HVAC&R Skills Workshop

MODULE 110

PROUDLY SPONSORED BY

AIRAH

REFRIGERATION SAFETY AND ENVIRONMENTAL REQUIREMENTS

STANDARD AS/NZS 5149

Skills summary

What?
A guide to the updated standard AS/NZS 5149, which deals with safety aspects of design, construction, installation and inspection of refrigeration and heat pump systems

Who?
HVAC&R apprentices, teachers, lecturers, contractors, facility managers, installers, mechanics/technicians and maintainers.

In 2016, Standards Australia adopted and published the new refrigeration safety and environmental standard *AS/NZS 5149 Refrigerating systems and heat pumps – Safety and environmental requirements*, replacing AS/NZS 1677.2:1998. The new AS/NZS 5149 standard is published in four parts comprising over 160 pages of technical safety and environmental requirements.

This Skills Workshop looks at the content of *AS/NZS 5149.1:2016 Part 1 Definitions, classification and selection criteria and AS/NZS 5149.2:2016 Part 2 Design, construction, testing, marking and documentation.* It complements Module 102, which can be found in HVAC&R Nation, June 2017.

PULL OUT

Standard AS/NZS 5149 specifies requirements for the safety aspects, in terms of the design, construction, installation and inspection of refrigerating appliances, systems and ancillary equipment intended for use or installation in institutional, public assembly, residential, commercial and industrial occupancies.

It applies to all stationary or mobile refrigerating systems excluding vehicle air conditioning. It can be applied to new systems, and existing system modifications, relocations and conversions, and also applies in the case of the conversion of a system for use with another refrigerant. It contains nearly one hundred helpful definitions related to system types, system locations, system pressures, system components, piping components, safety devices, working fluids, and refrigerant disposal.

PART 1: DEFINITIONS, CLASSIFICATION AND SELECTION CRITERIA

One of the most important functions of this standard is to enable a determination of the maximum safe quantity of refrigerant (charge) that is permitted in a particular system, based on the type and application of the system and the AS/NZS ISO 817 refrigerant classification. The standard also specifies system safety and environmental requirements for different refrigerant classifications based on the occupancy classification, the system classification and the location classification.

There are three categories of occupancy:
General occupancy – a
Supervised occupancy – b
Authorised occupancy – c

A list of typical examples is provided for each in Table 1. In Australia and New Zealand, machinery rooms are considered Authorised occupancy – c.

Categories	General characteristics	Examples
General occupancy – a	Rooms, parts of buildings, buildings where: • Sleeping facilities are provided • People are restricted in their movement • 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 termini, hotels, dwellings and restaurants.
Supervised occupancy – b	Rooms, parts of buildings, buildings where only a limited number of people can be assembled, some being necessarily acquainted with the general safety precautions of the establishment.	Offices, laboratories, places for general manufacturing, workplaces.
Authorised occupancy – c	Rooms, parts of buildings, buildings 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, for example, for chemicals, food, beverage, ice and ice-cream. Refineries, cold stores, dairies, abattoirs, and non-public areas in supermarkets.

Note: Occupancies can be classified by national requirements

Table 1: Categories of occupancy (from AS/NZS 5149.2:2016)

There are two main types of system classifications: direct and indirect. This is based on the heat transfer method used and the potential for leaks to enter occupied spaces, with several sub-categories within each class. For clarity the standard provides a schematic drawing of each system type.

- Direct systems do not use a secondary heat transfer fluid and include direct, open-spray, direct-ducted, and open-vented spray systems.
- Indirect systems do use a secondary heat transfer fluid and include indirect closed, indirect vented, indirect vented closed, double-indirect and high-pressure indirect systems.

There are four location classifications for these systems:

Class I Refrigerant-containing parts located within an occupied space

Class II Compressors and pressure vessels located in a machinery room or in the open air

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

Class IV Refrigerant-containing parts located in a ventilated enclosure.

From AS/NZS 817, refrigerants are classified into safety groups according to their flammability and toxicity, as shown in Table 2.

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

Table 2: Refrigerant Safety Classifications (from AS/NZS ISO 817:2016)

The maximum charge of refrigerant allowed in any specific application is calculated in accordance with the procedures of Annex A in the standard. This maximum quantity refers to the largest charge of any single refrigerating system within a space; each separate system or independent circuit is considered separately.

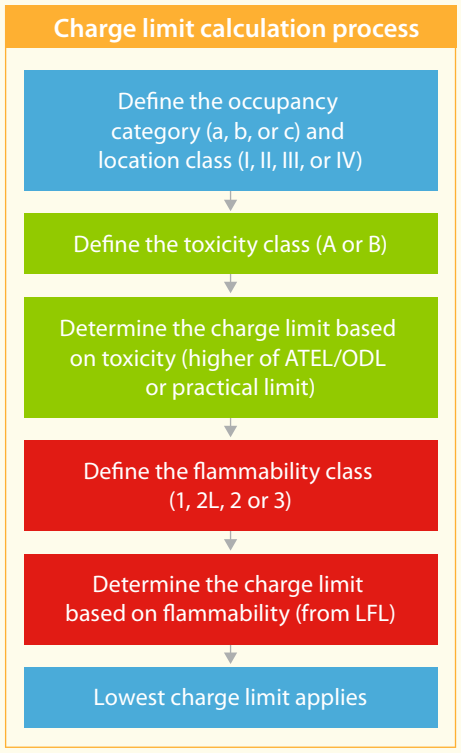
Maximum refrigerant quantities cannot be calculated for systems and appliances already covered by IEC or ISO product standards that specify refrigerant quantity limits. For example, allowable charge limits for multi-split and VRF air conditioners using A2L refrigerants are defined in AS/NZS 60335.2.40, so Annex A and Clause A.5 are not applicable to those system types.

Annex A outlines how to calculate the refrigerant charge limit for toxicity-based limits and flammability-based limits. The allowable charge can exceed this or be restricted below this under certain circumstances. For example, for spaces above 250m^2 floor area the charge limit calculations must use 250m^2 as the floor area. The charge limits for flammable A2L, A2, and A3 refrigerants are capped to a limit based on the LFL. For A2L refrigerants this cap is increased by a factor of 1.5 in recognition of the lower burning velocity of these refrigerants.

A1 and A2 charge limits are calculated based on the classification of occupancy, the system location and the class of the refrigerant. The charge limit is either the toxicity limit, which is based on the RCL, or the flammability limit, which is based on the LFL – whichever is smaller. Tables B1 and B2 provide all the refrigerant data required, including the safety classification, the practical limit, the ATEL/ODL, the LFL as well as environmental data such as the ODP and GWP of the refrigerant.

The standard also specifies how the space volume calculations must be carried out, for every space where there are refrigerant-containing parts. It clarifies how multiple inter-connected spaces, ducted multi-enclosure systems, building voids and false ceilings are treated. Volumes used are nett volumes, with appropriate allowances made for stored product, fittings and fixtures.

Where charge limits for A1 and A2L refrigerants are exceeded in a space, the system can still comply if special provisions are made to ensure at least an equivalent level of safety. These special provisions are detailed in paragraph A5 where the allowable refrigerant charge can be increased using QLMV



(Quantity Limit with Minimum Ventilation) or QLAV (Quantity Limit with Additional Ventilation). Special provisions can include natural or mechanical ventilation, safety shut-off valving, and safety alarms used in conjunction with refrigerant gas detection.

The standard also outlines how heat transfer fluids used in indirect systems must be treated, if they are one of the types listed in Annex B.

Annex C is an informative appendix that outlines some of the potential hazards for refrigerating systems that result from extremes of temperature, excessive pressure, refrigerant charge issues, refrigerant leaks and plant operation.

The variations made to ISO 5149.1:2014 to make it suitable for use in Australia and New Zealand are listed in Appendix ZZ.

Appendix ZA has been added to provide worked examples of determining allowable charge limits for several different refrigerant scenarios. Calculation of allowable charge limits can be complex given the many variables involved, and examples have been provided to assist users of the standard. These include:

- A machinery room for refrigerant R290
- A supermarket medium temperature rack system using R134a – public area
- A supermarket medium temperature rack system using R134a – plant room
- Self-contained refrigerated display cabinet using R290
- Cool room with a remote condensing unit for refrigerant safety Group A1 – no public access
- Cool room with a remote condensing unit for refrigerant safety Group A1 – with public access
- Cool room with a remote condensing unit for refrigerant safety Group A3 – with public access.

Appendix ZB outlines the relationship between the refrigerant safety classification system of AS/NZS 5149, the Australian Dangerous Goods (ADG) code and GHS classification systems (see below). These systems use different flammability classifications and the Appendix has been provided to clarify any potential confusion and misapplication.

PART 2: DESIGN, CONSTRUCTION, TESTING, MARKING AND DOCUMENTATION

This part of 5149 contains all the technical detail in relation to the design and construction of the system including pipes, piping components and fittings, component and system testing, marking and documentation, as well as the requirements for assemblies of components. More stringent requirements apply as the toxicity or flammability classification of the refrigerant increases (see Table 2).

Class 2L refrigerants must comply with the same requirements as Class 2 refrigerants unless specifically excluded or varied in the standard. There are several areas in ISO 5149.2 where stringency has been reduced for Class 2L refrigerants and several areas in AS/NZS 5149.2 where these stringency reductions have been amended (removed) for Australian use, for example excluding A2L refrigerants from the concessions of Clause 5.2.3.7 and amending Clause 5.2.7.2 to not allow fusible plugs to be used with A2L refrigerants.

The standard covers general requirements for pipes, components and assemblies, and specific requirements for piping joints, isolating valves, and materials that are used in the system. See for example Table 3 on copper pipe supports.

Outside diameter	Spacing
15 to 22mm (soft)	2m
22 to <54mm (half hard)	3m
54 to 67mm	4m

Table 3: Recommended maximum spacing for supports for copper pipes (from AS/NZS 5149.2:2016).

The testing required includes strength-pressure tests to establish fitness for purpose (which includes component testing, strength type testing or fatigue testing), tightness tests (to detect potential leaks) and a functional test of all the electrical safety circuits. The completed installation must also be inspected and safety-verified with the results recorded. A system visual inspection checklist is provided in Annex A.

Installation is covered in detail in the standard including location, access, pressure limiting arrangements, protection devices, testing, marking and documentation. As components are assembled into systems the standard covers issues such as plant support, maximum allowable pressures, pipe and fitting assembly, pipe location, support and protection, draining and venting arrangements, shut-off devices, pressure relief and relief pathways. There are a range of options available for pressure relief and a comprehensive four-page decision flow chart guides users through the various safety considerations and decision points for pressure protection.

PULLOUT

CLASSIFICATION CONFUSION

Appendix ZB of AS/NZS 5149.1 clarifies that the refrigerant R1234ze is classified as Lower Flammability A2L by ISO 817 but it is classed as non-flammable, non-toxic under the ADG and GHS systems; "Division 2.2" under ADG, and as "Gas Under Pressure H280" under GHS.

Most other A2, A2L (R32, R1234yf) and A3 (R290, R600a) refrigerants are classed as "Division 2.1 Flammable gases" under ADG, and as "Flammable Gases Category 1 H220" under GHS.

ADG and GHS classifications

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** Flammable gases Non-toxic gases	 **Division 2.2** Non-flammable	 **Division 2.3** Toxic gases

To determine which specific requirements apply, the assemblies must be categorised into one of four risk categories I, II, III, or IV depending on the GHS classification of the refrigerant, the phase of refrigerant in the assembly (gas/liquid), the strength pressure (PS) and the volume of the vessel or diameter of pipe/fitting. The risk category of the "assembly" is determined based on the highest risk category of the components it consists of.

All systems and the main components must be identified by marking, including the shut-off device and main control devices.

An identification plate must show the manufacturer/installer name, model number, manufacture year, refrigerant designation, refrigerant charge and maximum allowable pressures for high- and low- pressure sides of the refrigerant circuit.

The installer must provide a certificate of compliance that lists the settings of any adjustable safety devices. The installer must also provide a range of site documentation such as operating instructions, drawings (for complex systems) and a refrigerant log book for all systems with a refrigerant charge over 3kg.

Additional requirements for large volume R717 ammonia-based systems are included in Annex B.

The following variations were made to ISO 5149.2:2014 to allow its use in Australia and New Zealand:

- The standard does not apply to systems that are relocated
- Reference is made to AS 1170.4/NZS 4219 for information on seismic loading
- For 2L lower flammability refrigerants (such as Ammonia, R32 and R1234yf)
  - pipework must be protected to prevent damage
  - apart from the final connection to the unit, joints in occupied spaces must be permanent
  - system components must be shipped without refrigerant charge
- Systems using A2L refrigerants cannot use fusible plugs
- The hot surface temperature requirements have been made more stringent for all refrigerants
- The protection against explosion requirements have been extended to include A2L and B2L refrigerants
- The assessment of flammable refrigerants and associated ignition sources must be in accordance with AS/NZS 60079.10.1, including electrical compliance with AS/NZS 60079.14 where applicable
- Protection by ventilation provisions must meet the requirements of the AS/NZS 60079 series. ■

ADG Code Parts 1 and 2.

Glossary of acronyms

ADG	Australian Dangerous Goods
ATEL	Acute Toxicity Exposure Limit
GHS	Globally Harmonised System
GWP	Global Warming Potential
LFL	Lower Flammability Limit
ODL	Oxygen Deprivation Limit
ODP	Ozone Depletion Potential
QLAV	Quantity Limit with Additional Ventilation
QLMV	Quantity Limit with Minimum Ventilation
RCL	Refrigerant Concentration Limit
VRF	Variable Refrigerant Flow

MORE INFORMATION

This month's Skills Workshop was written by AIRAH Technical Advisor Vince Aherne, M.AIRAH.

For complete technical details refer to AS/NZS 5149 parts 1 and 2.

STANDARDS Australia

Next month:
Split system AC units – Secure fixing and safe condensate discharge