refer to AS/NZS 60079.10.1. The size of the temporary flammable zone should be determined from the charge in the system being serviced and whether the system is indoors or in a well-ventilated area (e.g. outdoors). For example, for a domestic fridge it could be a minimum of two metres, for larger system greater distances could be required.

Under no circumstances must the system be broken into, by means of cutting or breaking pipework, if it contains any flammable refrigerant or any other gas under pressure.

A number of other aspects must be considered when gaining access to a system:

- It is generally preferable to remove the entire refrigerant charge in case of unexpected failures.
- If refrigerant has been removed, the system must be flushed with oxygen-free dry nitrogen (OFDN). Although there will always be some residual flammable refrigerant left within the system, flushing with nitrogen can eliminate the risk of flash-fire by diluting residual refrigerant below the LEL. Depending on the circumstances (e.g. charge size and specific purging method), this process may need to be repeated several times.
- OFDN must then be purged through the system both before and during the brazing process; this operation is absolutely vital if brazing operations on the pipework are to take place.
- Due to the possibility of explosion, compressed air or oxygen must not, under any circumstances, be used for flushing, pressure testing or filling the system.

Where possible, it is preferable to use cold connection technologies instead of brazing when performing system repairs where there is a likelihood that residual flammable refrigerant is present.

## 6.5 Refrigerant recovery

The machine used for refrigerant recovery must be suitable for use with flammable refrigerants. In particular, it should not have any potential sources of ignition; the requirements are the same as those for a refrigerating system (see Section 4).

The recovery cylinder must be suitable for the refrigerant used, specifically, in terms of the pressure rating and the compatibility of valve seals, etc., and with a Class 2.1 label (diamond), see Section 11. Refrigerants of different safety group classifications (e.g. A1, A2, and A3) must not be mixed in recovery cylinders.

Container(s) must be carefully weighed during the transfer of the refrigerant and the permissible fill weight of refrigerant in the container at a reference temperature of 45°C must not be exceeded. All containers are required to be marked with a tare weight and some may have an indication of the weight of refrigerant that can safely be contained. If there is any doubt, the weight of the refrigerant which can be contained should be checked. Reference should be made to cylinder standards such as AS/NZS 1596, AS 4332 and NZS 5807.

Because odourant could be lost in the recovered refrigerant due to odourant fade, recovered refrigerant must not be transported in enclosed vehicles, nor stored in an enclosed space, and not be used for charging systems unless it is re-odourised.

## 6.6 Refrigerant venting

Venting may only be carried out for refrigerants that are not covered by the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*. Under certain circumstances it may be considered acceptable to vent hydrocarbon refrigerants. However, this can only be considered if the following local and national rules and regulations permit including:

- Legislation relating to waste material
- Environmental legislation
- WHS/OH&S legislation and regulation
- Legislation related to hazardous substances.

A risk assessment process must be adopted (see Clause 5.2), with control measures determined and implemented, before the venting of a system is conducted. Key issues to be considered include the amount of gas to be vented (volume/discharge rate), where it will go and any ability for accumulation of the released gas, the implications to public safety, the application of gas detection and alarms, the availability of fire protection, the extent of any hazardous areas generated, and the resulting requirements for equipment within that space.

Normally, venting is only carried out with systems that contain a small quantity of refrigerant, typically less than 150g; larger quantities should be recovered. If venting is to be carried out, a set of special procedures is required to ensure that it is done safely, by following the general safety procedures discussed within this section, and through appropriate use of a suitable hose:

- Venting to inside a building is not permissible under any circumstances
- Venting must not be to a public area, or where people are unaware of the procedure taking place
- The hose must be of sufficient length such that it will extend to at least 3m beyond the outside of the building
- The venting should only take place on the certainty that the refrigerant will not get blown back into any adjacent buildings, and that it will not migrate to a location below ground-level
- The hose is made of material that is compatible for use with the refrigerants and oil
- A device is used to raise the hose discharge at least 1m above ground level and so that the discharge is pointed in an upwards direction (to assist with dilution)
- Ideally, there should be a type of rose on the end of the hose so that the vented refrigerant can discharge in different directions, with fairly small outlet orifices (to assist with dilution)
- There must be no sources of ignition near the hose discharge
- Flammable gas warning sign must be positioned close to the hose discharge.

## 6.7 Topping up a system

A system with one refrigerant should never be topped up with another type of refrigerant, particularly a flammable refrigerant.

# 6.8 Tools and Equipment

## 6.8.1 General

Electrical and electronic tools used on systems containing flammable refrigerant should be rated for use in a hazardous area, or be used with a gas detector and suitable procedures to prove safety (see Clauses 5.5 and 6.4).

A flammable gas detector should be used to monitor the air in the work area. A dry-powder or $CO_2$ fire extinguisher must be available at the location.

A suitable ventilation fan should be used when working inside, if there is insufficient natural ventilation, or when working in a confined space.

If an electronic leak-detector is used, it must be suitable for detecting the particular type of flammable refrigerant. Most HFC-only leak detectors do not meet this requirement. As an alternative, leak-detection fluid may be used.

**Note:** Battery hand drills, screw drivers, heat guns, hair dryers and the like should never be used inside confined compartments, such as those of a domestic freezer or provision compartments. The brush type motors used, or heat produced from the element, introduces an ignition source into a very confined space.

## 6.8.2 Refrigerant recovery machines

HFC refrigerant recovery machines may not have been assessed for use with flammable refrigerants. Approval must be sought from the manufacturer before using a standard HFC recovery machine with any flammable refrigerant. Some machines may be safe to use with flammable HFCs but not hydrocarbon refrigerants. A refrigerant recovery machine suitable for use with hydrocarbon refrigerants is available and could be used with other flammable refrigerants.

## 6.8.3 Charge accuracy

Very accurate scales are necessary when charging small, critically-charged systems with some flammable refrigerants, such as hydrocarbon refrigerants. A scale accuracy that is suitable to the system refrigerant type and charge size is necessary. Many scales traditionally used for HFC refrigerant service may not be sufficiently accurate for use with hydrocarbon refrigerants.

The refrigerant charge is an important risk factor and any scales should provide the appropriate accuracy to ensure installed charges are correct.

**Note:** "Dial a charge" cylinders, with a sight glass in the cylinder, should not be used to charge systems with flammable refrigerant.

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# 7. Emergency planning

## 7.1 General

This section provides general guidance for PCBUs (see Clause 1.4) and workers on preparing and maintaining general emergency plans for fixed workplaces under Division 4 Section 43 of the model Work Health and Safety (WHS) Regulations and also under Victorian and Western Australian OH&S Regulations. Practical information is provided for technicians, contractors and SMEs on emergency planning duties and procedures.

The WHS Regulations require an emergency plan to be prepared, maintained and implemented in the event of an emergency for every workplace. These obligations extend to a contractor working on a refrigeration system. The requirements imposed on fulfilling these obligations are generally limited to the scope of work and authority.

For example, a contactor servicing a refrigeration system at a large commercial premises must prepare, maintain and implement an emergency plan dealing with the work they are undertaking; however, they do not necessarily have the authority to evacuate the premises. This function should be dealt with in the site's emergency plan. Consequently, the PCBU with the authority for the site should be consulted in the development of the contractor's own emergency plan.

This guide covers from very small systems with only 150g or less of flammable refrigerant, to very large systems with unrestricted flammable refrigerant charges of hundreds of kilograms. It is up to person responsible for preparing an emergency plan (the plan author) to determine what is applicable. The author of the emergency plan should ensure they check the respective WHS or OH&S Act within their jurisdiction, as the requirements and obligations may differ depending on the classification of the facility. The PCBU at the workplace may also be required to provide a copy of the emergency plan to the primary emergency service organisation.

Whilst the focus of this guide is on flammable refrigerants, emergency planning must adopt an "all hazards" approach covering the whole premises, in which flammable refrigerants are a single component of a refrigeration system within a facility. In addition, the emergency planning should consider which flammable refrigerant is in use, as some flammable refrigerants can be either toxic or produce toxic products of combustion.

## 7.2 Duty to prepare an emergency plan

PCBUs must ensure that an emergency plan is prepared for the workplace, including for workers who may work at multiple workplaces.

## 7.3 Preparing an emergency plan

### 7.3.1 What is an emergency plan?

An emergency plan is a written document detailing how a workplace and its occupants deal with or manage an emergency. An effective emergency plan consists of the preparedness, response and recovery activities and includes the agreed emergency management roles, responsibilities, strategies and system arrangements for the site. The level of detail in the emergency plan will depend on the complexity of the activities at the workplace involved, including how much and what types of hazardous materials are stored or used at the site.

An emergency plan must provide for the following:

- Emergency procedures, including an effective response to an emergency
- Evacuation procedures
- Notifying emergency service organisations at the earliest opportunity
- Medical treatment and assistance

- Effective communication between the person(s) authorised to coordinate the emergency response and all people at the workplace
- Testing of the emergency procedures – including the frequency of testing
- Information, training and instruction to relevant workers in relation to implementing the emergency procedures.

### 7.3.2 Types of emergencies covered

The types of emergencies to plan for may include fire, explosion, flammable gas leak, asphyxiation, acute toxic exposure, medical emergency, rescues, incidents with hazardous chemicals, bomb threats, armed confrontations, and natural disasters. Loss of refrigerant or failure of safety controls such as ventilation may also need to be identified for appropriate response measures.

The emergency plan should be based on a practical assessment of hazards associated with the work activity or workplace, and the possible consequences of an emergency occurring as a result of those hazards. External hazards should also be considered in preparing an emergency plan, e.g. a chemical storage facility across the road.

In developing the plan, consideration should be given to the application of all relevant laws, including public health laws (e.g. workplaces that are also public places) and state or territory disaster plans.

## 7.3.3 Level of detail

Emergency plans do not necessarily have to be lengthy or complex, and they should be easy to understand and tailored to the specific workplace where they apply.

In preparing an emergency plan, all relevant matters need to be considered including:

- Types of emergencies including common industry incident data and historical data of site
- Description of the area to be covered by the emergency plan with respect to people, locations, environment, boundaries, systems, plant and equipment.
- Consultation (workers, contractors, product and plant specialists, emergency services, local community)
- Documentation of the process of hazard identification and analysis.
- Gap analysis (against established standards)
- Description of the emergency management system
- Writing the plan using an established format and listing areas to be addressed and schematics/maps required
- Description as to how the emergency plan is activated and terminated
- Describe how the emergency plan is managed including documentation, record keeping and exercises
- Documented training and exercises
- Monitoring and review (checklists, exercise debriefs).

Special consideration may need to be provided for workers who travel for work, work alone or in remote locations.

### 7.3.4 Emergency plan checklist

A checklist to assist PCBUs prepare an emergency plan is provided in Appendix A.

## 7.4 Emergency procedures

Emergency procedures will describe the approaches applied to resolve specific situations. Procedures will detail precise duties of all staff and the arrangements for evacuation, rescue, first aid, resuscitation, and plant isolation. During an emergency, people need to have clear, simple, practical instructions to follow.

Emergency procedures need to be in place to address the following:

- Situation assessment to provided initial information on type and scale of incident, e.g. flammable gas leak
- Raising the alarm to alert others
- Responding to a sounding alarm including its acknowledgement (e.g. SCADA system) and actioning
- Evacuation procedures taking into account the location of the incident, the location of released gas, and any plume
- Detection of gas escape, utilising both fixed-type and portable or hand-held type detectors
- Safe work procedures to conduct anticipated emergency response actions
- Containment of releases
- Fixed fire protection equipment and its operation
- Emergency venting of plant (ventilation)
- Emergency shut down processes
- Provision for safe isolation of electrical equipment
- Closing valves to isolate the system into smaller sections to prevent or minimise further escape
- Equipment shut down
- Dealing with power outages
- System start-up after an emergency shut down

- Tables of the safe operating conditions for critical valves and components
- Diagram(s) of the current as-installed operating system showing integral parts and critical valves and their locations at the facility
- Availability of nominated staff to brief the emergency services
- Coordination with nominated emergency services contacts (emergency responders).

Where a site has fixed gas detection installed (including fixed detection in-built within a flammable refrigerant refrigeration and air conditioning unit), the specific associated emergency procedures due to a gas alarm must be detailed within the emergency plan.

## 7.5 Access to the emergency plan

Emergency plans should be readily accessible by workers or on display in the workplace, e.g. on a notice board.

## 7.6 Training in emergency procedures

Workers must be adequately trained in emergency procedures. Arrangements for informing, training and instructing workers must be set out in the emergency plan itself. Training may include practising evacuations, identifying assembly points, location of emergency equipment, first aid arrangements and how to safely shut down machinery and systems.

In determining training requirements, the following should be considered:

- New workers – inclusion of emergency procedure training in induction courses for new workers
- Existing workers – provision of refresher training for existing workers
- Visitors – provision of training for short-term contractors or visitors at the workplace (this may not need to be as extensive as may be required for workers)
- Emergency coordinators – provision of specific training for individuals who have a formal role in an emergency for example fire wardens, floor wardens, and first aid officers.

## 7.7 Implementing emergency plans

Emergency plans must be implemented in an emergency. Emergency services will assume control upon arrival. Their directions must be complied with.

## 7.8 Reviewing emergency plans

For emergency plans to remain current and effective they must be reviewed on a regular basis, typically every 12 months, and revised if necessary. Other catalysts for a review of the plans include:

- When there are changes to the workplace such as re-location or refurbishments
- When there are changes in the number or composition of staff, including an increase in the use of temporary contractors
- When new activities have been introduced
- Directly after the plan has been tested.

## 7.9 Further information

Further information on emergency planning, including guidance material and fact sheets, is available on from Safe Work Australia at **www.safeworkaustralia.gov.au**

In addition, reference should be made to AS 3745.

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# 8. Personal protection and safety information

## 8.1 General

This section provides general guidance on personal protective equipment and safety data sheets. Practical information is provided for technicians, contractors and SMEs.

## 8.2 Personal protective equipment

Personal protective equipment (PPE) includes chemical protective clothing, boots, gloves and respiratory protective equipment. The reader should ensure they check the respective WHS Act within their jurisdiction as the requirements and obligations may differ.

PPE is a risk-control measure (see SafeWork Australia code of practice for managing hazardous chemicals); however, it is generally only used as a last-resort measure where other risk-control measures have failed. Within the context of the Work Health and Safety (WHS) Act and Regulation the PCBU must ensure suitable PPE is provided to the worker.

In the context of this section there are two common situations when PPE is considered. They are:

- normal working conditions; and
- emergency response.

Obviously, during an emergency many of the everyday risk-control measures have failed and PPE becomes more important. However, it should not be considered the sole approach to manage the identified or suspected risks.

The selection of PPE is based on several factors. These include:

- The type and nature of the hazards – such as flammability, electrical, and airborne contaminants
- Location of the work or tasks – such as open area, confined space, working at heights
- The type of tasks, e.g. hot work, manual tasks or decanting chemicals
- Suitability of PPE for hazard – fire performance, chemical protection, heat dissipation
- Suitability of the operator – fitness, age, heat and psychological stress.

In addition to the selection of the PPE are the work policies and other factors to consider such as communication, work methodology, safety risk (such as for a rescue team), and gas detection.

Ensuring appropriate PPE for the workplace is critical, and considerations should include:

- selection and assessment
- policy and procedures
- training
- maintenance and servicing
- use and decontamination
- review and audits.

## 8.3 Protective clothing

It is recommended that protective clothing be provided at any workplace that contains a unit or system with a maximum flammable refrigerant charge of 5kg or above. In addition, one set of personal protective clothing should be provided for each set of self-contained breathing apparatus provided.

Guidance for the provision of personal protective equipment (PPE) is provided in AS/NZS 1677.2. All PPE on-site should be maintained in accordance with the

relevant Standards. All wearers of the PPE should be trained in its use. Companies that are required to provide PPE on-site should ensure that appropriate procedures are developed regarding the wearing of PPE and that these procedures are detailed within the site's emergency plan.

Considerations in selecting appropriate PPE should include:

- Eye protection must conform to AS/NZS 1336 and the appropriate part(s) of the AS/NZS 1337 (series)
- Eye wash – An eye fountain must be a fountain designed to effectively irrigate both eyes for a period of at least 30min. An eye irrigator must be an eyecup or other device to irrigate the eyes
- Gauntlet gloves must have separate fingers and thumb and must protect the hands and forearms
- Protective clothing – Cotton drill long trousers and long-sleeve shirts or full-length or seamless coveralls (synthetic and woollen clothing should not be used due to the risk of static electricity becoming a source of ignition). Also, long-sleeve jackets provide protection from the cold (refrigerant leak)
- Safety boots – Must conform to AS/NZS 2210.3 Type 1 and Type 4 (waterproof), and must be elastic sided boots or sewn tongue.

Procedures for the safe disposal and/or re-use of contaminated PPE (after use) should also be considered.

## 8.4 Location and storage

Personal protective equipment must be kept in an easily accessible unlocked cabinet outside (but near) the machine room. The cabinet must be reserved exclusively for such equipment and must be clearly marked in accordance with AS 1319.

**Note:** PPE should only be donned in a fresh, uncontaminated atmosphere.

## 8.5 Safety data sheets

Safety data sheets (SDS) are the main tool for ensuring that manufacturers and importers communicate enough information along the supply chain to allow safe use of their substances and mixtures. SDS include information about the properties of the substance, its hazards, instructions for handling, disposal and transport and also first-aid, fire-fighting and exposure control measures.

**Note:** SDS are also called material safety data sheets (MSDS) or product safety data sheets (PSDS).

Safety data sheets must be made available at a site where flammable refrigerants are used. These SDS must be current and supplied with an expiry date. The correct SDS for the actual refrigerant that is used must be available, as important information including PPE and first aid chemical safety information is contained within the SDS.

The manufacturer or importer is responsible for the preparation and supply of the SDS, and to supply it to any person who may be affected by the chemical, or to any person who requests it. SDS must be reviewed by the importer or manufacturer every five years.

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# 9. Marking and labelling

## 9.1 General

The information provided in this section is to ensure that refrigeration systems are adequately marked and labelled. This ensures that employees, maintenance personnel, the emergency services personnel and other persons are aware of the type of refrigerant contained in the system or unit, in accordance with the requirements of WHS/OH&S regulations.

## 9.2 Marking and labelling of systems and units

All refrigeration and air conditioning systems and units containing flammable refrigerant must be marked and labelled with a "Class label" as shown in Figure 9.1.

Example of a Class label:

For a unit or system containing a refrigerant charge of:

- ≤ 0.5kg – minimum label size is 15mm x 15mm
- > 0.5–≤ 5.0kg – minimum label size is 20mm x 20mm
- > 5.0–≤ 25.0kg – minimum label size is 50mm x 50mm
- > 25.0kg – minimum label size is 100mm x 100mm

**Note:** These are minimum label dimensions, for safety reasons the actual label dimensions should be as large as is reasonably practical.

Figure 9.1: Flammable gas label sizes

The installing contractor who charges the system must ensure that the labelling requirements are satisfied. The labels must be visible and clearly identifiable when the equipment is installed and operating.

Appliances complying with AS/NZS 60335.2.11, AS/NZS 60335.2.24, and commercial refrigerating appliances with an incorporated motor-compressor complying with AS/NZS 60335.2.89 or AS/NZS 60335.2.75, are delivered to the user pre-charged with refrigerant and are required to have a different warning label applied, the international symbol ISO 7010 W021. In order to comply with the requirements of these mandatory standards and the WHS regulations, both labels may need to be applied.

The unit or system must also have a permanently attached name plate as per the relevant electrical safety standard. The installing contractor who charges the system must ensure that the name plate has the refrigerant identifying "R" number, the chemical name or the chemical formula marked on it. See Figure 9.2 for an example name plate.

| Name plate information | |
|---|---|
| Manufacturer's name (or supplier) | |
| Manufacturer's model or type | |
| Manufacturer's serial number | |
| Refrigerant number | |
| Approximate refrigerant charge | |
| UN no. of refrigerant | |
| Correct Technical name | |
| For Australia – Class label | International – ISO 7010 W021 label |

**Note:** The yellow ISO 7010 W021 triangle marking is not in lieu of a Class 2.1 label (diamond); this ISO label is required in other legislation and standards (e.g. AS/NZS 60335 series of standards).

Figure 9.2: An example of a typical name plate

## 9.3 Marking and labelling of pipework

Interconnecting refrigerant pipework, i.e. pipework external to the unitary components, should be marked with a Class label (see Figure 9.1) every two metres where the pipework is visible. This includes pipework located in a ceiling space or any void which a person may access for maintenance or repair work within that space.

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# 10. Training

## 10.1 General

There is broad recognition that flammable refrigerants are used in many different system configurations, sizes and types of facilities. It is also widely recognised that personnel responsible for the design, installation commissioning, service, repair, and maintenance of these refrigeration or air conditioning systems (referred to as technicians, engineers, mechanics or contractors) must be appropriately trained.

Furthermore, the industry believes that training guidelines identifying the areas of study, together with the relevant knowledge, skills, and learning objectives for this training, eliminates confusion and provides a road map for companies struggling with the task of meeting government regulations.

This section identifies the key competencies of each level of staff working with flammable refrigerants and defines the training requirements to be a "competent person".

## 10.2 Competent person training

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. AS/NZS 1677.2 and ISO 5149 defines a competent person as a person who has had appropriate training or practical experience (or both) in the subject, sufficient to provide safe and satisfactory performance.

Anyone working on refrigeration and air conditioning systems containing flammable refrigerant should be trained to include the following:

- Knowledge of legislation, regulation and standards relating to flammable refrigerants
- Detailed knowledge of and skill in handling flammable refrigerants, personal protective equipment, refrigerant leakage prevention, handling of cylinders, charging, leak detection, recovery and disposal
- Knowledge of the properties and hazards of flammable refrigerant gases.

## 10.3 Worker training

This guide distinguishes three general levels of training that may be required to ensure safe working practices:

1. **Workplace induction training** – Awareness training provided to all workers when first employed, for all personnel working in an environment containing flammable refrigerants.
2. **WHS supervisor training** – Specific safety awareness training for building WHS/OH&S officers and building supervisors and managers working in an environment containing commercial/industrial refrigeration or conditioning systems with a charge of 2.5kg or more of flammable refrigerants (refer to Table 4.4 in Section 4).
3. **Technical service provider training** – Specific training of personnel working on refrigeration/air conditioning systems containing flammable refrigerants.

All of the above training levels must be reviewed where applicable and when there are changes to a site or procedures. In addition, ongoing professional development and regular refresher training for any people working with flammable refrigerants should also be undertaken.

## 10.4 Flammable refrigerant training

Training of persons to achieve competence in safety aspects of using flammable refrigerants should be undertaken by any person working on stationary refrigeration or air conditioning systems using flammable refrigerants. This includes site supervisors and managers, maintenance personnel, refrigeration and air conditioning mechanics, appliance service mechanics, contractors and engineers.

The competence of a person using flammable refrigerants is established by either:

a) Assessment by an approved Registered Training Organisation (RTO) against the relevant unit of competence, or

b) It can be demonstrated that the skills, knowledge and experience have been acquired that are to an equivalent or comparable standard to (a) above.

It is recommended that persons maintain their skills and competence, for example by the study of relevant updated literature, short courses and practical work experience, as appropriate.

# 10.5 Hazardous areas training

For persons working in or with electrical equipment for hazardous areas, the competencies outlined in AS/NZS 4761.1 apply. Managers, technicians, and designers should be competent to this standard, with a relevant unit(s) of competence appropriate for the role and equipment. For a definition of hazardous areas refer to Clause 4.4.

# 10.6 Specific training requirements

## 10.6.1 Technicians, mechanics, and contractors

A qualified technician, mechanic, or contractor should complete the following recommended minimum formal training requirements:

- Certificate III in the Refrigeration/Air Conditioning trade, or
- Certificate II or III in Appliance Servicing for domestic self contained refrigeration/air conditioning appliances, and
- National Restricted Electrical License (NREL) - (also known as Restricted Workers Electrical License and various other titles, refer to Clause 10.7).

And the following specific flammable refrigerant units of competency from the electrotechnology training package available through TAFE and other registered training organisations (RTOs):

- UEENEEJ174A – Apply safety awareness and legal requirements for hydrocarbon refrigerants, and
- UEENEEJ175A – Service and repair self-contained hydrocarbon air conditioning and refrigeration systems, or
- UEENEEJ176A – Install and commission hydrocarbon refrigeration systems, components and associated equipment.

In Queensland, the use of hydrocarbon refrigerants is regulated under the Petroleum and *Gas (Production and Safety) Act 2004* **www.legislation.qld.gov.au**. This includes approval of the refrigerating device and licence to undertake gas work on the refrigeration device.

Anyone installing, removing, altering, repairing, servicing, testing or certifying a hydrocarbon refrigerant based system or device (i.e. charging, discharging or breaking into a refrigeration system that uses hydrocarbon refrigerants) must hold a Gas Work Licence (Hydrocarbon Refrigerants) to do so.

## 10.6.2 Design and application engineers

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

Design and application engineers should complete the following recommended minimum formal training requirements:

- Recognised Bachelor of Mechanical or Electrical Engineering or Diploma in Refrigeration and Air Conditioning.

And the following units of competency from the electrotechnology training package available through TAFE and other RTOs:

- UEENEEJ174A – Apply safety awareness and legal requirements for hydrocarbon refrigerants, and
- UEENEEJ177A – Design hydrocarbon refrigerated systems.

## 10.6.3 Owners, site supervisors and managers

Someone who oversees the day-to-day operations of a business carries a duty of care, and as such should be aware of the safety risks involved with the operation of any refrigerating or air conditioning equipment containing a flammable refrigerant installed on their premises.

Note: This requirement applies to persons possessing or operating equipment in which the refrigerant charge exceeds the requirements for electrical systems in a hazardous environment as specified in AS/NZS 1677.2.

Owners, site supervisors and managers should complete the following unit of competency from the electrotechnology training package available through TAFE and other RTOs:

- UEENEEJ174A – Apply safety awareness and legal requirements for hydrocarbon refrigerants.

## 10.7 National Restricted Electrical Licence (NREL)

The following state arrangements apply for training and competencies for restricted electrical licensing for personnel that work on refrigeration and air conditioning systems.

**NSW – Disconnection and reconnection of fixed electrical equipment**

www.fairtrading.nsw.gov.au

**NT – Restricted Electrical Licence**

www.electricallicensing.nt.gov.au

**Qld – Restricted Electrical Licence**

www.justice.qld.gov.au

**SA – Restricted electrical workers registration**

www.sa.gov.au

**Tas – Restricted Electrical Workers Licence**

www.wst.tas.gov.au

**Vic – Restricted Electrical Workers Licence**

www.esv.vic.gov.au

**WA – Restricted Electrical Licence**

www.commerce.wa.gov.au

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# 11. Storage

## 11.1 General

The information provided in this section is intended for persons involved in the refrigeration industry, particularly technicians, contractors and SMEs who store flammable refrigerants at a premises. Specific information is provided on small-scale storage applications for use by small and medium sized PCBUs. For large-scale storage applications, the specific standards and regulations should be referred to.

**Note:** Not all classes of gases are included in this section, and where premises store more than one class of gas, additional requirements will apply.

## 11.2 Flammable refrigerant gas cylinders

Appropriate cylinders should be used for flammable refrigerants. The cylinders used for non-flammable refrigerants often do not have collars to protect valving and relief valves. These cylinders are not adequate for use with flammable refrigerants.

**Note:** The marking and labelling requirements for flammable refrigerant gas cylinders are covered in Section 12 of this guide.

## 11.3 Storage and handling of gases in cylinders, including refrigerant gases

AS 4332 sets out the requirements for the storage of gases, and Section 2 of the standard deals with the storage of gases in minor storage. Storage of flammable gases such as LP gas, acetylene, hydrogen, hydrocarbon refrigerants (Group A3), and refrigerant gases of Safety Group A2 in cylinders, in quantities not exceeding 500L may be classified as minor storage.

Where gases of mixed classes are kept in minor storage, the aggregate quantity of all gases must not exceed 2000L (water capacity). For information on cylinder sizes and water capacity, see Table 11.1.

If the quantities of stored gases exceed the quantity criteria of Section 2 of AS 4332 for classification as a minor storage, then Section 2 does not apply and the requirements of subsequent sections of the standard will be applicable.

## 11.4 Storage at residential premises

The maximum quantity of gas cylinders stored at a residential premises must not exceed 50L (water capacity of cylinders). For information on cylinder sizes and water capacity, see Table 11.1.

The following precautions should be observed when storing gas cylinders:

- Ensure the storage area is well-ventilated
- Don't store the gas cylinders near sources of ignition such as electrical power points, lights and switches, electric motors and like equipment
- Keep the gas cylinders out of the sun and away from sources of heat
- Protect the gas cylinder from falling or being knocked over
- The storage area must be free of combustible or waste materials.

All gas cylinders must be secured so as to prevent theft or tampering.

**Note:** Check with the property insurance provider to see if they have any additional requirements regarding the storage of gas cylinders.

### Table 11.1 Gas cylinder sizes and water capacity

| Class and division | Cylinder size | Water capacity |
|---|---|---|
| 2.1 | **ACETYLENE** | |
| | D size | 10 litres |
| | E size | 24 litres |
| | G size | 50 litres |
| 2.1 | **LP GAS** | |
| | N | 11 litres |
| | P (9kg) | 22 litres |
| | Q/T (18kg) | 44 litres |
| | R | 65 litres |
| | S (45kg) | 108 litres |
| | 90kg | 200 litres |
| 2.1 | **FLAMMABLE REFRIGERANT GASES** | |
| | Includes all A2 and A3 refrigerant gases | 11 litres |
| | Includes all A2 and A3 refrigerant gases | 22 litres |

## 11.5 Storage at commercial premises

Buildings used for storing flammable refrigerants should be compliant with the applicable edition of the Building Code of Australia, and unodourised flammable gas should be regarded as a special hazard.

If located on bush fire prone land or within direct sight of a bushfire hazard, the storage area for refrigerants should be kept clear of vegetation to a distance of 10m and shielded on the hazard side of the installation. All external fittings should be metal.

Storage shall be in accordance with AS 4332. Table 11.2 provides some examples of ideal gas storage situations.

### Table 11.2 Ideal gas cylinder storage

| | |
|---|---|
| Brick building with four compartments with lockable gates for security. | The lay-out of this gas cylinder storage is ideal as it allows the flammable gases to be stored at one end (right hand end), the non-flammable gases in the next compartment, and the oxidizing gas (oxygen) in the next compartment or in the fourth (end) compartment.<br><br>The separation distance required for Class 2.1 Flammable gases to be at least 3m from the oxygen is easily achieved, in this scenario. |
| Class 2.1 Flammable gases in metal storage cage. | By storing only Class 2.1 Flammable gases, there is no need for segregation provided there is no oxygen or toxic gas within 3m or any other dangerous goods within 3m.<br><br>Any ignition source must also be at least 3m away. |

## 11.6 Indoor storage areas

The requirements for indoor storage areas can be found in Section 2 of AS/NZS 4332.

## 11.7 Minimum fire protection for minor storage areas

The minimum fire protection for gas storage facilities, where the aggregate water capacity of the gas cylinders is less than 1000L, is a water hose (see Figure 11.1) connected and ready for use.

Figure 11.1: Water hose

For a gas storage area where the aggregate water capacity of the gas cylinders is between 1,000 and 2,000L, the minimum fire protection facilities is one of the two following options (see Figure 11.2):

Option 1: A hose reel.

Option 2: A 2A 60B (E) fire extinguisher

and a hose reel

Figure 11.2: Fire protection options – 1000 to 2,000L storage

## 11.8 Placarding requirements

SafeWork Australia has provided a guide to placard and manifest quantities, refer to **www.safeworkaustralia.gov.au**

Individual state and territory requirements may differ. The SafeWork Australia guide applies to those states and territories who now use or will use harmonised Work Health and Safety (WHS) legislation instead of their previous OH&S laws.

Table 11.3 outlines the various requirements for placarding storage areas.

### Table 11.3 Placardable quantities

| Legislation | Class Division | Placardable Quantity | Class Label required |
|---|---|---|---|
| Work Health and Safety Regulations | 2.1 | 200 litres | |
| **Victoria** *Dangerous Goods (Storage & Handling) Regulations 2012* | 2.1 | 500 litres | |
| **Western Australia** *Dangerous Goods Safety (Storage and Handling of Non-Explosives) Regulations 2007* | 2.1 | 500 litres | |

## 11.9 Other signs

Areas storing flammable gasses should display danger signage as illustrated in Figure 11.3

Figure 11.3: Danger sign

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# 12. Transport

## 12.1 General

The information provided in this section is intended for persons involved in the refrigeration industry, particularly persons who service, maintain, repair or install refrigeration units and transport refrigerant gases as part of those services.

For persons engaged in the commercial transport of dangerous goods, there are other requirements and therefore reference must be made to the relevant state or territory legislation. The state or territory legislation covering the transport of dangerous goods can usually be found on the applicable agency's web site.

There is a Model Act and Model Regulations for the transport of dangerous goods in Australia. Although there are minor variations in the states and territories legislation, all states and territories adopt the Australian Code for the Transport of Dangerous Goods by Road or Rail, and this ensures that the transport requirements across Australia are consistent.

## 12.2 Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code)

The purpose of the ADG Code (see Figure 12.1) is to ensure uniformity and consistency in technical requirements across jurisdictions applying to the land transport of dangerous goods. The ADG Code adopts the structure, format, definitions and concepts of the United Nations Recommendations on the Transport of Dangerous Goods Model Regulations while retaining Australian-specific provisions.

Figure 12.1: DG Code Parts 1 and 2

The ADG Code is available online here **www.ntc.gov.au**

The ADG Code provides detailed technical specifications and recommendations applicable to the transport of dangerous goods in Australia by road and rail. The ADG Code covers the requirements for classification, packaging, marking and labelling of substances and articles that meet the United Nations classification criteria for dangerous goods.

## 12.3 ADG definitions and general provisions for gas transport

The ADG defines a gas as a substance which:

(a) at 50°C has a vapour pressure greater than 300kPa; or

(b) is completely gaseous at 20°C at a standard pressure of 101.3kPa.

The transport condition of a gas is described according to its physical state as:

1) Compressed gas – a gas that, when packaged under pressure for transport, is entirely gaseous at -50°C; this category includes all gases with a critical temperature less than or equal to -50°C; or

2) Liquefied gas – a gas that, when packaged under pressure for transport, is partially liquid at temperatures above -50°C. A distinction is made between:

a. High-pressure liquefied gas – a gas with a critical temperature between 50°C and +65°C, and

b. Low-pressure liquefied gas – a gas with a critical temperature above+65°C; or

3) Refrigerated liquefied gas –a gas that, when packaged, is made partially liquid because of its low temperature; or

4) Dissolved gas – a gas that, when packaged under pressure for transport, is dissolved in a liquid-phase solvent.

The class comprises compressed gases, liquefied gases, dissolved gases, refrigerated liquefied gases, mixtures of one or more vapours of substances of other classes, articles charged with a gas, and aerosols.

**Note:** Aerosols are not dealt with in this industry guide. For aerosol requirements see the ADG Code.

## 12.4 ADG Class 2 divisions

Substances of Class 2 are assigned to one of three divisions in the ADG based on the primary hazard of the gas during transport. These divisions are designated; Division 2.1 Flammable gases, Division 2.2 Non-flammable, non-toxic gases, and Division 2.3 Toxic gases. Flammable refrigerants are all covered under Division 2.1.

(a) *Division 2.1 Flammable gases*

*Gases which at 20°C and a standard pressure of 101.3kPa:*

(i) *Are ignitable when in a mixture of 13 per cent or less by volume with air; or*

(ii) *Have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit. Flammability should be determined by tests or by calculation in accordance with methods adopted by ISO (see ISO 10156: 1996). Where insufficient data are available to use these methods, tests by a comparable method recognised by the competent authority may be used.*

Gas mixtures, including vapour substances from other classes, are classified in one of the three divisions. Information on gas mixtures can be found in ADG Code (page 67 of Volume 1).

## 12.5 ADG gas cylinder marking and labelling

Gas cylinders must be marked with:

- The proper shipping name for the dangerous goods
- The United Nations number, preceded by the letters "UN", and
- a Class label (diamond)

**Note:** For example: UN 3252 DIFLUOROMETHANE (REFRIGERANT GAS R 32)

The gas cylinder labelling must include the Class label (primary risk) and, if applicable, a Class label identifying the subsidiary risk. Figure 12.2 provides example labels.

| Division 2.1 | Division 2.2 | Division 2.3 |
|---|---|---|
| Flammable gases<br>Non-toxic gases | Non-Flammable | Toxic gases |

Figure 12.2: Example gas cylinder Class labels

## 12.6 Marking and labelling of imported gas cylinders

In the case of gas cylinders imported and labelled in accordance with the United Nations Globally Harmonised System (GHS) as shown in Table 12.1, these labels are accepted for storage, but not for transport.

For transport, the marking and labelling requirements of ADG must be applied.

### Table 12.1 United Nations Globally Harmonised System (GHS)

| United Nations Globally Harmonised System – Label Elements | | | |
|---|---|---|---|
| Flammable gases | | Chemically unstable gases | |
| Category 1 | Category 2 | Category 3 | Category 4 |
| **Danger** **Extremely flammable gas** | **No pictogram** **Warning** **Flammable gas** | **No additional pictogram** **No additional signal word** **May react explosively even in the absence of air** | **No additional pictogram** **No additional signal word** **May react explosively even in the absence of air at elevated pressure and/or temp.** |
| Equivalent dangerous goods labels | | | |
| **Division 2.1** | **Division 2.1** | Chemically unstable gases (GHS system) will fall into one of three divisions of a Class 2 Dangerous Goods and they are: **2.1** **2.2** **2.3** | |

## 12.7 ADG transport requirements – all vehicles

The following are the minimum requirements for the transport of refrigerant gas cylinders of less than 250L (water capacity of cylinders) in vehicles:

- Gas cylinders must not be stored on the transport vehicle near a source of heat.
- If the gas is in liquid form, the cylinder must be stowed upright to ensure the pressure-release device communicates with the vapour space.
- The main cylinder valve must always be shut and any regulator removed prior to loading.
- Ventilation is required to prevent the build-up of vapours that are likely to increase the risk.
- For vans, station wagons, utilities with a canopy or cover and other enclosed vehicles, one means of providing ventilation is to stow the gas cylinders in a cabinet, that is vented externally only and not into the vehicle.
- Security of the gas cylinders while on the vehicle must be maintained. In the case of a tray truck or utility, gas cylinders would need to be in a locked cage to prevent theft if the vehicle is left unattended.
- It is recommended that the vehicle be fitted with a fire extinguisher which has a preferable rating of at least 30B.

For quantities in excess of 250L (water capacity of cylinders) additional requirements apply, refer to ADG.

**Note:** Unodourised flammable refrigerant, including recovered refrigerant that has suffered from odourant fade, should not be transported in an enclosed vehicle or stored in an enclosed space, regardless of the quantity.

## 12.8 Transport vehicle – self-assessment tools

To assist the technician, contractor, and SME assess their flammable gas cylinders transport arrangements for compliance, two self-assessment tools are provided in Appendix B:

- Self-assessment for the transport of refrigeration gases in an open vehicle such as a tray truck or utility.
- Self-assessment for the transport of refrigeration gases in an enclosed vehicle or a utility with a canopy or cover.

For quantities greater than 250L of Division 2.1 Flammable gases, the full requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG 7) apply and reference must be made to the ADG 7 for requirements.

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# 13. Compliance audit tool

## 13.1 General

The information provided in this section is intended for the occupier of the premises where the refrigeration system is installed and operated.

## 13.2 Audit tool

The following flammable refrigerant industry guide compliance audit tool can be used to assess the compliance of any flammable refrigerant-based installation against the requirements outlined in this guide.

| Flammable Refrigerants – Safety Guide: Compliance audit tool | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Reference in cuide | Legislation (see note) | Audit item | Yes | No | N/A | Recommended action or comment | Target date | Completion date |
| **Clause 1.3** | WHS<br>OHS<br>DG | Is your system designed for the use of A2 or A3 flammable refrigerants? | | | | If the answer is NO, refer to Section 1.3 Converting systems and equipment, review and action the relevant part(s). | | |
| **Clause 2.4** | WHS<br>OHS<br>ESR | Has all electrical wiring and equipment been installed in accordance with the relevant Australian Standards?<br>Does the equipment have the appropriate certification for compliance with the electrical regulations? | | | | If the answer is unknown, or is NO, contact the supplier or installer and/or maintenance company to confirm this in writing.<br>If it cannot be confirmed, a competent person needs to be engaged to confirm or otherwise as well as remedy any non-compliance. | | |
| **Clause 4.5 and 4.6** | WHS<br>OHS | Is the amount of refrigerant in the system AND the location of the system in accordance with the requirements outlined in Clause 4.5, and Tables 4.1, 4.3 and 4.4? | | | | If the answer is NO to either or both requirements, further action needs to be taken to correct the non-compliance. | | |
| **Clause 4.7.2** | WHS<br>OHS | Has the manufacturer stated the maximum surface temperature for hot surfaces? | | | | If applicable, obtain information from manufacturer (or supplier).<br>Once the information is provided, review requirements listed in Section 4.7 | | |

| Flammable Refrigerants – Safety Guide: Compliance audit tool | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Reference in cuide | Legislation (see note) | Audit item | Yes | No | N/A | Recommended action or comment | Target date | Completion date |
| **Clause 4.7.3 and 4.7.4** | WHS<br>OHS<br>DG | Has the refrigeration equipment been installed near equipment that has an ignition source such as electrical contactors, switches or a naked flame? | | | | Eliminate the ignition source or relocate the refrigeration equipment. | | |
| **Clause 4.11 Appendix C** | WHS<br>OHS<br>DG | Have you notified your local fire brigade, to inform them that there is refrigeration equipment on site that contains a flammable refrigerant gas? | | | | If NO, contact your local fire brigade.<br>Refer to Appendix C for notification form.<br>**Note:** Section 7 also requires contact with the fire brigade with reference to the emergency plan | | |
| **Clause 4.8** | WHS<br>OHS | Have all serviceable mechanical joints in the refrigeration system been replaced where refrigerant could leak and pool? | | | | Replace serviceable mechanical joints with permanent joints. | | |
| **Clause 4.9 and 4.10** | WHS<br>OHS | Are the pressure vessels and pressure relief suitable for flammable refrigerants? | | | | If not suitable, replace. | | |
| **Clause 5.2** | WHS<br>OHS<br>DG | Has a site hazard identification and risk assessment been undertaken, taking into account flammable refrigerant gases and equipment that is on the premises? | | | | If NO, undertake a hazard identification and risk assessment for the refrigeration system and for the site in total. | | |
| **Clause 5.3** | WHS<br>OHS | Is a gas detection system required? | | | | The risk assessment, as per Clause 5.2 (immediately above) will determine if gas detection is required. | | |
| **Clause 6.1** | WHS<br>OHS<br>DG | Is regular maintenance undertaken on the system and records kept?<br>If a contractor is used, does the contractor provide details of the maintenance performed? | | | | Ensure records are maintained for regular maintenance and also breakdown maintenance. | | |

| Flammable Refrigerants – Safety Guide: Compliance audit tool | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Reference in cuide | Legislation (see note) | Audit item | Yes | No | N/A | Recommended action or comment | Target date | Completion date |
| **Section 7** | WHS<br>OHS | Has an emergency plan been prepared for the premises? | | | | If a plan has not been prepared, refer to Appendix A: Emergency plan checklist for guidance.<br><br>It is recommended to touch base with your local fire brigade regarding your emergency plan. | | |
| **Section 8** | WHS<br>OHS<br>DG | Is appropriate personal protection equipment (PPE) available to employees? | | | | The safety data sheet (SDS or MSDS) provides information about what PPE is required. | | |
| **Clause 9.2** | WHS<br>OHS<br>DG | Is the refrigeration system marked to indicate that a flammable gas is used in the system? | | | | If there is no Class label (diamond) visible, on the system, affix a Class 2.1 label to the system. | | |
| **Figure 9.2** | WHS<br>OHS<br>DG | Does the refrigeration system have a name plate affixed to it? | | | | See Figure 9.2 for an example of a name plate. | | |
| **Clause 9.3** | WHS<br>OHS<br>DG | Is the pipework marked with a Class label (diamond) every 2m, where visible? | | | | If NO, affix Class label(s) to the pipework. | | |
| **Section 10** | WHS<br>OHS<br>DG | Are persons, who have a duty or responsibility regarding the refrigeration system, trained? | | | | **Note:** Training should not be limited to just the refrigeration system. | | |
| **Section 11** | WHS<br>OHS<br>DG | Is there storage of gas cylinders at the premises? | | | | If YES, undertake a review of the requirements listed in Section 11 – Storage, to ensure gas cylinders are stored safely. | | |
| **Section 12 Appendix B** | DG | Does your company transport gas cylinders? | | | | If YES, conduct an audit using the Audit Tool in Appendix B (B2 and/or B3 as applicable). | | |

Note on legislation:

WHS = Workplace Heath and Safety legislation. All states and territories except Victoria and Western Australia.

OHS = Occupational Health and Safety legislation. Victoria and Western Australia only.

DG = Dangerous Goods legislation. All states and territories.

ESR = Electrical Safety Regulations. All states and territories.

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# Appendix A. Checklists

## A1 High-wall split-system checklist

The following is a checklist 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 refrigerant in a domestic dwelling or in light commercial application such as a restaurant, café or small office:

| High-wall split-system checklist | 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:<br>a. If the installation is to be a conversion, is the current system in good condition and leak-tight?<br>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 allowable charge and the applicable maximum charge limit:<br>a. Refer Clause 4.5. This system will be defined as human comfort, and Annex GG of AS/NZS60335.2.40 applies.<br>b. Identify the occupancy category (see Table 4.3).<br>c. Identify where the refrigerant containing parts will be located and determine the location classification (see Table 4.4).<br>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.<br>e. Measure smallest room that is to be air conditioned by the system. Calculate the allowable charge using the formula in Annex GG. | |
| 5. Identify potential sources of ignition (SOI) -– Refer Clause 4.7:<br>a. Is the split-system designed and approved for flammable refrigerants?<br>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?<br>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. 7. Does the system have the appropriate pressure equipment ratings and approvals for flammable refrigerants? – Refer Clause 4.9.<br>a. If the system is to be converted, does it have a pressure-relief valve? – Refer Clause 4.10. | |
| 6. Does the system have any serviceable joints within the occupied space or inside the cabinet of the outdoor unit? These must be removed and replaced by brazed or permanent mechanical joints – Refer Clause 4.8. | |

| High-wall split-system checklist | Yes? No? or N/A |
|---|---|
| 7. Does the system have the appropriate pressure equipment ratings and approvals for flammable refrigerants? – Refer Clause 4.9.<br>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:<br>a. Check the work area is safe and setup a temporary flammable zone – Refer Clauses 6.3 and 6.4.<br>b. Ensure you have the appropriate tools and equipment – Refer Clause 6.8.<br>c. Do you have the appropriate personal protective equipment? – Refer Section 8.<br>d. If the system is a conversion, recover the HCFC or HFC refrigerant.<br>**Note:** An ARCtick licence is required for this work.<br>e. Remove all serviceable-type joints (e.g. flare joints) from the occupied space and replace with either a permanent mechanical joint or braze – Refer Clause 4.8.<br>f. Eliminate all potential SOI – Refer Clause 4.7.<br>g. Pressure and leak-test the system.<br>h. Commission the system and provide written operating and maintenance instructions. | |
| 9. Marking and labelling of the system:<br>a. Ensure that both the indoor and outdoor units are labelled with a Class label as per Clause 9.2.<br>b. The name plate or serial plate must also be appropriately marked – Refer Clause 9.2.<br>c. Interconnecting pipework should also be labelled with a 'Class label' – Refer Clause 9.3. | |

# A2 Cool room refrigeration system checklist

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

| Cool room refrigeration system checklist | Yes? No? or N/A |
|---|---|
| 1. Have you received the appropriate training and are you competent to install or convert a commercial refrigeration system? – Refer Section 10. | |
| 2. Conduct a risk assessment – Refer Clause 5.2:<br>a. If the installation is to be a conversion, is the current system in good condition and leak-tight?<br>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 as the contractor working on a flammable system? The site's emergency plan will also have to be updated if it does not account for a refrigeration system that has flammable refrigerant – Refer Section 7. | |
| 4. Determine the allowable charge and the applicable maximum charge limit:<br>a. Refer Clause 4.5 – The allowable charge limit is calculated by the practical limit for the refrigerant multiplied by the room net volume.<br>b. Identify the occupancy category (see Table 4.3). In this example, it will be Category I – General Occupancy (note the inside of the cool room is not considered as occupied space if only used for storage).<br>c. Identify where the refrigerant-containing parts will be located and determine the location classification (see Table 4.4). In this example, the system is a direct system as refrigerant-containing parts are located in the occupied space.<br>d. Is the system located above ground or below ground? If above ground, the maximum charge is 1.5kg for "other systems" in Occupancy Category I. If below ground, the maximum charge is 1kg and special consideration must be given to the risk of pooling of leaked refrigerant.<br>e. Measure smallest room that has refrigerant containing parts of the system. Calculate the allowable charge using the formula – practical limit multiplied by room net volume. The allowable charge must not exceed the maximum charge in 4(d) above. Note: the smallest room with refrigerant-containing parts may not be the cool room. 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:<br>a. Is the refrigeration system designed and approved for flammable refrigerants?<br>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?<br>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 – both inside the cool room 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:<br>a. If the system is to be converted, does it have a pressure-relief valve? – Refer Clause 4.10. | |

| Cool room refrigeration system checklist | Yes? No? or N/A |
|---|---|
| 8. Installation of a new system or conversion of an existing system:<br>a. Check the work area is safe and setup a 'temporary flammable zone' – Refer Clauses 6.3 and 6.4.<br>b. Ensure you have the appropriate tools and equipment – Refer Clause 6.8.<br>c. Do you have the appropriate personal protective equipment? – Refer Section 8.<br>d. If the system is a conversion, recover the HCFC or HFC refrigerant.<br>**Note:** An ARCtick licence is required for this work.<br>e. Remove all serviceable-type joints (e.g. flare joints) from the occupied space and replace with either a permanent mechanical joint or braze – Refer Clause 4.8.<br>f. Eliminate all potential SOI – Refer Clause 4.7.<br>g. Pressure and leak-test the system.<br>h. Commission the system and provide written operating and maintenance instructions. | |
| 9. Marking and labelling of the system:<br>a. Ensure that both the condensing unit and the evaporator are labelled with a Class label as per Clause 9.2.<br>b. The name plate or serial plate must also be appropriately marked – Refer Clause 9.2.<br>c. Interconnecting pipework should also be labelled with a Class label – Refer Clause 9.3. | |

# A3 Plant room-based refrigeration system checklist

The following is a checklist of issues that need to be addressed by the installer, to install or convert a typical plant room-based refrigeration system to use flammable refrigerant in a commercial application:

| Plant room-based refrigeration system checklist | Yes? No? or N/A |
|---|---|
| 1. Have you received the appropriate training and are you competent to install or convert a plant room-based refrigeration system? – Refer Section 10. | |
| 2. Conduct a risk assessment – Refer Clause 5.2:<br>a. If the installation is to be a conversion, is the current system in good condition and leak-tight?<br>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 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 allowable charge and the applicable maximum charge limit:<br>a. Refer Clause 4.5, the allowable charge limit is calculated by the practical limit for the refrigerant multiplied by the room net volume.<br>b. Identify the occupancy category (see Table 4.3). In this example, it will be Category III – Authorised Occupancy.<br>c. Identify where the refrigerant containing parts will be located and determine the location classification (see Table 4.4). In this example, the system is a direct system with compressors and pressure vessels in a plant room, and only evaporators as refrigerant-containing parts located in the cool room. (Note that neither plant room nor cool room is considered occupied space in AS/NZS 1677.2.)<br>d. Is the system located above ground or below ground? If above ground, the maximum charge is 25kg for "other systems" in Occupancy Category III. If below ground, the maximum charge is 1kg and special consideration must be given to the risk of pooling of leaked refrigerant.<br>e. Measure smallest room that has refrigerant-containing parts of the system. Calculate the allowable charge using the formula – practical limit multiplied by room net volume. The allowable charge must not exceed the maximum charge in 4(d) above. Note: the smallest room with refrigerant-containing parts may not be the cool room. Check the volume of the space that the condensing unit is located in, unless it is mounted outdoors.<br>f. Does any piping containing flammable refrigerant pass through any areas of Occupancy Category I or II? Any piping must be removed from Category I areas, and be appropriately protected in Category II areas – Refer AS/NZS 1677.2, Clause 4.3.2. | |
| 5. Identify potential sources of ignition (SOI) – Refer Clause 4.7:<br>a. Is the refrigeration system designed and approved for flammable refrigerants?<br>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? (Including electrical equipment not suitable for operation in a flammable atmosphere).<br>c. Confirm that both the plant room and cool room are fitted with flammable gas detectors that will raise an alarm and cause isolation of power (apart from emergency lighting and ventilation etc).<br>d. Confirm that any electrical equipment intended to continue operating after detection of flammable gas is suitable for operation in a flammable atmosphere.<br>**Notes:**<br>1. Gas detectors should detect gas with the highest possible sensitivity and well before the atmosphere becomes flammable.<br>2 Isolation of power includes all sources including control systems, and must take place at a point before the power enters the room.<br>e. Check the location the system is to be installed in for SOI. Do not locate the system near gas-fired boilers or other SOI. | |

| Plant room-based refrigeration system checklist | Yes? No? or N/A |
|---|---|
| 6. Does the system have any serviceable joints, both inside the cool room and the plant room? If so, can they be replaced? The use of serviceable joints is permitted (as neither plant room nor cool room are "occupied space") but wherever reasonably possible, should 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:<br>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 Clause 3.8.<br>a. Does the plant room ventilation system draw from an appropriate location? For heavier-than-air refrigerants, the extraction ventilation system should draw in at low level In the plant room and cool room.<br>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?<br>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?<br>d. If the plant room contains switchboards with ventilation fans, the switchboard ventilation air intakes should draw in fresh air from outside the plant room. | |
| 9. Installation of a new system or conversion of an existing system:<br>a. Check the work area is safe and setup a temporary flammable zone – Refer Clauses 6.3 and 6.4.<br>b. Ensure you have the appropriate tools and equipment – Refer Clause 6.8.<br>c. Do you have the appropriate Personal Protective Equipment? – Refer Section 8.<br>d. If the system is a conversion, recover the HCFC or HFC refrigerant.<br>**Note:** An ARCtick licence is required for this work.<br>e. Remove serviceable-type joints (e.g. flare joints) as far as practical from the plant room, cool room and interconnecting piping, and replace with either a permanent mechanical joint , weld or braze – Refer Clause 4.8.<br>f. Eliminate all potential SOI – Refer Clause 4.7.<br>g. Pressure and leak-test the system.<br>h. Commission the system and provide written operating, maintenance and safety instructions.<br>**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:<br>a. Ensure that both the condensing unit and the evaporator are labelled with a Class label as per Clause 9.2.<br>b. The name plate or serial plate must also be appropriately marked – Refer Clause 9.2.<br>c. Interconnecting pipework should also be labelled with a Class label – 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).

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| Checklist – Emergency Plans | Yes? | No? |
|---|---|---|
| **Responsibilities**<br>• Has someone with appropriate skills been made responsible for specific actions in an emergency, e.g. managing an evacuation or assigning area wardens?<br>• Is someone responsible for making sure all workers and others in the workplace, e.g. contractors, customers and visitors are accounted for in an evacuation?<br>• Do workers working alone know what to do in an emergency?<br>• Are specific procedures in place for critical functions, e.g. power shutdowns? | | |
| **Emergency contact details**<br>• Are emergency contact details relevant to the types of possible threats, for example fire brigade, police and poison information centre?<br>• Are the emergency contact details displayed at the workplace in an easily accessible location?<br>• Are contact details updated regularly? | | |
| **Evacuations**<br>• Have all emergencies requiring an evacuation at the workplace been identified?<br>• Has an evacuation procedure been prepared (if applicable)?<br>• Does the procedure:<br>– Address all types of situations and hazards which may arise at the workplace<br>– Cover everyone who may be present at the workplace<br>– Allow for quick and safe evacuation when needed<br>– Clearly identify routes to safe assembly areas, considering special assistance for hearing, vision or mobility-impaired people; and<br>– Include a process for accounting for persons? | | |
| **Evacuations for a fixed workplace**<br>• Is the evacuation procedure clearly and prominently displayed at the workplace, where practicable?<br>• 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?<br>• 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?<br>• Are all exits, corridors and aisles readily accessible and kept clear of obstructions?<br>• Does the workplace have illuminated exit signs? | | |
| **Fire protection equipment**<br>• 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?<br>• Is it properly maintained and regularly checked and tested by the local fire authority or fire equipment supplier?<br>• Is the area where the equipment is stored kept clear of obstructions?<br>• Are adequate numbers of workers trained to use fire extinguishers? Do they know what type of extinguisher to use for different types of fires? | | |

| Checklist – Emergency Plans | Yes? | No? |
|---|---|---|
| **Extreme weather conditions**<br>• 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?<br>• 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?<br>• Do procedures identify the closest designated safe place?<br>• Do procedures accommodate evacuation procedures of the relevant local authorities, e.g. the fire services, SES and police?<br>• Do workers have access to reliable communications equipment?<br>• Are workers trained in emergency evacuation and related procedures?<br>• 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**<br>• Are current safety data sheets available for all hazardous chemicals on site?<br>• Are all hazardous chemicals labelled and stored in a safe manner?<br>• Is appropriate equipment available to initially respond to a chemical incident, e.g. absorbent material to contain a liquid spill?<br>• Is appropriate personal protective equipment and training provided to protect workers who are called on to deal with an unplanned chemical release? | | |
| **First aid**<br>• Has a first aid assessment been conducted?<br>• Does the workplace have trained first aiders and suitable first aid facilities?<br>• Are workers aware of where first aid facilities are kept and who first aiders are? | | |
| **Neighbouring businesses**<br>• Have neighbouring businesses been considered if an emergency occurs? How would they be advised if an emergency situation arises (if applicable)?<br>• Should they be consulted about the preparation and coordination of emergency plans?<br>• Have the risks from neighbouring businesses been considered, e.g. fire from restaurant/takeaway food outlets, Q-fever from cattle yards or vehicle accidents on major roads? | | |
| **Post incident follow-up**<br>• Are there procedures in place to notify the relevant regulator about a notifiable incident where necessary?<br>• 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?<br>• 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**<br>• Are emergency plan practice runs undertaken to assess the effectiveness of the emergency plan, e.g. evacuation drills?<br>• Is someone responsible for documenting and retaining the results of emergency plan practice runs?<br>• Is someone responsible for reviewing the emergency plan and informing workers of any revisions? | | |

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# Appendix B. Self-assessment tools – Refrigerant cylinder transport

## B1 General

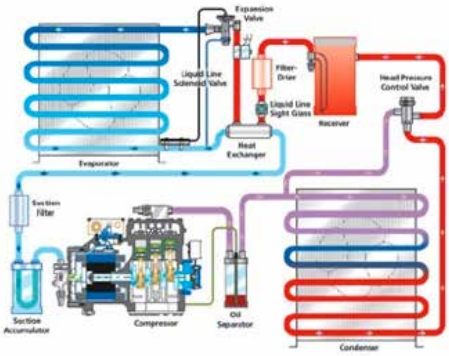
This appendix outlines two self-assessment tools for assessing the arrangements for refrigerant cylinder transport, as follows:

- Self-assessment for the transport of cylinders containing refrigeration gases in an open vehicle, such as a tray truck or utility, in B2.
- Self-assessment for the transport of cylinders containing refrigeration gases in an enclosed vehicle or a utility with a canopy or cover, in B3.

For quantities greater than 250L of Division 2.1 Flammable gases, the full requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG 7) apply and reference must be made to the ADG 7 for requirements.

## B2 Transport of refrigeration gases in an open vehicle

### Transport of gas cylinders associated with the refrigeration industry



## Transport assessment for a tray truck or utility (without a canopy or cover)

This self-assessment document is for the transport of gas cylinders up to a quantity of 250L of Division 2.1 Flammable gases in open vehicles, such as tray trucks or utilities, and should be read in conjunction with Section 12 of this guide.

For quantities greater than 250L of Division 2.1 Flammable gases, the full requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG 7) apply and reference must be made to the ADG 7 for requirements.

## Traffic light assessment system for the transport of Class 2 dangerous goods – refrigerant and other gases

| | | |
|---|---|---|
| | | MANDATORY ACTION ITEM |
| | | CONSIDER |
| | | SATISFACTORY |

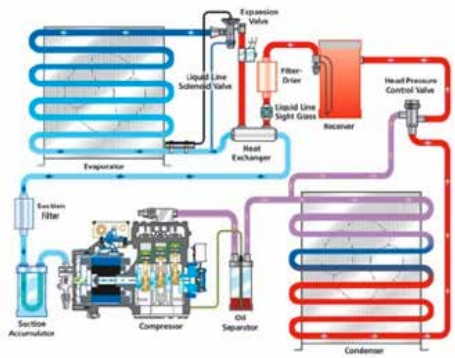
| | | | | Comment and/or action required |
|---|---|---|---|---|
| 1 | **Flammable gases** Will Division 2.1 Flammable gases be transported? | | | If NO, see assessment for other gases. |
| 2 | What is the maximum quantity of flammable gases to be transported (quantity is determined by the water capacity (in litres) of the cylinder? | **Litres** | | |
| 3 | Is the maximum quantity of flammable gases not more than 250 litres? | **Yes** | **No** | If the quantity is ≥250 litres then full compliance with the ADG 7 is required. |
| 4 | Are the gas cylinders stored in a lockable cage(s) so as to prevent unauthorised access and is the cage securely attached to the vehicle? | **Yes** | **No** | **If NO – the following action is required:** Provide a lockable cage and secure it permanently to the vehicle. |

| | | | | Comment and/or action required |
|---|---|---|---|---|
| 5 | Are there warning signs displayed on the cage? | Yes | No | **If NO – the following action is required:** Provide warning signs for the cage |
| 6 | Are the gas cylinders stored in an upright (vertical) position and restrained to ensure they cannot move during transport? | Yes | No | **If NO – the following action is required:** Ensure the cylinders are vertical and restrained. |
| 7 | Have the regulators been removed from all cylinder prior to transport? | Yes | No | **If NO – the following action is required:** Remove the regulator. |
| 8 | **Fire extinguisher** Is the vehicle fitted with a fire extinguisher of at least a 10B rating? A 30B fire extinguisher is recommended. | Yes | No | **For vehicles transporting Division 2.1 Flammable gases (acetylene, LP gas, hydrogen and other flammable gases) it is recommended that the vehicle be fitted with a minimum size 10B fire extinguisher.** **A 30B fire extinguisher is the minimum size for placard loads.** |
| **Additional information – Class 2 dangerous goods** | | | | |
| 9 | **Safety data sheets (SDSs and MSDSs)** SDSs/MSDSs are available on request from your gas supplier. | | | A safety data sheet, for the specific gas, will provide additional useful information such as:<br>• First aid measures<br>• Fire-fighting measures<br>• Spillage, leaking cylinders<br>• Storage and Handling<br>• Personal protection (PPE)<br>• Transport information<br>• Other information<br>**Note:** New national health and safety laws came into effect on 1/1/2012, and material safety data sheets MSDSs are now known as safety data sheets (SDS). |
| | Australian Code for the Transport of Dangerous Goods by Road and Rail – Seventh Edition | | | For the transport of gas cylinders in quantities above 250L, refer to the Australian Dangerous Goods Code. |

# B3 Transport of refrigeration gases in an enclosed vehicle

A self-assessment tool for the transport of gas cylinders up to a quantity of 250L of Division 2.1 Flammable gases in enclosed vehicles.

## Transport of gas cylinders associated with the refrigeration industry



## Transport assessment for an enclosed vehicle

## Enclosed vehicles include:

Utility with an enclosed compartment

Utility with a cover over the tray

When the covers are down, the vehicle is deemed an enclosed vehicle

Utility with a canopy

Enclosed trailer

This self-assessment document is for the transport of gas cylinders up to a quantity of 250L of Division 2.1 Flammable gases in enclosed vehicles such as vans and wagons, and should be read in conjunction with the Section 12 of this guide.

For quantities greater than 250L of Division 2.1 Flammable gases, the full requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG 7) apply and reference must be made to the ADG 7 for requirements.

## Traffic light assessment system for the transport of Class 2 dangerous goods in a "tool of trade" vehicle

| | | |
|---|---|---|
| | | MANDATORY ACTION ITEM |
| | | CONSIDER |
| | | SATISFACTORY |

| Transport of gas cylinders in a vehicle that is an enclosed vehicle | | | |
|---|---|---|---|
| **Transport of gas cylinders in an enclosed vehicle** | **Yes** | **No** | **Action required** |
| Is the vehicle that is to be used to transport the gas cylinder(s) an enclosed vehicle?<br>That is to say the luggage area of the vehicle is not open to the elements (open air) and includes such vehicles as:<br>• A van (with or without windows)<br>• A panel van<br>• A station wagon<br>• A utility with a canopy over the tray or luggage/storage area<br>• A utility with a torneau cover over the tray<br>• Other type of vehicle whereby the luggage/storage compartment is part of the inside of the vehicle | | | **If the answer to this question is YES, consider a vehicle with an open luggage/storage space such as a tray truck.**<br>For vehicles with a canopy over the tray of the vehicle, install a vent that aids the circulation of air which will negate the build-up of any flammable gases in the storage area of the vehicle. |
| Is the water capacity of all gas cylinders transported, less than 250L? | | | **If the answer to this question is NO, then the (relaxed) conditions for a "Tool of Trade" vehicle do not apply.** |
| Are the gas cylinders stored in a cabinet(s) inside the vehicle? | | | |
| Is the cabinet sealed whereby any gas escape cannot enter the inside of the enclosed vehicle? | | | As an example, the seal around the door of the cabinet should be similar to a door on a household refrigerator. The cold air in the refrigerator is held in by the door seal. |
| Is there a pipe or tube in the cabinet, which is vented to the outside? | | | The pipe or tube allows any leaking gases to be discharged to outside atmosphere. |
| <br>Are there appropriate markings on the door of the cabinet, to indicate its contents? | | | |

| Transport of gas cylinders in a vehicle that is an enclosed vehicle | | | |
|---|---|---|---|
| **Transport of gas cylinders in an enclosed vehicle** | **Yes** | **No** | **Action required** |
| Are the gas cylinders stored in an upright (vertical) position and restrained to ensure they cannot move during transport? | | | Flammable gas cylinders must be stored and used upright at all times. |
| **Fire extinguisher** Is the vehicle fitted with a fire extinguisher of at least a 10B rating? | | | For vehicles transporting Division 2.1 Flammable gases (acetylene, LP gas, hydrogen etc) it is recommended that the vehicle be fitted with a minimum size 10B fire extinguisher. |
| **Additional information – Class 2 dangerous goods** | | | |
| **Safety data sheets (SDSs and MSDSs)** SDSs/MSDSs are available on request from your gas supplier. | | | A safety data sheet, for the specific gas, will provide additional useful information such as:<br>• First aid measures<br>• Fire-fighting measures<br>• Spillage, leaking cylinders<br>• Storage and handling<br>• Personal protection (PPE)<br>• Transport information<br>• Other information<br>**Note:** New national health and safety laws came into effect on 1/1/2012, and material safety data sheets MSDSs are now known as safety data sheets (SDS). |
| Australian Code for the Transport of Dangerous Goods by Road and Rail – Seventh Edition | | | For the transport of gas cylinders in quantities above 250L, refer to the Australian Dangerous Goods Code. |

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# Appendix C. Example fire service notification template

Australasian Fire and Emergency Service Authorities Council

**This notification form is reproduced courtesy of AFAC**

Upon installation of a refrigeration or air conditioning system that is charged with 5kg or more of a flammable refrigerant, this form should be completed by the installer, and given to the fire station that is responsible for the local area. If you are unsure which fire station is responsible for the local area you should contact the fire service using the public contact number available through directory assistance.

If the flammable refrigerant is changed from one flammable refrigerant to another, a new notification should be sent.

Similarly, if a flammable refrigerant system is decommissioned or removed, notification should be provided to the fire service advising of the change.

**Note:** This recommendation may not be applicable in all jurisdictions.

afac
Australasian Fire and Emergency Service Authorities Council

# FLAMMABLE GAS REFRIGERANT NOTIFICATION FORM

**Refrigeration or air conditioning system containing 5kg or more of flammable refrigerant**

## 1. Premises

Premises Name: _____

Premises Street and Nº: _____

Premises Suburb: _____

Postcode: _____ DP/Lot number: _____

## 2. Installer contact

Name: _____

Company: _____

Postal Address: _____

Suburb/Postcode: _____ Telephone: _____

Email: _____

## 3. Premises contact

Name: _____

Company: _____

Postal Address: _____

Suburb/Postcode: _____ Telephone: _____

Email: _____

## 4. Refrigerant and system details

Type of system installed:

- ☐ Indirect system (i.e. chiller, cannot leak flammable refrigerant indoors) situated on a rooftop:
- ☐ Indirect system (i.e. chiller, cannot leak flammable refrigerant indoors) situated at ground level
- ☐ Direct system (e.g. air conditioning or process cooling, can leak refrigerant indoors)
- ☐ Outdoor industrial refrigeration plant
- ☐ Other (please specify) _____

Type of refrigerant: _____

Quantity of refrigerant: _____

Location of pressure-relief device installed: _____

**Note:** This should include location of release points if redirected via vents/pipes.

This form should be sent to the local fire station responsible for the site location.

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# Appendix D. References and Resources

## The following Standards are referenced in this guide:

**AS/NZS 1020** The control of undesirable static electricity

**AS 1210** Pressure vessels

**AS 1216** Class labels for dangerous goods

**AS 1482** Electrical equipment for explosive atmospheres – Protection by ventilation – Type of protection v

**AS/NZS 1596** The storage and handling of LP gas

**AS/NZS 1677.1** Refrigeration systems, part one: Refrigerant classification

**AS/NZS 1677.2** Refrigeration systems, part two: Safety requirements

**AS 2030.1** Gas cylinders – General requirements

**AS/NZS 2865** Safe working in a confined space

**AS 2931** Selection and use of emergency procedure guides for the transport of dangerous goods

**AS 2971** Serially produced pressure vessels

**AS/NZS 3000** Electrical installations (known as the Australian/New Zealand Wiring Rules)

**AS 3745** Planning for emergencies in facilities

**AS 4211.3** Gas recovery or combined recovery and recycling equipment – Fluorocarbon refrigerants from commercial/domestic refrigeration and airconditioning systems

**AS 4332** The storage and handling of gases in cylinders

**AS 4343** Pressure equipment – Hazard levels

**AS 4484** Gas cylinders for industrial, scientific, medical and refrigerant use – Labelling and colour-coding

**AS/NZS 4761.1** Competencies for working with electrical equipment for hazardous areas (EEHA) – Competency standards

**AS/NZS ISO 31000** Risk management – Principles and guidelines

**AS/NZS 60079.10.1** Explosive atmospheres – Classification of areas – Explosive gas atmospheres

**AS/NZS 60079.14** Explosive atmospheres – Electrical installations design, selection and erection

**AS/NZS 60079.17** Explosive atmospheres – Electrical installations inspection and maintenance

**AS/NZS 60079.29.2** Explosive atmospheres – Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen

**AS/NZS 60335.1** Household and similar electrical appliances – Safety – General requirements

**AS/NZS 60335.2.11** Particular requirements for tumble dryers

**AS/NZS 60335.2.24** Particular requirements for refrigerating appliances, ice cream appliances and ice makers

**AS/NZS 60335.2.34** Particular requirements for motor compressors

**AS/NZS60335.2.40** Particular requirements for electrical heat pumps, air conditioners and dehumidifiers

**AS/NZS 60335.2.75** Particular requirements for commercial dispensing appliances and vending machines

**AS/NZS 60335.2.89** Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor

**HB 158** Delivering assurance based on ISO 31000:2009 Risk management – Principles and guidelines

**NZS 5807** Code of practice for industrial identification by colour, wording or other coding

**ISO 5149** Mechanical refrigerating systems used for cooling and heating – Safety requirements

**ISO 817** Refrigerants – Designation system

**ISO 7010** Graphical symbols – Safety colours and safety signs – Registered safety signs

**ISO 10156** Gases and gas mixtures – Determination of five potential and oxidizing ability for the selection of cylinder valve outlets

**ASHRAE 34** Designation and safety classification of refrigerants

**www.infostore.saiglobal.com/store**

## The following SafeWork Australia approved codes of practice are referenced in this guide:

- Managing risks of hazardous chemicals in the workplace
- Managing the risks of plant in the workplace
- Managing electrical risks in the workplace

**www.safeworkaustralia.gov.au**

## The following documents were referred to when drafting this guide:

EN 378 – Refrigerating systems and heat pumps – Safety and environmental requirements

Part 1: Basic requirements, definitions, classification and selection criteria

Part 2: Design, construction, testing, marking and documentation

Part 3: Installation site and personal protection

Part 4: Operation, maintenance, repair and recovery

ISO/FDIS 5149 – Refrigerating systems and heat pumps – Safety and environmental requirements

Part 1: Definitions, classification and selection criteria

Part 2: Design, construction, testing, marking and documentation

Part 3: Installation site

Part 4: Operation, maintenance, repair and recovery

**www.infostore.saiglobal.com/store**

Victorian Code of Practice – Ammonia refrigeration (2010) **www.airah.org.au**

Design and manufacture of refrigerated cabinets running on hydrocarbon refrigerants – Final draft V1 for BRA, Federation of Environmental Trade Associations Ltd, 2012

Guide to flammable refrigerants, British Refrigeration Association, 2012 **www.feta.co.uk**

A2 & A3 Refrigerants (flammable including hydrocarbons) Code of Practice, The Institute Of Refrigeration (IOR), 2009 **www.ior.org.uk**

Operation of split air conditioning systems with hydrocarbon refrigerant, Proklima International, 2012

Guidelines for the safe use of hydrocarbon refrigerants: Deutsche Gesellschaft für Internationale Zusammenarbeit GIZ (2012) **www.giz.de**

Refrigerant Handling Code of Practice 2007 part one – Self-contained low-charge systems **www.airah.org.au**

Refrigerant Handling Code of Practice 2007 part two – Systems other than self-contained low-charge systems **www.airah.org.au**

## Research:

GTRC sponsored research papers and referenced documents inside these papers.

- Discussion paper to proposed revisions of AS/NZS 1677, March 2013
- Simulated LPG Leakage Tests using Carbon Dioxide as a Surrogate Gas, March 2013

## Regulatory links:

WHS Regulations
**www.safeworkaustralia.gov.au**

Petroleum and Gas (Production and Safety) Act 2004
**www.legislation.qld.gov.au**

Petroleum and Gas (Production and Safety) Regulations 2004 **www.legislation.qld.gov.au**

Queensland hydrocarbon refrigerant licensing
**www.mines.industry.qld.gov.au**
Placard manifest requirements
**www.safeworkaustralia.gov.au**

## Bulletins and alerts:

WA – Safe use of flammable refrigerants
**www.dmp.wa.gov.au**

NSW – Exposure to high concentrations of LPG: Safety alert
**www.workcover.nsw.gov.au**

NSW – Decanting of liquefied petroleum gas into cylinders: Safety alert **www.workcover.nsw.gov.au**

Transporting flammable gases: Safety alerts

- Qld – Safe storage and transport
  **www.deir.qld.gov.au**
- NT – Storing gas cylinders in vehicles
  **www.worksafe.nt.gov.au**
- Vic – Storing gas cylinders in vehicles
  **www.worksafe.vic.gov.au**
- NSW – Transporting of small gas cylinders
  **www.workcover.nsw.gov.au**

## Organisation Websites – Links to organisations

- **www.airah.org.au**
  Flammable refrigerant resources and technical publications
- **www.infostore.saiglobal.com/store**
  Australian and International Standards
- **www.safeworkaustralia.gov.au**
  WHS Act, Regulations and Codes of Practice
- **www.hsis.safeworkaustralia.gov.au**
  Hazardous substances information system
- **www.erac.gov.au**
  Electrical regulations and mandatory electrical product standards

## Training

Link to VET Training
**www.training.gov.au**
Database on Vocational Education and Training in Australia

Link to BOC online training
**www.boconline.co.uk**
BOC online safety training