VICTORIAN CODE OF PRACTICE

AMMONIA REFRIGERATION

Edition 1 – 2010
ACKNOWLEDGEMENTS

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CODE OF PRACTICE – AMMONIA REFRIGERATION
THE LEGISLATIVE FRAMEWORK - VICTORIA

Occupational Health & Safety Act 2004

The 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.

Occupational Health & Safety Regulations 2007

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

Dangerous Goods Act 1985

The Act sets out the general duties for the manufacture, storage, transport, transfer, sale and use of dangerous goods and the import of explosives into Victoria. The Act also enables regulations to be made about dangerous goods.

Dangerous Goods (Storage & Handling) Regulations 2000

The Regulations set out specific duties for people who manufacture, import, supply, store or handle dangerous goods. Section 45(1) of the Act states that failure to comply with regulations made under the Act is an offence.

Code of Practice Victoria - Ammonia Refrigeration

The Code provides practical guidance to companies that have industrial ammonia plants onsite on how to comply with the Regulations.

Code of Practice for the Storage and Handling of Dangerous Goods

The Code provides practical guidance to manufacturers and suppliers of dangerous goods, and occupiers storing and handling those dangerous goods, on how to comply with the Regulations.

Key Australian Standards relating to industrial ammonia refrigeration that are referred to in this Code are:
AS/NZS 1677 Part 1- 1998 – Refrigeration systems, Refrigerant Classification
AS/NZS 1677 Part 2 – 1998 – Refrigeration systems, Safety Requirements
AS/NZS 2022 – 2003 – Anhydrous Ammonia – Storage & Handling
AS 3788 – 1996 – Pressure Equipment, In-service Inspection

NB: Always refer to the current standard.
PART 1: INTRODUCTION

1.1 WHAT IS A CODE OF PRACTICE?

The Dangerous Goods Act 1985 (the Act) empowers the Minister to approve codes of practice.

What are they?

An approved code of practice gives practical guidance on how to comply with a general duty under the Act or a specific duty under the Regulations. Compliance with the provisions in an approved code of practice, where relevant, may constitute compliance with the provisions of the Act or Regulations to which the code is giving practical guidance.

Generally, an approved code of practice contains various courses of action which are designed to achieve health and safety standards required to comply with the Act and Regulations. Codes usually contain a number of options for meeting standards.

Who do they apply to?

Codes of practice may be written to provide practical guidance for any person placed under obligation by the Act or its Regulations, for example, occupiers, manufacturers and employees.

Each approved code of practice will state the people for whom the guidance is intended.

What is their legal status?

The provisions in a code are not mandatory. That is, a person may choose to comply with the relevant provision of the Regulations in some other way, provided that the method used also fulfils the requirements of the Regulations. A person or company cannot be prosecuted simply for failing to comply with an approved code of practice.

However, in legal proceedings, failure to observe a relevant approved code of practice can be used as evidence that a person or company has contravened or failed to comply with the provisions of the Act or Regulations. If a person has not adopted the method described in the code, it is up to that person to show that the legal requirement has been met by an alternative method. Therefore, an approved code of practice should be followed, unless there is an alternative course of action that would also fulfil the requirements of the Act or Regulations.

A WorkSafe inspector may cite an approved code of practice as a means of remedying alleged non-compliance when issuing an Improvement Notice or a Prohibition Notice. Similarly, a health and safety representative may cite an
approved code of practice in a Provisional Improvement Notice when providing
directions as to how to remedy an alleged non-compliance.
1.2 WHAT IS AN INDUSTRY CODE OF PRACTICE?

An informative guide to facilitate safe working conditions in relation to ammonia refrigeration systems. This Industry Code will be helpful to all people working in and around ammonia refrigeration systems.

An industry code of practice is a practical guide to employers and others who have duties under the Occupational Health and Safety Act 2004 (the OHS Act), the Occupational Health and Safety Regulations 2007 (OHS Regulations), The Dangerous Goods Act 1985 and the Dangerous Goods (Storage & Handling) Regulations 2000,

An industry code of practice is intended to be used in conjunction with the requirements of the Acts and Regulations above but does not have the same legal force. An industry code of practice is advisory rather than mandatory. However, in legal proceedings under the Acts or Regulations, failure to observe a relevant industry code of practice is admissible in evidence concerning an offence under the OHS Act or Regulation.

1.3 COMPETENCIES OF PEOPLE CARRYING OUT DUTIES.

A Competent Person

WorkSafe Victoria has defined a Competent Person regarding occupational health and safety in document titled

How WorkSafe applies the law in relation to Employing or engaging suitably qualified persons to provide health and safety advice

Edition No 1 October 2008

Follow this link to view the document www.worksafe.vic.gov.au/Employing or engaging suitably qualified persons to provide health and safety advice

1.4 RELATIONSHIP WITH OTHER CODES OF PRACTICE

This ammonia refrigeration code should be used in conjunction with the Code of Practice for the Storage and Handling of Dangerous Goods (2000) and Safe Operation of Cold Storage Facilities, 2008 - www.worksafe.vic.gov.au

1.5 PROPERTIES OF ANHYDROUS AMMONIA

The chart below lists Anhydrous Ammonia physical and chemical properties.
### Physical and Chemical Data

**Anhydrous Ammonia**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular symbol</td>
<td>NH₃</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>17.03</td>
</tr>
<tr>
<td>Appearance</td>
<td>liquid and gas, colourless</td>
</tr>
<tr>
<td>Odour</td>
<td>penetrating, pungent</td>
</tr>
<tr>
<td>Boiling point at 101.3 kPa abs.</td>
<td>33.4°C</td>
</tr>
<tr>
<td>Freezing point at 101.3 kPa abs.</td>
<td>177.7°C</td>
</tr>
<tr>
<td>Critical temperature</td>
<td>132.4°C</td>
</tr>
<tr>
<td>Critical pressure</td>
<td>11.95 kPa</td>
</tr>
<tr>
<td>Critical density</td>
<td>235 kg/m³</td>
</tr>
<tr>
<td>Specific volume of gas at 15°C and 101.3 kPa abs</td>
<td>approximately 1.387 m³/kg</td>
</tr>
<tr>
<td>Heat of fusion</td>
<td>332.9 kJ/kg</td>
</tr>
<tr>
<td>Heat of formation, gas, at 25°C</td>
<td>2721.6 kJ/kg</td>
</tr>
<tr>
<td>Specific heat, gas, at 15°C – Cp</td>
<td>2177.1 J/(kg°C)</td>
</tr>
<tr>
<td>– Cv</td>
<td>1632.9 J/(kg°C)</td>
</tr>
<tr>
<td>Thermal conductivity – Gas at 0°C</td>
<td>0.9222 w/m°C</td>
</tr>
<tr>
<td>Liquid –15°C – 35°C</td>
<td>0.502 w/m°C</td>
</tr>
<tr>
<td>Electrical conductivity – Liquid at –35°C</td>
<td>&gt;1 x 10⁷ ohm/cm</td>
</tr>
<tr>
<td>– Liquid at –79°C</td>
<td>13 x 10⁷ ohm/cm</td>
</tr>
</tbody>
</table>

**Aqueous Ammonia**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>colourless liquid</td>
</tr>
<tr>
<td>Colour</td>
<td>penetrating, pungent</td>
</tr>
<tr>
<td>Density at 15°C – 25% ammonia solution</td>
<td>810 kg/m³</td>
</tr>
<tr>
<td>Density at 15°C – 32% ammonia solution</td>
<td>890 kg/m³</td>
</tr>
<tr>
<td>Volume of solution per litre – 25% ammonia solution</td>
<td>1103 litres approx.</td>
</tr>
<tr>
<td>Volume of solution per litre – 32% ammonia solution</td>
<td>1125 litres approx.</td>
</tr>
<tr>
<td>Heat absorption of anhydrous gas in water when forming 10% solution</td>
<td>2035 kJ/kg</td>
</tr>
<tr>
<td>Heat of solution of anhydrous liquid in water when forming 10% solution</td>
<td>500 kJ/kg</td>
</tr>
<tr>
<td>Volume of anhydrous gas absorbed by 1 volume of water at –18°C</td>
<td>1.148 volumes</td>
</tr>
</tbody>
</table>

**Note 1**: Ammonia concentrations in air are flammable in concentrations between 15 and 28%. The Lower Explosive Limit (LEL) of ammonia in air mixtures is 15% = 150,000 ppm. Any combustion equipment (such as boilers), naked flames or air compressors shall not be located in the ammonia refrigeration machinery room space.

**Note 2**: It is mandatory that you obtain a current (less than 5 years of issue date) Material Safety Data Sheet from your supplier.
PART 2: SAFETY REQUIREMENTS FOR DESIGN AND MODIFICATION

2.1 INTRODUCTION

This provides a guide for the design and the requirements for refrigeration systems, Plant Room and cool room constructions where ammonia is used as a refrigerant.

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

2.2 BUILDING CODE OF AUSTRALIA (BCA) - 2010 COMPLIANCE

REQUIREMENTS FOR AMMONIA REFRIGERATION SYSTEMS AND COOLROOM CONSTRUCTION

Ammonia (Type B2) Refrigerant, Unrestricted Charge Category III Occupancy

Most refrigerated buildings are classified as “Class 7b” this classification is determined by the purpose for which it is designed, constructed or adapted to be used. A Class 7b building is one used “for storage, or display of goods or produce for sale by wholesale”, a plant or machinery room must have the same classification as the part of the building in which it is situated.

The BCA requirements read in relation to ammonia refrigeration systems and cool-rooms can be broken into three broad categories:

Category 1 - Ammonia Refrigeration Systems:

BCA – Section E, Services and Equipment,
E1.0 Deemed-to-Satisfy Provisions.
(a) Where a Building Solution is proposed to comply with the Deemed-to-Satisfy Provision, Performance Requirements EP1.1 to EP1.6 are satisfied by complying with E1.1 to E1.10.
E1.10 Provision for special hazards.
Stating: -
Suitable additional provision must be made if special problems of fighting fire could arise because of:
(a) The nature or quantity of materials stored, displayed or used in a building or on the allotment.

Interpretation:
The refrigerant anhydrous ammonia is classed as a toxic gas. When involved in fire or leak it can present hazardous conditions to those on site, attending
emergency responders and the local community. The building surveyor must ensure that this special provision has been adhered to in the design, documentation and ongoing maintenance plans of the plant as part of the sign off procedure.

**Recommended Solution:**
- The respective building surveyor has to be a competent person qualified for the inspection or an independent third party engagement is required.
- Engage the services of a person that can show competence by demonstrating their experience and abilities as ammonia refrigeration system designers as well as their knowledge of the Acts and Regulations in this code and the AS/NZS1677.2-1998, for example a member of AIRAH or IEAust.

**Category 2 - Refrigerated Cool-rooms:**

**BCA – Section G, Ancillary Provisions,**
**G1.0 Deemed-to-Satisfy Provisions.**

(b) Where a Building Solution is proposed to comply with the Deemed-to-Satisfy Provision, Performance Requirements GP1.2 to GP1.4 are satisfied by complying with G1.1 to G1.2.

**GF1.3 Refrigerated chambers, strong-rooms and vaults**

**Stating:** -
(a) A refrigerated or cooling chamber, strongroom or vault or the like that is capable of accommodating a person is to have safety measures to facilitate escape and for alerting people outside such a space in the event of an emergency.

**Performance Requirements.**

**GP1.3**

Any refrigerated or cooling chamber, or the like which is sufficient size for a person to enter must:
(a) Have adequate means of communicating with or alerting other occupants in the building in the case of an emergency; and
(b) Have a door which is:
(i) Of adequate dimensions to allow occupants to readily escape; and
(ii) Be openable from inside without a key at all times.

**Interpretation:**

- AS/NZS 1677.2:1998.4.2 Safety Provisions for Personnel In Refrigerated Spaces. This section provides an extended list that covers the items related to safety of personnel in refrigerated spaces, this could be used as a guide when designing deemed to comply outcomes.
- The respective building surveyor is to sign off the room’s safety provisions after the designer has confirmed compliance.

**BCA 2010  - Prescriptive Approach**

**G1.2 – Refrigerated chambers, strong-rooms and vaults**
(a) A refrigerated or cooling chamber, strongroom or vault which is of sufficient size for a person to enter must have-

(i) a door which is capable of being opened by hand from inside without a key; and

(ii) internal lighting controlled only by a switch which is located adjacent to the entrance doorway inside the chamber, strongroom or vault; and

(iii) an indicator lamp positioned outside the chamber, strongroom or vault which is illuminated when the interior lights required by (a) (ii) are switched on; and

(iv) an alarm that is-

a. located outside but controllable only from within the chamber, strongroom or vault; and

b. able to achieve a sound pressure level outside the chamber, strongroom or vault of 90dB(A) when measured 3m from the sounding device.

(c) A door required by (a) (i) in a refrigerated or cooling chamber must have a doorway with a clear width of not less than 600mm and a clear height not less than 1.5m

Interpretation:
- AS/NZS 1677.2:1998,4.2 Safety Provisions for Personnel In Refrigerated Spaces. This section provides an extended list that covers the items as shown above.
- The respective building designers surveyor is to sign off these room safety provisions.

Category 3 - Insulated Panels for Cool-room Construction:

BCA – Section C, Fire Resistance,
C1.10 Deemed-to-Satisfy Provisions.
1. Scope
This Specification sets out requirements in relation to the fire hazard properties of

(a) floor materials and floor coverings; and

(b) wall and ceiling linings.

2. Class 2 to 9 buildings: General requirements

(d) In the case of a composite member or assembly, be constructed so that when assembled as proposed in a building-

(i) Any material which does not comply with (clause 1) is protected on all sides and edges from exposure to air; and

(ii) The member or assembly, when tested in accordance with Specification A2.4, has a Smoke-Developed Index and Spread-of – Flame Index not exceeding those prescribed in (b); and
(iii) The member or assembly retains the protection in position so that it prevents ignition of the material and continues to screen it from access to free air for a period of not less than 10 minutes.

C1.10a Deemed-to-Satisfy Provisions.

3. Walls and Ceilings

(b) The group number of a material is as follows when tested or predicted in accordance with sub-clause (a)

(i) A Group 1 material is one that does not reach flashover when exposed to 100kW for 600 seconds followed by exposure to 300 kW for 600 seconds.

(ii) A Group 2 material is one that reaches flashover when exposed to 300kW for 600 seconds after not reaching flashover when exposure to 100 kW for 600 seconds.

(iii) A Group 3 material is one that reaches flashover in more than 120 seconds but within 600 seconds when exposure to 100 kW.

(c) A material used as a finish, surface lining or attachment to a wall or ceiling lining must be a Group 1, Group 2 or Group 3 material used in accordance with Table 2 and for buildings not fitted with a sprinkler system complying with Specification E1.5, have –

(i) A smoke growth rate index not more than 100, or

(ii) An average specific extinction area less than 250m²/kg.

Interpretation:
Test Standard AS ISO 9705:1993
Fire Test Certification:
Class of building 7, Wall and Ceiling Lining Materials (Material Groups Permitted)

- Expanded Polystyrene (EPS) sandwich panel. This material complies with Groups 1, 2 and 3 providing the relevant construction panel thickness limits and installation fixings parameters are followed. The smoke growth index identified in BCA Specification C1.10a, clause 3c is not more than 100 m²/s² *1000, and the product may be used in buildings with or without a sprinkler system complying with specification E1.5.

- Polyisocyanurate (PIR) foam core sandwich panel. This material complies with BCA Group 2 and 3, providing the relevant construction panel thickness limits and installation fixings parameters are followed. The smoke growth index identified in BCA Specification C1.10a, clause 3c is not more than 100 m²/s² *1000, and the product may be used in buildings with or without a sprinkler system complying with specification E1.5.

- Polystyrene/Phenolic composite foam (PPCS) sandwich panel. This material complies with BCA Group 1, 2 & 3, providing the relevant construction panel thickness limits and installation fixings parameters are followed. The smoke growth index identified in BCA Specification C1.10a, clause 3b (i) Group 1 and 3c (i) is not more than 100 m²/s² * 1000, and the
product may be used in buildings with or without a sprinkler system complying with specification E1.5.

**Comparison Table.**
Simultaneous Determination of Ignitability, Flame Propagation, Heat Release and Smoke Release to AS/NZS1530.3:1999, (Data from test certificates) Zero is the best result.

<table>
<thead>
<tr>
<th>Panel Type</th>
<th>Ignitability Index (0-20)</th>
<th>Spread of Flame Index (0-10)</th>
<th>Heat Evolved Index (0-10)</th>
<th>Smoke Developed Index (0-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPS-Enclosed Panel(^1)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0 to 1</td>
</tr>
<tr>
<td>PIR – Steel Faced Sandwich Panel(^2)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>PPCS – Steel Faced Sandwich panel(^3)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Table 1

**Conclusion:**

- Based on this review all panel types are in compliance with the BCA regulations,
- EPS – it is strongly recommended that Group 1 construction be specified for large commercial and industrial installations as this will provide improved fire hazard properties.
- PIR complies with Group 2 or Group 3 BCA ratings. Recommendations are to specify Group 2 installations, as this will provide improved fire hazard properties. Note Group 2 is excluded for Fire-isolated exits which is a Group 1 application.
- PPCS complies with all three BCA group ratings. Recommendations are to specify Group 1 installations for large commercial and industrial applications, as this will provide the optimum fire rating performance.
- Most insurance companies have expressed support for either PIR or PPCS panel materials. Consult your insurance company for further information.

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2 CSIRO Report FNE8218, 20\(^{th}\) July 2003. Kingspan, Insulated panel results to AS1530
- **Approvals for new projects** may require the input of the local fire authority. In some cases the local fire authority may override BCA requirements.

- **It can be seen that all three-panel types** in common use have similar fire hazard properties.

- **The building surveyor** would sign off the BCA construction group as part of the development application permit.

- **This interpretation** is intended to be used as a guide only it is not a substitute for not following the correct compliance and approvals procedures.

- **Purchasers** of insulated panel products should request copies of the suppliers fire test data reports to verify the quality of products being offered. These reports should be passed onto the building surveyor or relevant authority.

- Fire services have expressed concerns in relation to the appropriateness of the test methods cited in BCA Specification C1.10a for testing composite materials and materials with thermoplastic cores, such as EPS. These concerns were detailed in a submission to the Building Codes Board by representatives from the insurance industry, registered testing authorities and fire safety engineers. It is recommended that the Chief Officer of the local fire brigade be engaged and nominated as a stakeholder by the building owner and design team to introduce the fire brigade to the trial concept design so that relevant fire safety and fire fighting matters are highlighted at an early stage.

- A risk based assessment should be conducted for all buildings incorporating sandwich panel systems. Each building should be considered on its own merit, taking account of the application, choice of sandwich panel system and fire risk measures in place. Prevention of ignition and containment of early fire spread is critical. Specific and detailed risk assessment is crucial. Where high levels of fire risk management are not achievable, and the risk of ignition is high, the use of panel systems with high fire performance characteristics should be considered.

- **Informative - Additional guidance from the Fire Services on Sandwich Panel Systems** can be found on the following link.

2.3 **RECOMMENDATIONS/ADVICE FOR OWNERS/OCCUPIERS (INFORMATIVE)**

2.3.1 **AMMONIA - AIR MIXTURES AND SOURCES OF IGNITION**

Escaped Ammonia can create a flammable air mixture under certain conditions and be able to be ignited from common sources of ignition. The most likely sources of ignition found in ammonia refrigeration machinery rooms relate to
electrical items. Ammonia’s relatively high Lower explosive level (LEL) allows for ammonia air concentrations to be monitored and alarmed at levels well below the LEL. Australian and international standards indicate that specially protected electrical items are not required in ammonia refrigeration machinery rooms provided all electrical circuits are isolated at a safe location should the ammonia concentration detected inside the machinery room reach 20% of LEL or 30,000 PPM. The only exceptions are the exhaust fan/s which must be fitted with EXN or explosion proof motors (as per ISO50079) and ideally wiring systems complying with Zone 2 AS/NZS2381.1:1999 - cable, the emergency lighting which will also must be explosion proof with individual battery backup the LEL ammonia detection system only needs to be explosion proof if it is to operate at high levels and have a UPS (battery back-up) good for at least 1 hour. Unprotected electrical equipment should not be installed within 1m of charging and draining points or safety relief valve outlets.

The indication that specially protected electrical items are not required means that the ammonia refrigeration machinery room will not be declared a hazardous area under AS/NZS2430.1.1:1997 and standard electrical equipment can be installed and used within the machinery room space.

This document reviews the Classification of Hazardous areas of a Refrigeration ammonia plant in regard to AS/NZS2430.1:1997
Ammonia has a flammability range of 15 to 34%, and the Lower Explosion Level (LEL) of ammonia is 150,000 ppm. Which is well above easily detectable levels and in orders-of-magnitude is above accepted levels of occupational health exposure of less than 50 parts per million (ppm). Attention to personal health and safety in ammonia plants for ammonia concentrations lower than the explosive limit is listed in AS/NZS 2430.3.9:1997.
Section 7.2.3 (AS/NZ 2430.3.9:1997) Filling or unloading points and the discharge of relief valves. The area within 1m in all directions surrounding each point is classed as a Zone 2 Hazardous area.

Providing the plant room is adequately ventilated the areas as listed above would be classed as Zone 2 hazardous areas. Maintenance procedures should be put in place to ensure operation of the installed exhaust fan/s or natural ventilation. In practice the filling and unloading points within the ammonia plant room, should be reviewed to ascertain that a 1m separation is maintained between any of the described points and any hazardous electrical equipment installation.

Isolating all electrical circuits from a "safe location" means a location outside of the machinery room in a safe area where ammonia - air mixtures are very unlikely to be present. The safe area may be an electrical switch room separated from the machinery room by a sealed gas tight wall.

The static or forced ventilation requirements must comply with AS/NZS1677.2:1998.
The nature of refrigerated spaces is that they are usually well sealed. Therefore it is possible that high concentrations of ammonia in air could occur in spaces directly refrigerated using ammonia if there were a rupture in the evaporator/s. Detecting ammonia concentrations reliably in air can be difficult at temperatures below freezing. It is of great importance to select a suitable ammonia detector for this type of application. Generally speaking refrigerated spaces using direct ammonia are not required to be fitted with detectors for AS1677 compliance, but may be good risk management practice. They are not deemed to be occupied spaces. Whilst there are no records of ammonia fires or explosions in refrigerated spaces in Australia or New Zealand, there have been incidents reported overseas. Direct refrigerated spaces need to be considered when evaluating risks with ammonia.

2.3.2 FIRE SPRINKLERS IN MACHINERY ROOMS

Most common ammonia refrigeration compressors are open driven by drip proof squirrel cage electric motors.

Some compressors are fitted with TEFC (totally enclosed fan cooled) motors (which are weatherproof) and weatherproof control systems. These machines are generally installed outdoors.

Deluging a drip proof motor with water will be likely to cause major damage and burnout.

Therefore it is undesirable to use water based fire sprinklers in an ammonia refrigeration machinery room with drip proof motors. In the unlikely event that all of the equipment in the machinery room is weatherproof, then sprinklers would be acceptable.

Note: The decision regarding the type and installation of sprinklers in machinery rooms will consequently be determined by the fire engineer, the building surveyor and the user’s insurance company.

2.3.3 OTHER EQUIPMENT CONSIDERATIONS

Air compressors shall not be located in ammonia refrigeration machinery rooms. Possible issues – ingress of ammonia into the processed air will distribute it throughout the plant.

2.3.3.1 Pipe Stress analysis is mandatory for low temperature systems as per AS/NZS 4041 – Pressure Testing. For more information see Appendix 1

2.3.4 BEST PRACTICE FOR PLANT ROOM CONSTRUCTION

Ammonia refrigeration plant rooms should be constructed from fire resistant materials such as concrete. This will make an effective fire separation and in most instances eliminate the requirement for fire sprinklers and also help to contain ammonia leaks. Walls and doors which separate ammonia refrigeration
plant rooms from other parts of the building, ceiling spaces, switch rooms, boiler rooms etc. should have at least a 1 hour fire rating, however local building or fire regulations may call for a higher fire rating.

The floors should be concrete and areas where liquid ammonia leaks are possible, such as under liquid ammonia pumps, should be bunded. The floors should be graded and drained to the sewers via appropriate interception pits.

Drums of new refrigeration oil and oil drained from the plant waiting for disposal or recycling should be stored in bunded storage areas undercover. Refrigeration oil must not, in any circumstances, be disposed of through the sewers. Spills should be covered with absorbent materials and disposed of with the help of chemical waste disposal companies.

The refrigeration plant room should be ventilated using natural ventilation or explosion proofed electrical fans. Minimum ventilation rates are stipulated in the Australian Standard AS/NZS 1677.2:1998 Clause 4.7.2, and some international insurance companies require higher ventilation rates. A separate, sealed electrical control room should be installed adjacent to the refrigeration plant room. It is good practice to pressurize the electrical control room to prevent the ingress of dust and ammonia in case of a refrigerant leak. The walls and doors between the control room and the plant room should be at least 1 hour fire rated.

If evaporative condensers are used, the surface around and under the condensers should be impervious and drained to sewers. Water treatment chemicals must not be allowed to enter the storm water drains.

In some instances explosion vents are installed in the walls or roof of ammonia refrigeration plant rooms should be provided where reasonably practical, and some international insurance companies require them as mandatory.
2.3.5 COMMON NON COMPLIANCE ITEMS – AS/NZS1677.2: 1998

The following list details commonly found non compliance items:

Alarms
☑ No general Evacuation alarm
☑ No designated evacuation areas
☑ Remote alarm required. AS1677.2.1998 Section 4.9 (Appendix D)

Plant Drawings
☑ No P&ID’s & Layout drawings.

Electrical and Lighting AS1677.2.1998 Section 4.7, 4.8 and 4.9
☑ Install plant room emergency lighting
☑ Interlock plant room ventilation with leak detectors
☑ Install leak detection c/w maintenance disable timer.
☑ Check ventilation system installed for hazard compliance.

Valve Identification Lock out tags.
☑ Mark valves for closure in an emergency.

Equipment Name Tags. AS1677.2.1998 Section 5.4
☑ ‘No Unauthorised entry prohibited’ sign on plant room door.
☑ Update valve tags, relief valves & pressure vessel registers.

Machinery Rooms Entry-Exit. AS1677.2.1998 Section 4.7
☑ No Unauthorised entry prohibited sign on plant room door.

Pressure Vessels AS1677.2.1998 Section 3.4
☑ Vessel name-Markings

Piping Installation AS1677.2.1998 Section 3.6
☑ Piping & Electrical penetrations in plant room not sealed

Relief Valves AS1677.2.1998 Section 3.7
☑ Testing & maintenance program as per AS3766
☑ Relief Valve registers to be developed.
☑ Include service dates and settings
☑ Extend relief outlets out of work space.

Plant Room Ventilation AS1677.2.1998 Section 4.7
☑ Provide switching outside plant room at ground level.
   Refrigerant Detectors AS1677.2.1998 Section 4.8
☑ Instigate Leak detector installation.

See Appendix 1 - LIST OF AUSTRALIAN STANDARDS REFERENCE DOCUMENTS
Note: In the interests of best practice, plants installed prior to the release of AS1677:1998, must be enhanced where practical to provide a safe environment.
PART 3 – HAZARD IDENTIFICATION, RISK ASSESSMENT AND CONTROLS

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 either be 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 or alternatively more complex hazards may require an OHS 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 you to make decisions about the order in which risks should be controlled.

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

Further specific information relating to hazard identification, risk assessment and controls processes maybe obtained by reading Pages 16 – 35 of the Code of Practice – Storage and Handling of Dangerous Goods – No.27 2000 – WorkSafe
The table below is an example of a risk process flow chart:

![Risk Process Flow Chart Diagram]

Table 2 – Risk Process Flow Chart
For further guidance please refer to Page 59: Appendix 4 – A system for Ranking Risks, of the Code of Practice – Storage and Handling of Dangerous Goods – 2000 (Victoria).
PART 4: EMERGENCY PLANNING

4.1 Introduction

This section is intended to provide guidance to sites that store and use anhydrous ammonia, in particular as a refrigerant to prepare, respond to, and recover from emergencies.

The purpose of an emergency plan is to minimise the effects of any emergency that occurs at premises where anhydrous ammonia is stored and handled.

Emergencies, although undesirable, are not altogether unavoidable. Although we all aim to minimize the risk of and accident occurring, there is a need to ensure that preparations are in place to protect, people, property, neighbours and the environment when an accident occurs. This is done by devising an Emergency Plan.

An emergency plan is a written document detailing how a site/facility and its occupants deal or manage emergency events that may possibly occur. An effective emergency plan consists of the preparedness, response and recovery activities and includes the agreed emergency management roles, responsibilities, strategies and system arrangements of the site. The level of detail in an emergency management plan will depend on the complexity of the site involved and how much ammonia is being used in the plant and stored.

These plans should be simple, flexible, tested and reviewed. It should be communicated to and available to all employees in the workplace. Employees should be trained in all Emergency Procedures and regularly practice various emergency scenarios to ensure that the documented procedures and plans work successfully.

A company has a legal obligation and duty of care to prepare an emergency plan as required by legislation such as:

- Occupational Health and Safety Act and Regulations
- Dangerous Goods Act and Regulations.

4.1.1 What is an Emergency?

Although definitions vary between organizations, an emergency can simply be described as an event or situation that threatens serious damage to human welfare in a place, or environment of a place or the property of a place.

There are generally three types of emergencies that could occur on a site that stores/uses Ammonia:

- local area emergency; eg. Plant Room
- site emergency incident confined to site; and
- external emergency incident impacting offsite.

When describing the emergency response for each type of incident, the facility will need to consider in which situation the emergency plan applies. In general, the facility should consider incidents such as:

- Fire;
- Security;
- Medical;
- Electrical outage;
- Mechanical or process failure;
- Natural events such as storms or cyclones; and
- Hazardous materials releases.

Note 1: Response procedures should be developed when considering training of people working in and around an ammonia plant, specialist knowledge and available PPE and PPC.

Note 2: It is understood that it is a major concern of all business owners to keep their facility operating in an emergency. A well formulated emergency plan and response will assist a site in the safe and timely management of an emergency helping to minimise product loss and interruption. A robust emergency plan will also assist a site to work more closely with the emergency services leading to an earlier resolution to an emergency situation.

Note 3: Business continuity should be considered as part of a company’s emergency plan development. Companies should confirm with their insurance provider that adequate coverage is provided for any emergency services attendance in times of a HazMat / Chemical incident (eg. Ammonia leak). The fire levy component of insurance policies only covers fire service attendance for fire.

4.2 Developing Emergency Plans

There are many guidance documents available to assist in emergency planning, and in developing and writing an emergency plan (see Appendix 2 – MFB/CFA).

Note: In developing your emergency plan (via “Notification of Dangerous Goods Storage and Handling” form from WorkSafe Victoria’s website) You will also be required to notify WorkSafe in writing that the premises contains quantities of all dangerous goods including ammonia, that exceed the “Manifest Quantity”. The description of Ammonia is that it is a Class 2.3 Dangerous good, the Manifest quantity on this basis is 500L. Once dangerous goods quantities exceed “manifest” levels you must also seek written advice from the fire services regarding the emergency plan and have regard for that written advice. ie Fire protection report will also need to have a Dangerous Goods Manifest.
In Victoria, the Code of Practice for the Storage and Handling of Dangerous Goods outlines what should be included in an emergency plan. The 20 point gap analysis chart shown below is used by the Fire services when reviewing emergency plans for adequacy.

The emergency plan should include the following matters:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
| Site and Hazard Details | 1. Name, location, address and nature of operations  
2. Detailed map of the facility and surrounding area  
3. Inventory of Schedule 2 materials  
4. Maximum/minimum number of persons expected at the facility  
5. Infrastructure likely to be affected by an incident  
6. Emergency planning assumptions  
7. Description of measures to control the consequence of each hazard and major incident |
| Command, Structure, and Personnel | 8. Details of emergency contact personnel  
9. Allocation of personnel for implementing the plan  
10. Arrangements for "mutual aid" between adjacent facilities |
| Qualifications | 11. Procedures for providing early warning of an incident  
12. Details of onsite and offsite warning systems  
13. Contact details for the emergency services  
14. Details of onsite communications systems |
| Resources | 15. Details of emergency resources onsite  
16. Arrangements for obtaining additional external resources  
17. Procedures for safe evacuation and muster of personnel |
| Procedures | 18. Details of control points and procedures for essential services  
19. Procedures for containment of any incident  
20. Procedures for decontamination following an incident |

Appendix 2 details examples to assist in developing an emergency plan from the Victorian Fire Services.

The emergency plan should be implemented whenever an emergency incident occurs at the facility. The Emergency plan should have clear, quantifiable and measureable objectives. It is intended to describe the emergency management arrangements at your facility and the relationship to the jurisdictional emergency response agencies and other facility plans such as business continuity. The emergency plan's application may range from extinguishing a small fire through to a major ammonia leak.

Emergency plans must be reviewed regularly particularly when changes have been made on site to dangerous goods quantities or to work practices and systems that may affect the operation of the plan.
Dangerous Goods regulation 437 requires that an emergency plan must be submitted to the relevant fire service at intervals of no more than five years from when the plan was developed or last reviewed.

If an emergency could impact beyond the perimeter of your premises, you must also consult with people who are in control of adjacent premises.

Where a premise’s stores and handles dangerous goods in quantities that exceed “Manifest Quantity” it follows that a Manifest must be prepared. Once a Manifest is required, this also requires the occupier of the premises to ‘Notify the Authority’ of the dangerous goods on site.

Reading Regulation 427 (1) and Regulation 506 (1) in isolation may lead to the conclusion that only quantities of dangerous goods that exceed Manifest Quantity need to be included in the Manifest and Notification. This is not correct as the Manifest Quantity is a trigger point to have a Manifest and to ‘Notify the Authority’.

Once the trigger point has been reached, Regulation 506 (2) (v) and (vi) apply. This means that ALL dangerous goods on site must be ‘Notified’ to the Authority and included in the Manifest.

You may also be required to consult with other authorities responsible for the environment and planning as well as local government, to ensure consistency with legislation and emergency planning, for example, State Emergency Disaster Plans. There are several key elements to consider when preparing the emergency plan:

- Consultation

Preparing an emergency plan requires an established consultation process and involving the appropriate personnel with the necessary expertise. These persons may range from operators, engineers, communications specialists and Occupational Health and Safety Advisors at the facility to the Emergency Response agencies. Broad consultation enables everyone to develop a clear understanding of their roles and responsibilities before any emergency occurs.

4.3 Manifest and Emergency Information Container

A manifest must be kept on site for all facilities where the quantities of dangerous goods exceeds manifest levels detailed in schedule 2 of the Dangerous goods regulations 2000. The manifest is used by attending emergency services to access vital information relevant to the facility. The information that must be included in the manifest is detailed in schedule 3 of the dangerous goods regulations.

The manifest must be located in a place readily accessible to the emergency services. The preferred method of locating the manifest is in an Emergency Information Container (EIC) which is red and identified with the words
"Emergency Information". The EIC should be located near to the main entrances to the property.
Information in the EIC is recommended to be kept in a Emergency Information Book (EIB) which is supplied by the Fire Services. The EIB is divided into 5 sections standardising the dangerous goods manifest details across the state.

Emergency Information Container  Emergency Information Book

Refer to appendix 4 for additional information on information to be included in a manifest and notification requirements

4.4 Emergency Response Resourcing Considerations

A facility needs to ensure those with a role in the emergency response are trained and appropriately resourced. The training should be commensurate with the role, using recognised standards and practiced on a regular basis. Training may range from Incident management training, media training to HAZMAT (Hazardous Material) emergency response training. The emergency management resources should match the agreed approaches and where resources are not "owned" by the facility robust arrangements should be in place to ensure these resources are available at any time. The resources may include:

- Electronic resources;
- Technical expertise;
- Mitigation equipment such as fire fighting equipment, neutralising agents, pipe repair equipment or product transfer equipment;
- Waste management equipment;
- Respiratory and skin protection; and
- Ammonia detection.
- Wind direction

A robust maintenance program should be established to ensure the nominated resources are serviceable.

As Ammonia can be detected at very low concentrations, sites should consider the advantages of a portable gas detector in assisting them to accurately
determine the extent of the air contamination and the potential for any off site impact.
PART 5: MAINTENANCE

5.1 INTRODUCTION

Regular maintenance is essential to the safe and reliable operation of an ammonia refrigeration plant. Maintenance is covered in the AS/NZ1677.2 Section 6. The relevant sections of the Australian/New Zealand Standards, relating to maintenance of ammonia plants is detailed below for your reference. Also included in this section are common maintenance faults/failures, recommendations and a suggested format for the Plant Operating Maintenance Manual.

5.2 MAINTENANCE REQUIREMENTS – AS/NZS1677.2:1998

Please note that the detail below is referenced directly from the AS/NZS1677.2:1998 and the section numbers and clauses referenced are from the standard:

Section 5 – Testing Inspection, Documentation and Marking.

Clause 5.2 – Inspections – Pressure Equipment

5.2.1 Each system shall be inspected while in normal operation for safety (piping should be periodically inspected for excessive vibration, rust and ice formation).

5.2.2 Inspection of pressure vessels shall be in accordance with AS/NZS 1200 – this standard refers to AS/NZS3788:2006 “Pressure Equipment In-Service Inspection” which states that internal inspections are to be carried out every 12 years.

It is recommended that external ultrasonic and visual testing be undertaken but not to exceed every 12 years for example – oil separators, oil filters, strainer housings general overview of the overall internal condition of vessels/pipework. For covers removed and inspected every 12 years and this should give a Components that can be opened for internal inspection should have surface of the vessels/pipework are not affected by corrosion ensure that the ensure that the outer surface of the vessels/pipework are not affected by corrosion ensure that the outer

Note: The risk of stress corrosion cracking is more likely to be found in high pressure liquid receivers and where the ammonia is very dry (<2000 PPM or 0.2%) This comes from Appendix C of AS/NZS2022:2003. It is noted that commercially available ammonia has 0.5% impurities in Air, Moisture etc.
An initial pressure equipment inspection should be carried out after the first year in service. This can be deferred if owner is satisfied safety is not compromised as per AS/NZS3788:2006 – 4.4.2.

5.2.3 Inspection of pressure piping shall be in accordance with AS/NZS 1200

Refer to recommendation above for pipework inspections. In addition to this supporting brackets and fixtures should be inspected for corrosion, damage, mounting stability and weight loading. For insulated ammonia lines the insulation vapour seal/condition needs to be checked on a regular basis (annually).

Clause 5.3 – Documentation – Clause 5.3.1

Materials Test Certificates – where required by the purchaser or inspection body, material test certificates shall be provided in accordance with the applicable standards.

Clause 5.4 – Marking

5.4.1 Marking of refrigeration systems installed or modified onsite. Safety instructions relating to the refrigerant in use shall be prominently displayed in refrigeration rooms. It is recommended that hazchem placarding be installed on or near liquid receivers/plant rooms, preferably in a clearly visible location on entry to the plant.

5.4.2 Marking of compressor units/systems and liquid refrigerant pumps – It is recommended that you record and clearly identify in your Plant Operations Manual, which component maintenance has been performed on and frequency as per Table 1 (included in the AS1677.2: 1998).

5.4.3 Marking of pipes – Pipes shall be marked in accordance with AS/NZS 1345 – clearly marked pipework indicating flow direction, gas liquid and type of refrigerant or coolant.

5.4.5 Marking of other parts – Main shutoff valves and controls for services (gas, air, water and electricity) and remote control devices and pressure limiting devices shall be clearly marked.

It is mandatory that the main king valve (main liquid isolation valve) be clearly identified.

Best Practice recommends that a documented valve numbering system be implemented including:

- Process and instrumentation diagram
- Valve and equipment documentation and tagging
- Detailed operation and emergency procedures
The requirements for signage relating to identification for isolation and shut of valves for the fire services in event of an incident or fire (white writing on red background) is contained in AS 1319 (1994) – Safety signs for the occupational environment – Section 2.3.6 – Fire Signs.
Refer to examples below of king valves, other valve identification, directional flows and identification,
Section 6 of AS/NZA1677.2 1998 – Operation and Maintenance

6.1 Charging and discharging refrigerant –

6.1.1 Charging – Warning: Extreme care should be taken not to overfill the refrigeration system beyond the quantity specified and marked for your receiver capacity (should be found in your Plant Maintenance Manual) or with refrigerants other than those identified in the markings (refer to 5.4 above).

It is recommended that a suitable plant operator/refrigeration mechanic undertake this task. See details of definitions of ‘competent person/s’ in the Training Section of this document. It is essential that approved/tested charging equipment is used for this task (eg. An in date tested ammonia charging hose). Appropriate awareness signage be displayed around area where charging is taking place is also recommended.

NB: It is recommended that appropriate PPE for this task would be eye/face protection (goggles and a face shield), no exposed skin, gloves, steel capped boots and have an approved ammonia canister mask close at hand in case of leak. Ammonia contaminated water must not be discharged to storm water or sewer even when diluted.

Discharging: In AS/NZS1677.2:1998. It is recommended that any discharge of ammonia be kept to a minimum by pumping down the system and final evacuation into contained water. Disposal of the contaminated water will need to comply with the Dangerous Goods Act 1985 and the Environmental Code unless it can be disposed of onsite via waste management processes.

6.2 Operation and Maintenance Manual – The contractor or manufacturer shall provide at least one copy of an operating and maintenance manual containing at least the information given in 6.2.2.

6.2.2 Contents of the Operation and Maintenance Manual.
   • Name, address and phone number of manufacturer or supplier
• Address and telephone number for customer service if different from the one above.
• Full instructions for the operation, maintenance and servicing of the system and its components. Include the following as appropriate.
• A description of the system and its components, its function and its purpose including a refrigeration system schematic and electrical circuit diagram.
• Normal starting and stopping procedures.
• Stopping procedures in emergency
• Causes of possible faults and appropriate methods of repair
• Proposals for planned maintenance including leak testing
• Reference to the requirements of clause 6.1 regarding charging of the equipment
• A warning against charging with the wrong refrigerant
• Precautions relating to the storage of refrigerants in a machinery room
• Precautions to be taken to prevent the freezing of water in condensers, coolers or similar in low ambient temperatures or by normal reduction in system pressure temperatures
• The functions, routine testing and maintenance of all safety and alarm devices (eg. Emergency lighting, visual and audible alarms, refrigerant detectors and emergency ventilation) that are parts of the appliance, system or installation supplied.
• Procedures to be followed in the event of emergencies or injuries to persons ie. First aid
• Details of necessary protective equipment stressing the importance of its routine maintenance, replenishment and use to ensure its readiness for immediate and effective use

6.3 Pressure Equipment – Pressure equipment shall be operated and maintained and inspected in accordance with AS 3873 and inspected during its lifetime in accordance with AS/NZS 3788.

5.3 COMMON MAINTENANCE FAULTS/FAILURES

It is essential to understand what are the common types of incidents reported within the refrigeration industry or have occurred historically at your facility. Ammonia releases at facilities are common in poorly maintained/operated plants. They range from activation of pressure safety devices to failure of pipework or valves.

Reported investigations of ammonia incidents suggest the most common causes are human error and equipment failure. Many of these facilities had no written and practiced procedures. For example, procedures to shut down or start up the refrigeration system, during or after an emergency. Understanding the causes of incidents assists managing the facility and its systems to prevent incidents. The incidents and their frequency provide a useful basis by which to assess your emergency planning and the applicability of the emergency plan.
Below are examples of typical faults and failures:

- **High pressure cutouts or failures**
  - Faulty condenser fans or pumps
  - Dirty condenser water strainers, coils or blocked sprays
  - Loss of water supply to condenser (water cooled units only)
  - Excessive load or extreme ambient conditions
  - Excessive ammonia charge
  - Non condensables in system

- **Low pressure cutouts or failures**
  - Evaporator or Chillers iced or frozen up
  - Evaporator fans not functioning correctly
  - Chilled water / glycol pumps not functioning correctly
  - System short of ammonia / refrigerant
  - Block strainers or filters
  - Compressor load controller not functioning correctly
  - Incorrect operation / position of system valves
  - System set in manual mode not controlling automatically

- **Low temperature cutouts or failures**
  - Evaporator or Chiller iced up or frozen
  - Blocked water strainers or filters on chilled water / glycol systems
  - Compressor load controller not functioning correctly
  - System controller not functioning correctly

- **High ammonia level faults**
  - Excessive liquid ammonia in low side vessels / compressor
  - Faulty liquid control valves
  - Faulty liquid makeup valves
  - Faulty control floats
  - Liquid trapped between isolating and/or control valves.

- **Compressor operational faults**
  - Compressor tripping safety control, HP/LP, Oil Pressure, Oil or Discharge temperature, Oil level switch, Flow switch.
  - Compressor low oil levels
  - Compressor oil filters blocked
  - Compressor oil cooler blocked, or faulty cooling supply pump/strainer
  - Compressor exceeding normal operating pressures
  - System safety controls stopping compressor
  - Motor or starter operational issues
- Causes of Ammonia Releases
  - Corrosion
  - Liquid Hammer
  - Not testing relief valves
  - Seal leakage
  - Screwed fitting leakage
  - Uncapped valves
  - Plugs left off gauge valves
  - Broken gauge lines
5.4 TEMPLATE FOR COMPANY MAINTENANCE AND OPERATING MANUAL.

It is recommended that owners have a Plant Operation and Maintenance Manual be available at your site for personnel and maintenance contractors to refer to. A written record of maintenance performed on the system shall be maintained and be available at the site. Inspection of pressure vessels and pressure piping shall be in accordance with AS/NZS 1200.

<table>
<thead>
<tr>
<th>Type of equipment</th>
<th>Type of inspection</th>
<th>Carried out by</th>
<th>Frequency (at least)</th>
<th>Items requiring attention include</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressors</td>
<td>Operational/Inspection</td>
<td>Plant Operator/Operating Staff</td>
<td>Daily Checks/Once per Shift</td>
<td>Compressor Operating Pressure &amp; temperature readings. Oil level, Oil &amp; Refrigerant Leaks Operation of Oil return, Any Noise/Vibration</td>
</tr>
<tr>
<td></td>
<td>Major inspection/maintenance</td>
<td>Operating or Maintenance staff</td>
<td>3 monthly</td>
<td>Operational controls, Drive conditions including guarding, Test Functional Operation of All safety cut-outs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance staff</td>
<td>6 monthly</td>
<td>Dinitation/Review of all safety cut-outs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annual or to manufacturer’s instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vessels and heat exchangers</td>
<td>Operational/Inspection</td>
<td>Operating or maintenance staff</td>
<td>Weekly</td>
<td>Check external condition Conditions of heat transferring liquids Correct defrost or air coolers Correct operation of control valves Oil draining (Log register should be kept) Purging ammonia condensables</td>
</tr>
<tr>
<td></td>
<td>Operating or maintenance staff</td>
<td>Monthly</td>
<td>Inspect sight glass level controls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maintenance staff</td>
<td>6 monthly</td>
<td>Inspect and clean as necessary</td>
<td>Exchanger surfaces</td>
</tr>
<tr>
<td></td>
<td>Maintenance staff</td>
<td></td>
<td></td>
<td>Check associated equipment e.g. fans, impellers and guards Test safety cut-out controls high levels etc</td>
</tr>
<tr>
<td>Annual Inspection</td>
<td>Maintenance supervisor or engineering manager</td>
<td>Annually or after extended period out of service</td>
<td></td>
<td>Detailed inspection external condition, vessels or insulation, Heat exchanger tubes bundles Associated equipment e.g. fans, impellers, controls, safety provisions Clean filters/strainers &amp; inspect control valves</td>
</tr>
<tr>
<td></td>
<td>Maintenance staff</td>
<td>As above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent inspection</td>
<td>Competent person</td>
<td>5 yearly</td>
<td></td>
<td>As determined by the competent person but typically external inspection of vessel &amp; supports guards safety controls, Insulated vessels - inspect vessel or spot test to see if insulated sound</td>
</tr>
<tr>
<td>Ammonia pumps</td>
<td>Operational inspection</td>
<td>Operating or maintenance staff</td>
<td>Monthly/Quarterly</td>
<td>Defrost and external inspection of pumps</td>
</tr>
<tr>
<td>Safety inspection</td>
<td>Maintenance staff</td>
<td>6 Monthly</td>
<td></td>
<td>Test operation of differential safety controls &amp; low level cut-out switch's</td>
</tr>
<tr>
<td>Major inspection/ Maintenance staff</td>
<td>Annual</td>
<td></td>
<td></td>
<td>Open and inspect for possible wear or damage</td>
</tr>
<tr>
<td>Type of equipment</td>
<td>Type of inspection</td>
<td>Carried out by</td>
<td>Frequency (at least)</td>
<td>Items requiring attention include</td>
</tr>
<tr>
<td>-------------------</td>
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</tr>
<tr>
<td>Control &amp; Sensing devices</td>
<td>Operational/Safety Inspection</td>
<td>Maintenance staff/Maintenance supervisor</td>
<td>6 monthly</td>
<td>Test function &amp; operation of all sensing devices</td>
</tr>
<tr>
<td>Control Valves</td>
<td>Operational</td>
<td>Maintenance staff</td>
<td>6 monthly</td>
<td>Control / make-up valves for function &amp; operation Clean all control valve strainers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 yearly</td>
<td>Test all isolation valves for function; overhaul or replace as necessary</td>
</tr>
<tr>
<td>Piping</td>
<td>Operational Inspection/Maintenance</td>
<td>Maintenance supervisor/engineering manager</td>
<td>Annually</td>
<td>Inspect all piping and supports, arrange to make good as required Inspect all insulation; if any deterioration remove, inspect and reinstate as necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 years</td>
<td>Inspect pipework for corrosion under insulation in sample locations</td>
</tr>
<tr>
<td>Compressors</td>
<td>Operational inspection</td>
<td>Operating staff</td>
<td>Daily</td>
<td>Pressure &amp; temperature readings Oil level Oil return Noise/Vibration</td>
</tr>
<tr>
<td></td>
<td>Major inspection/maintenance</td>
<td>Operating or maintenance staff</td>
<td>3 monthly</td>
<td>Drive conditions including guards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 monthly</td>
<td>Test all safety cut-outs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Annually or to manufacturer's instructions</td>
<td>Drive alignment Foundation bolts Valves and cylinder heads (further dismantling/Inspection as per manufacturer's instructions in hours run) Oil change: Change/replace filters/strainers</td>
</tr>
<tr>
<td>Valves</td>
<td>Inspection</td>
<td>Maintenance staff/supervisor</td>
<td>6 monthly</td>
<td>Spindles and glands of uncapped valves all stop valves</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 monthly</td>
<td>Control valves for function Clean all filters</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 yearly</td>
<td>Test all stop valves for function; overhaul or replace as necessary</td>
</tr>
<tr>
<td>Control &amp; Sensing devices</td>
<td>Maintenance</td>
<td>Maintenance staff/supervisor</td>
<td>8 monthly</td>
<td>Testing function and operation of control devices</td>
</tr>
<tr>
<td>Pressure relief devices</td>
<td>Inspection/Maintenance</td>
<td>Maintenance supervisor/safety staff</td>
<td>12 monthly</td>
<td>Inspect external condition including vent lines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 yearly</td>
<td>Renew all bursting discs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 yearly</td>
<td>Renew or replace all relief valves</td>
</tr>
<tr>
<td>Piping</td>
<td>Inspection/Maintenance</td>
<td>Maintenance supervisor/engineering manager</td>
<td>Annually</td>
<td>Inspect all uninsulated piping and supports, arrange to make good as required Inspect all insulation; if any deterioration remove, inspect and reinstate as necessary Check supports</td>
</tr>
</tbody>
</table>
5.5 REFRIGERATION OILS

Only refrigeration oils approved by the compressor manufacturer should be used.

Where different brand of compressors are used the compatibility of the recommended refrigeration oils with different brands of compressors should be checked. Some refrigeration oils can damage shaft seals and flange gaskets and may cause ammonia leaks.

Refrigeration oil blends may react with each other. Blending can affect the pour and flash points of the oil mix, pollute the refrigeration system, damage components and make it difficult to drain carry over oil from the plant.

5.6 VIBRATION

One of the most frequent causes of ammonia leaks is by vibration. Vibration can be caused by inadequate machinery foundations and supports, loose mounting bolts, misalignment of couplings, loose belts, unbalanced fans and ice on fan blades.

Vibrating machinery results in bearing, seal failures, fatigue failures of pipes, oil and gauge lines and loose flange connections.

Regular physical plant inspections, ultrasonic testing and observing changes to normal noise levels are the best way to identify vibration problems before fatigue failures occur. Where the vibration cannot be eliminated it is good practice to retrofit flexible piping and flexible joints. However flexible joints can be a point of early failure.
PART 6: PLACARDING (IDENTIFICATION) SIGNAGE

As with all dangerous goods, the ability for fire services responding to sites to determine the hazards presented at sites starts with appropriate signage.

The signage or placarding on site quickly indicates to fire services arriving at a scene what they can be potentially dealing with. This enables responders to put into action operational procedures to protect their crews, the health and safety of site occupants and any contingencies needed to effectively control an incident.

In Victoria, sites storing anhydrous ammonia in excess of “Placarding Quantities” under Schedule 2 of the Dangerous Goods – Storage and Handling Regulations 2000 must install placard signage as per Regulation 429 & Regulation 430. Placarding requirements are further detailed in schedule 4 of the above mentioned regulations.

Outer Warning Placard

To be placed at every entry where over 50 litres of anhydrous ammonia is on site.

HAZCHEM

Dangerous Goods Class Labels (Anhydrous Ammonia)

To be used wherever storage cylinders and receivers (less than 500 litres) are located

Placard - Example

On or adjacent to any storage container over 500 litres
PART 7: PERSONAL PROTECTIVE EQUIPMENT (PPE)

Guidance for the provision of Personal Protective Equipment (PPE) is provided in AS1677.1&2:1998 and AS2022:2003. It should be noted that all PPE on site should be maintained in line with appropriate standards. All wearers of the PPE should be trained in its use. Companies that are required to have PPE on site should ensure that adequate procedures are developed regarding the wearing of PPE and that the procedures are detailed within the site's emergency plan.

This Code of Practice refers to the PPE & Respiratory Protective Equipment requirements of AS/NZS 2022:2003, Page 6 states - "This standard is not applicable to- (c) refrigeration systems, where anhydrous ammonia is used solely as a refrigerant"

Australian Standards give a base line for PPE requirements. Variations to the standards should not be implemented without a thorough performance based review of a site's emergency needs and should be undertaken in consultation with the fire service.

Sites utilizing canisters for breathing protection need to develop strict guidelines in their selection and use. Guidelines should detail procedures for the use and change over of canisters to ensure that wearers have adequate breathing protection for the duration of use.

Self Contained Breathing Apparatus (SCBA) is the highest level of respiratory protection. It is required to be on site once 900 kg of refrigerant is exceeded. High levels of personal protection should always be encouraged at sites. Procedures should be detailed in the emergency plan covering the identified potential times of use. As breathing apparatus affords such a high level of personal protection, its use should be encouraged whenever the likelihood of gas inhalation may occur such as during certain maintenance routines, during mitigation efforts in times of a leak or where site assistance may be required from the fire services to implement shut down procedures or repairs.

In addition to the equipment listed below, a portable Ammonia gas detectors should be considered at all sites storing Anhydrous Ammonia. Portable gas detectors give an accurate reading of gas concentrations which then enables a site to monitor and respond to any released Ammonia within their workplace within safe operating levels.

7.1 RESPIRATORY PROTECTION

Respirators or breathing equipment shall be provided as follows:

(a) Where the quantity of a Group B2 (AS/NZS1677.1) refrigerant does not exceed 225 kg, at least one respirator shall be provided.

(b) Where the quantity of a Group B2 refrigerant exceeds 225 kg, at least two respirators shall be provided.

(c) Where the quantity of any refrigerant exceeds 900 kg, at least one self-contained breathing apparatus having an effective life of a least 25 min shall be provided.
(d) Respirators and breathing apparatus shall be of the full face type, and shall comply with AS/NZS1716.1:1991. Any canister used shall be suitable for the refrigerant employed.

(e) Respirators and breathing apparatus shall be selected, used, inspected and maintained in accordance with AS/NZS 1.1715:1991. In particular—
(i) a logbook of inspections and any renewals or replacements shall be kept;
(ii) inspections shall be carried out every 3 months or less;
(iii) canisters shall be renewed immediately after use and at a marked expiry date.
(iv) cylinders of compressed air shall be renewed or refilled immediately after use.

NOTES:

1 Factory compressed air and the like is unacceptable for this application.
2 It is important that all persons likely to use these respirators be given practice in the fitting and use of respirators.
3 Canister respirators are not suitable for high concentrations of gases or for prolonged periods.
4 A respirator is commonly known as a carbon filter canister style full face mask. Refer to item (c) below. See pic below.

5. Breathing apparatus refers to a SCBA. Refer item (h) below.

7.2 PROTECTIVE CLOTHING

Where ammonia is the refrigerant and is in excess of 900 kg, one set of protective clothing which complies with AS 2022 shall be provided for each set of self-contained breathing apparatus.

Protective Clothing List from AS2022:2003

Clause 2.3.1 states that safety equipment shall comply with the following requirements:

(a) A face-shield shall incorporate a transparent visor, supported in front of the face to shield the eyes, face forehead and neck.
(b) Gas-tight goggles shall be of the eyecup or wide vision type, constructed so as to prevent the ingress of gases, fumes, dust and splashes of liquid into the spaces enclosed by the goggles in front of the eyes.

(c) A canister respirator shall be a full face-piece respirator having a filter contained in a renewable canister, sufficient to provide protection against limited concentrations of anhydrous ammonia.

(d) Gauntlet gloves shall have separate fingers and thumb, shall protect hands and forearms, and shall be made of rubber or PVC impervious to anhydrous ammonia.

(e) Thermal gloves shall be lined with insulating material, and shall have an outer surface impervious to anhydrous ammonia.

(f) Proper clothing shall consist of normal working apparel, which can be buttoned up at the wrist and throat to provide some skin protection in low ammonia concentrations.

(g) A protective suit and hood shall consist of apparel constructed of material impervious to anhydrous ammonia and in one piece having all air gaps effectively sealed.

(h) Self-contained breathing apparatus shall comprise a respirator which supplies the wearer with air or oxygen from containers carried by him and shall have an effective life of at least 25 min. Speech diaphragms shall be incorporated. If required to be used on a vehicle, the apparatus shall be suitable for use when driving.

(i) A safety shower or bath shall be either a shower having a rose fitting 2m above the base, or a bath in which a person can be fully immersed.

(j) An eye fountain shall be a fountain designed to effectively irrigate both eyes for a period of at least 30 min. An eye irrigator shall be an eyecup or other device to irrigate the eyes.

(k) Rubber boots shall be at least mid calf length gumboots.

Level of Alarm – PPM Settings for Ammonia

(Recommended by the MFB/CFA)

<table>
<thead>
<tr>
<th>LEVEL OF ALARM</th>
<th>PPM</th>
<th>MAINTENANCE PERSONNEL CONSIDERATIONS</th>
<th>EMERGENCY PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>25</td>
<td>Notify supervisor – maintenance person or team investigate alarm (full PPE / PPC) use portable gas detector (if available) Control leak if competent and trained to so Implement shut down procedures if required</td>
<td>Contact and inform Chief Warden – standby for use of site Ammonia Emergency Procedures If uncontrolled leak – and cannot be isolated easily and safely – contact 000 and ask for fire service assistance – implement site Ammonia Emergency Procedures Await fire services attendance to assist in isolation of ammonia system Have maintenance crews meet fire service personnel to provide information of ammonia system or immediately contact your refrigeration mechanic immediately to attend.</td>
</tr>
<tr>
<td>Exposure Level</td>
<td>Value</td>
<td>Action 1</td>
<td>Action 2</td>
</tr>
<tr>
<td>----------------</td>
<td>-------</td>
<td>--------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>MEDIUM</strong></td>
<td>300</td>
<td>Notify supervisor — maintenance person or team Investigate alarm (full PPE / PPC) use portable gas detector (if available)</td>
<td>Contact and inform Chief Warden – standby for use of site Ammonia Emergency Procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum 2 person response</td>
<td>Contact 000 and ask for fire service assistance — implement Ammonia Emergency Procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implement site Ammonia Emergency Procedures</td>
<td>Consider and plan for evacuation (if safe to do so)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Await fire services attendance to assist in isolation of ammonia system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Have maintenance crews meet fire service personnel to provide information of ammonia system/s or immediately contact your refrigeration mechanic immediately to attend.</td>
</tr>
<tr>
<td><strong>HIGH</strong></td>
<td>700+</td>
<td>Immediately implement site Ammonia Emergency Procedures</td>
<td>Contact and inform Chief Warden — immediately implement site Ammonia Emergency Procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* This level has an immediate effect on health — persons should be removed / evacuated / shelter in place from harm straight away — immediately contacting emergency services will assist in some specialist resources taking less time to reach site / premises.</td>
<td>Contact 000 and ask for fire service assistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Check wind direction before evacuation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Immediately evacuate persons on site (if safe to do so) to pre-organised Emergency Assembly Areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Await fire services attendance to assist in isolation of ammonia system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Have maintenance crews meet fire service personnel to provide information of ammonia system/s or immediately contact your refrigeration mechanic immediately to attend.</td>
</tr>
</tbody>
</table>

Table 4 - Exposure Levels
Ammonia has the following human effects as the below approximate concentrations:

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Possible Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Minimal irritation</td>
</tr>
<tr>
<td>25</td>
<td>Time Weighted Average exposure standard</td>
</tr>
<tr>
<td>35</td>
<td>Short Term Exposure Limit</td>
</tr>
<tr>
<td>9 – 50</td>
<td>Nasal dryness, olfactory fatigue and moderate irritation</td>
</tr>
<tr>
<td>125 – 135</td>
<td>Definite nose, throat and chest irritation</td>
</tr>
<tr>
<td>140</td>
<td>Slight eye irritation</td>
</tr>
<tr>
<td>150</td>
<td>Spasm of the larynx</td>
</tr>
<tr>
<td>300</td>
<td>Immediately Dangerous to Life or Health value</td>
</tr>
<tr>
<td>500</td>
<td>30 minute exposure at this concentration may produce exaggerated deep, rapid or laboured breathing, increased blood pressure and pulse rate; and upper respiratory tract irritation that can persist for 24 hours</td>
</tr>
<tr>
<td>700</td>
<td>Immediate eye irritation</td>
</tr>
<tr>
<td>1,500 – 10,000</td>
<td>Shortness of breath, convulsive coughing, chest pain, respiratory spasm, pink frothy sputum, rapid asphyxia, and delayed pulmonary oedema which may be fatal. Other effects include runny nose, headache, nausea and vomiting</td>
</tr>
<tr>
<td>&gt; 2,500</td>
<td>Sever eye irritation with swelling of the eyelids, excessive tears, increased intraocular pressure corneal ulceration and temporary blindness.</td>
</tr>
</tbody>
</table>

Table 5 – Human Effects of Ammonia Exposure

Based on the relevant exposure standards, the human effects table and the Fire Services Protective Action Zones, it is recommended that the alarms be set to the following:

- Low Alarm: 35ppm.
- Medium Alarm: 300ppm
- High Alarm: 700ppm

Definitions

*Time Weighted Average:* The concentration expressed as a time weighted average concentration for the substance over an 8 hour day for a 5 day week. During periods of continuous daily exposure to an airborne contaminant the worker should come to no short or long term health harm. These values are set by Safework Australia

*Short Term Exposure Limits:* These are expressed as the airborne concentration of substances to which a worker can be exposed to for a period of 15 minutes. Worker should have more than 4 of these 15 minutes exposure per day with at least one hour between exposures. Workers exposed at this level should suffer no intolerable irritation, chronic or irreversible tissue change or narcosis to an extent that could precipitate industrial accidents. These values are set by Safework Australia.
Immediately Dangerous to Life and Health: These values are set by the National Institute for Occupational Health and Safety in the USA. IDLH is defined as an atmospheric concentration of any toxic, corrosive or asphyxiating substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual’s ability to escape from a dangerous atmosphere.

Note Protective Action Zones: The Fire services in Australia typically define the warm zone as any concentration above the time weighted average exposure standard and the hot zone as any concentration above the IDLH value. For ammonia this implies that PPE would be worn for concentrations above 25ppm. For anhydrous ammonia, Chemdata advises the use of fully encapsulated gas suits.

7.3 LOCATION AND STORAGE

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

![Breathing Apparatus](image)

Note: PPE should only be donned in a fresh uncontaminated atmosphere.
PART 8: AMMONIA DETECTION SYSTEMS

8.1 Fixed Detection Systems

Ammonia detectors are essential in quantifying the local concentration of ammonia, so that different levels of action can be taken in event of the severity of an ammonia leak. The purpose of an ammonia leak detector is simply to sense and communicate the presence of ammonia for personal or property protection. The detector can also control isolation of electrical equipment and the operating refrigeration system. Different sensing levels detected will depend on the location of the sensor and its operational parameters. Ammonia detectors are of utmost value in alerting that ammonia is present in an unmanned plant where no people are present. It is possible and desirable that automatic action then be initiated to improve safety before people actually arrive.

Leak detectors are typically installed in machinery rooms. Australian Standard 1677 part 2 section 4.8 indicates the requirements and quantities of the leak detectors to be installed in these areas.

- Ammonia detectors installed in plant rooms should be programmed to activate the plant room ventilation system and to open access doors when a leak is detected. The impact of ammonia dispersion on the plant room surrounds has to be assessed.
- Ammonia detectors installed in chambers should be programmed to close the liquid supply valve to reduce the ammonia pressure inside the evaporator and to stop the evaporator fans to limit the dispersion of the leaking gas

<table>
<thead>
<tr>
<th>Refrigerant Leak Detectors Check List</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are ammonia leak detectors provided in the machinery room? (AS 1677.2 sect.4.8.2.1 compliance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do they raise an alarm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do they activate at approximately 30ppm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do they cause all electrical circuits in the machinery room to be isolated by means of circuit breakers located in a safe place when the concentration exceeds 30,000ppm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are the detectors positioned so as to give warning before a dangerous accumulation can occur? (AS 1677.2 sect.4.8.2.2 compliance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the detector system initiate an alarm in the machinery room and also at a remote location so action can be taken? (AS 1677.2 sect.4.8.2.3 compliance)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6 – Refrigerant Leak Detectors Check List

Types of Ammonia Detection Systems

There are a number of different types of ammonia detectors available. These include:
- SEMI CONDUCTOR - These units have been used widely in the ammonia refrigeration industry for a number of decades. They are generally limited to lower level concentrations of up to 1000 PPM. They are very reliable with units operating satisfactorily for 15 years or more. They do have potential cross contamination issues, which means they can be set off by gases other than ammonia with a low molecular weight, such as propane fork lift exhaust fumes, welding fumes or peeling an orange underneath them. Generally speaking, those cross contamination issues have been quite easy to manage, with people experiencing very few problems in a modern plant.

- ELECTRO CHEMICAL - These units have been widely used in the ammonia refrigeration industry. They can operate with concentrations up to 1000 PPM. They generally have a life expectancy of 2 to 4 years with a percentage of heads experiencing failure within 1 to 2 years. These units will require a greater amount of maintenance than the semi conductor type.

- INFRA RED - These units can operate at higher LEL concentrations and are quite expensive. Their reliability and life expectancy are very good. These units are usually selected for LEL duty and shunt tripping. They are available with a hazardous classified housing. However these units still require recalibration.

- CATALYTIC – These units can be used for ammonia LEL monitoring and are generally cost effective. They can be susceptible to poisoning and require inspections/calibration at least twice a year. These units are available with a hazardous classified housing.

When selecting ammonia detectors, the cost of ongoing maintenance needs to be taken into account, particularly if there are a number of detectors involved. A situation where detection systems are allowed to fall into disrepair because of the high ongoing cost of maintenance would be highly undesirable and potentially even more dangerous than not having a detection system at all. People may enter the plant with the full expectation that the detection system is working satisfactorily, to be then surprised by a dangerous situation. Therefore thorough investigation needs to be done before selecting the type of detection system to ensure it will be cost effective and reliable well into the future.

8.2 Portable Detection Systems

Hand held portable detectors - These units are available with a snorkel or sensing pipe on them to enable the ammonia levels in an area or a confined space to be assessed at a distance, prior to people entering the area. They will normally be set up to sense in the 0 to 1000 PPM range. These units are available for purchase or hire by contractors, facility owners or occupiers. The majority of ammonia hand held detectors are electro chemical type and are therefore specific to ammonia and do require frequent maintenance and re calibration.

Personal ammonia detectors - The most popular personal ammonia specific detectors are pocket or belt mounted, electro chemical units usually with a range of 0 to 300 or 0 to 500 PPM. They will have a lower TWA (time weighted average) alarm setting at 25 PPM and when that triggers it can be acknowledged which will silence the beeper. At that point the higher alarm setting of 300 to 500 PPM will remain armed and if that is tripped the beeper cannot be silenced, by acknowledging it.

These personal ammonia detectors are set up in this way so they can be used by
experienced ammonia technicians or operators, in conjunction with canister type respirators. Once the ammonia concentration is above the lower TWA alarm setting and the operator has put on the respirator, they then need to know (as they can't smell it) when the level reaches 300 to 500 PPM so he can take evasive action. The detector will sound the alarm, which will continue for as long as they are in an environment with a level equal to or above the higher alarm setting. These personal ammonia detectors will require frequent maintenance and re calibration.
PART 9: TRAINING

9.1 INTRODUCTION

There is broad recognition that ammonia refrigeration systems exist in many different configurations, sizes and types of facilities. It is also widely recognized that personnel responsible for operation of refrigeration systems (referred to as ‘operators’, ‘technicians’, ‘engineers’, ‘mechanics’ and ‘contractors’) have to understand the importance of effectively training system operators. Furthermore, the industry believes that training guidelines identifying the areas of study and learning objectives for training system operators eliminates confusion and provides a road map for companies struggling with the task of meeting governmental regulations. This section will identify key competencies of each level of staff working in an ammonia plant and the training that would describe adequately a ‘competent person’.

9.2 COMPETENT PERSON

The AS1677.2 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.

A competent person is defined as a ‘person who has acquired through training, qualification or experience, or a combination of them, the knowledge and skills to carry out a particular task.

Refer to Part 1, Introduction – 1.3 which outlines WorkSafe Victoria’s position.

9.3 DUTY OF CARE – INDIVIDUALS/COMPANIES

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. For an action in negligence, there must be an identified duty of care in law. Duty of care may be considered a formalisation of the implicit responsibilities held by an individual towards another individual within society. It is not a requirement that a duty of care be defined by law, though it will often develop through the jurisprudence of common law.

Included in the OHS Act 2004 please note the following:

21 – Duties of employers to employees
(1) An employer must, so far as is reasonably practicable, provide and maintain for employees of the employer a working environment that is safe and without risks to health.

25 – Duties of employees
(1) While at work, an employee must –
(a) take reasonable care for his or her own health and safety; and
(b) take reasonable care for the health and safety of persons who may be affected by the employee's acts or omissions at a workplace; and
(c) co-operate with his or her employer with respect to any action taken by the employer to comply with a requirement imposed by or under this Act or the regulations.
9.4 TRAINING OF PEOPLE WORKING IN AND AROUND AN AMMONIA PLANT

There are 4 levels of training that a company will provide:

a) Induction of all new employees and contractors.
b) Additional training – Emergency evacuation drills/training for all employees and contractors. These drills are recommended at least every 6 months.
c) Specific Ammonia training for employees and contractors that are working in an ammonia plant.
d) PPE Training.

NOTE: 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 in and around the ammonia plant must also be undertaken.

9.5 SPECIFIC AMMONIA TRAINING - COMPETENCE

Training of persons to achieve competence in safety aspects of refrigerating systems, environmental and energy conservation requirements should be undertaken by any employee/person working in and around plant equipment including – plant operators, supervisors, maintenance personnel/contractors and engineers.

The competence of a person should be assessed by an approved ‘Registered Training Organisation’ (RTO). The certification of competence should be as required by state and national regulations or where no competence exists, the competence training listed below can be used.

It is also recommended that persons shall maintain their competence as appropriate eg. By the study of relevant updated literature, short courses and practical work.

9.6 TERMS AND DEFINITIONS

For the purpose of this code the following terms and definitions will apply:

Qualification – Evidence of a certain level of training, professional knowledge, skill and experience.

Certification – Procedure used to demonstrate the qualification of personnel at a level and leading to the issue of a certificate.

Certificate – Document issued under the rules of the assessment system indicating that the named person is competent to deal with the requirements for ammonia refrigeration systems.

9.7 PLANT OPERATOR

A person with competence in plant operations will be able to show competence in the following:
• Identify pieces of refrigeration plant and equipment
• Identify the mode of operation of refrigeration plant and equipment
• Carry out the normal operation of the plant and equipment
• Observe the safe operation of the equipment
• Record the operating parameters of the equipment
• Take appropriate action to counteract the affects of equipment malfunction
• Undertake basic maintenance of the refrigeration plant and equipment which is limited to:
  • Charging oil
  • Charging refrigerant
  • Leak testing
  • Draining oil
• Take action, within an organisation's guidelines, in an emergency situation
• Order consumables
• Communicate effectively
• Be aware of PPE/PPC availability and be trained to be competent in the use of such equipment.

NB: It should be noted that a plant operator does not necessarily have to have the skills to do any major equipment maintenance, repairs or plant modifications.

Minimum Training Required

• On the job – 12 months
• Complete an accredited course provided by an RTO that covers industrial ammonia theory and practical work such as the AIRAH Industrial Plant Operations short course VBQ039 – Course in Industrial Refrigeration (Plant Operations) - Operate Ammonia Refrigeration Plant. This is a course that contains both theory and practical components, each of 24 hours including assessments in order to obtain a Statement of Attainment.

9.8 MAINTENANCE MANAGER/CONTRACTOR

A person able to show competence in the following:

• Identify components of refrigeration plant and equipment
• Identify the mode of operation of refrigeration plant and equipment
• Determine the operating conditions of refrigeration plant and equipment
• Install, service and repair components of refrigeration plant and equipment
• Diagnose and rectify faults of refrigeration plant and equipment
• Install, service and repair components of refrigeration plant and equipment
• Test and commission refrigeration plant and equipment

Minimum Training Required

A Maintenance Contractor will have completed a four year apprenticeship with a recognised training provider eg. TAFE. The minimum qualification is the
Certificate III in Refrigeration & Air Conditioning incorporating 4 years practical experience in industrial ammonia refrigeration.

9.9 PLANT MANAGER/SUPERVISOR

The Plant Manager should be competent to ensure that a refrigerating system using ammonia conforms to the safety requirements of AS/NZS1677.2:1998. He/she should also have comprehensive knowledge of the legislation and regulations relating to ammonia refrigerating plants and systems and should be able to carry out the following:

9.9.1 Develop/review piping and instrument diagrams (P&ID), operation and maintenance manuals

9.9.2 Conduct safety audits and hazard analysis of ammonia refrigeration plants.

9.9.3 Training requirements: Bachelor of Mechanical or Electrical engineering or equivalents and the following:

i) Comprehensive refrigeration technical knowledge
ii) Comprehensive knowledge in safety standards, eg AS/NZS 1677.2:1998
iii) Comprehensive knowledge in legislation concerning OHS and environmental protection
iv) Comprehensive knowledge in handling of ammonia, personnel protection requirements and leakage prevention.
v) Comprehensive knowledge in energy conservation and sustainability.
vi) Practical experience in design, construction, installation, testing/commissioning, maintenance and repair of ammonia refrigeration plants (minimum 5 years)
vii) Ongoing professional development provided by RTO’s and member organisations dealing in refrigeration and particularly industrial ammonia (eg. Industrial Refrigeration/Plant Optimisation, Ammonia Emergency Response and any other courses provided by an RTO pertaining to safety and maintenance)

9.10 PERSONAL PROTECTIVE EQUIPMENT TRAINING

It is essential that any person that may need to use a Breathing Canister, SCBA or a Hazmat Suit, is trained competently.

a) Breathing Canister – these are kept onsite and staff will need to be trained by a ‘competent person’ in the use of these.
b) Self Contained Breathing Apparatus (SCBA) – training and re-training is required for any person that will use this equipment. The training must be conducted by a Certificate IV qualified trainer in Breathing Apparatus. Anyone undertaking this training must have documented certification. This training is offered by the fire services as well as certified individuals and companies.

c) Gas Tight (Hazmat) suits would only be kept on large ammonia sites. A non accredited short course is provided by AIRAH as an Ammonia Emergency Response. Prior to undertaking this course it is a requirement that all participants have certified SCBA and Confined Space training. Other courses in emergency management may also be available through other RTO’s.

Reference materials

In AS/NZS 2022:2003 (Ammonia handling & storage), clause 1.3.5 "Filler", it states - "A competent person authorised to fill container with anhydrous ammonia."

In AS/NZS 1877.2:1998 (Safety requirements of refrigeration. plants), clause 1.4.6 "Competent person", it states "A person who has appropriate training or practical experience (or both) in the subject, sufficient to provide safe and satisfactory performance."
9.11 EMERGENCY PREPAREDNESS

A Facility needs to ensure those with a role in the emergency response are trained and appropriately resourced. The training should be commensurate with the role, using recognised standards and practiced on a regular basis. Training may range from Incident management training, media training to HAZMAT emergency response training.

It is highly recommended that facilities contact the relevant Dangerous Goods department of the fire services (eg MFB or CFA) in their area to conduct joint ammonia emergency exercises and site familiarisation visits.
PART 10: AUDITING

The table below is a simple Audit checklist which can be completed by the owner/occupier of the Ammonia refrigeration plant to assist in documented compliance to the Act, Regulations and other associated requirements.

By completing the questions and then documenting Corrective Actions with reasonable completion dates, a plan has been developed. The implementation of the corrective actions by the proposed dates, means that the action has been completed.

By recording on an Annual basis and implementing Corrective actions this is a documented review of the processes of managing the risks of an Ammonia refrigeration plant.

<table>
<thead>
<tr>
<th>Reference in Code of Practice</th>
<th>Dangerous Goods (Storage &amp; Handling) Regulations 2003 Requirement</th>
<th>Requirement/Recommendation</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
<th>Recommended Action/Comment</th>
<th>Target Date</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1 - 1.5 Regulation 438</td>
<td>Do you have current Material Safety Data Sheets for Anhydrous Ammonia?</td>
<td></td>
<td></td>
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<tr>
<td>Part 2 - 2.2</td>
<td>Do your buildings housing ammonia refrigeration systems (Plant and Coolrooms &amp; Special machinery rooms) comply with the Building Code of Australia (BCA)?</td>
<td></td>
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<tr>
<td>Part 2 - 2.2</td>
<td>Which category of the BCA applies to your Ammonia refrigeration system? Do you comply with the identified category?</td>
<td></td>
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<tr>
<td>Part 2 - 2.3.1 Regulation 425</td>
<td>Is your ammonia plant subject to atmospheric conditions that are flammable, explosive or an asphyxiant?</td>
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<tr>
<td>Part 2 - 2.3.1 Regulation 426</td>
<td>If yes to the questions immediately above than has the action(s) been taken to reduce the risk as far as reasonably practicable or eliminated?</td>
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<tr>
<td>Part 2 AS/NZS1677, 2: 1996, Clause 4.7.2</td>
<td>If the refrigeration plant and equipment is located within a room/building, is appropriate natural or mechanical ventilation provided?</td>
<td></td>
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</tr>
<tr>
<td>Part 3 Regulation 404</td>
<td>Hazard Identification, Risk Assessment &amp; Controls is a 3-step process. STEP ONE - Have you identified all hazards associated with the anhydrous ammonia refrigeration system?</td>
<td></td>
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<tr>
<td>Part 3 Regulation 405</td>
<td>STEP TWO - Has a risk assessment been undertaken?</td>
<td></td>
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<tr>
<td>Part 3 Regulation 407</td>
<td>STEP THREE - Has the risks identified, been controlled to reduce or eliminate the risk of injury to people or damage to property?</td>
<td></td>
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</tr>
<tr>
<td>Reference in Code of Practice</td>
<td>Dangerous Goods (Storage &amp; Handling) Regulations 2000 Requirement</td>
<td>Requirement/ Recommendation</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Recommended Action/ Comment</td>
<td>Target Date</td>
<td>Completion Date</td>
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<tr>
<td>Part 4</td>
<td>Regulation 437</td>
<td>Is there a written emergency management plan developed in consultation with the fire service?</td>
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<tr>
<td>Part 4</td>
<td>Regulation 437</td>
<td>Is there a system in place for reporting notifiable incidents to the authorities?</td>
<td></td>
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<tr>
<td>Part 4 - 4.2</td>
<td>Regulation 437</td>
<td>Is there a written emergency management plan developed in consultation with the fire service?</td>
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<tr>
<td>Part 4 - 4.2</td>
<td>Regulation 437</td>
<td>Has the Emergency Management plan been updated, as conditions change in circumstances, or at intervals of not more than 5 years?</td>
<td></td>
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<tr>
<td>Part 4 - 4.3</td>
<td>Regulation 427</td>
<td>Is your emergency information (manifest) located in the emergency information container, and is the container located in the location recommended by the fire services?</td>
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<tr>
<td>Part 4</td>
<td></td>
<td>Are emergency evacuation drills conducted on a regular basis (6 monthly)?</td>
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<tr>
<td>Part 5</td>
<td>Regulation 418</td>
<td>Is there a formal and effective maintenance system or program in place for anhydrous ammonia refrigeration plant and equipment?</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Part 5 - 5.4</td>
<td>AS/NZS 1677 Clause 6.2.1</td>
<td>Do you have a copy of the operating and maintenance manual for the refrigeration plant and equipment on site</td>
<td></td>
<td></td>
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<tr>
<td>Part 6</td>
<td>Regulation 429</td>
<td>Are there warning signs such as a HAZCHEM sign on the entrance to the premises and placarding on the receiver?</td>
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<tr>
<td>Part 7</td>
<td>AS/NZS 1677 and AS 2022</td>
<td>Is the PPE provided?</td>
<td></td>
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<tr>
<td>Part 7</td>
<td></td>
<td>Is the PPE regularly maintained as per the Manufacturer’s instructions?</td>
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<tr>
<td>Part 8</td>
<td>AS/NZS 1677 Part 2</td>
<td>Does your premises have Fixed Ammonia leak detectors?</td>
<td></td>
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<tr>
<td>Part 8</td>
<td>AS/NZS 1677 Part 2 Clause 4.8.1</td>
<td>Do you have a visual and audible evacuation alarm system installed?</td>
<td></td>
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</tr>
<tr>
<td>Reference in Code of Practice</td>
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</tr>
<tr>
<td>Part 9</td>
<td>AS/NZS 1677 Part 2: Clause 4.6.1</td>
<td>Is the evacuation alarm system maintained?</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part 9</td>
<td>Regulation 402</td>
<td>Are relevant people trained and currently competent in the use of PPE?</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part 9 - 9.4</td>
<td>Regulation 402</td>
<td>Is induction and emergency evacuation training conducted for all employees and contractors?</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appendix 4</td>
<td>Regulation 506</td>
<td>Have you determined the amount of anhydrous ammonia in the refrigeration system (water capacity of the receiver)</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appendix 4</td>
<td>Regulation 506</td>
<td>If the water capacity of the receiver is greater than 500 litres, has WorkSafe been notified of the presence of the dangerous goods on your site?</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part 7 and Appendix 6</td>
<td>Regulation 405 and AS/NZS 2022</td>
<td>Is there adequate first aid facilities and emergency equipment such as safety shower/eye wash station close to the refrigeration plant room?</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appendix 4</td>
<td>Regulation 421</td>
<td>Is refrigerant piping protected against vehicle impact where applicable?</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appendix 4</td>
<td>AS/NZS 1545</td>
<td>Is pipe work appropriately marked?</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
APPENDICES

APPENDIX 1 - REQUIREMENTS FOR AMMONIA PIPING DESIGN TO AS/NZS 1677.2:1998 REFRIGERATING SYSTEMS

- AS/NZS1677.2:1998 clause 3.6.1 states that piping and fittings shall comply with AS/NZS1200. This also notes that AS/NZS 1200 references AS 4041 and also states other standards for piping. ASME B31.5 would be acceptable under the alternative provisions of AS/NZS 1200.

- AS/NZS1200 “Pressure Equipment” is called up under Australian and New Zealand Legislation this in turn references AS 4041 “Pressure Piping” as well as many other Materials and Components standards and other design, fabrication, testing, inspection and assurance standards.

- It is our view this chain of references and standards make it mandatory that all ammonia systems piping design comply with AS 4041 – 1998 Pressure Piping.

- Sections of AS 4041 –1998 nominate the following with respect to design requirements: -

  1.1 (viii) Low temperature and refrigeration piping within the scope of AS/NZS1677.2:1998

  1.6 (c) Alternative Standard Piping for refrigeration plant ANSI/ASME B31.5

  3.27 Flexibility, Stress Analysis and Support Design.

  3.2.7.1 General, piping shall be installed in a way to, absorb thermal expansion, wind loading, dead weight, seismic effects and material stress limitations.

R8 Requirement for Flexibility Analysis. A flexibility analysis shall be made where the designer has doubt regarding the ability of the system to comply with the design. Where interpretation of a simplified analysis indicates that any of the effects listed in the design requirement may occur, a comprehensive analysis shall be made. Piping in low temperature service shall be subject to a flexibility analysis.

Based on this assessment listing the key points from the respective standards it is our view, that all ammonia refrigeration piping systems shall be subject to a flexibility analysis in order to determine the pipe grade used, class of piping installation and requirements for welding and testing so that the installation is in compliance with the relevant standards.
APPENDIX 2 - LIST OF AUSTRALIAN STANDARDS AND/OR AUSTRALIAN/NEW ZEALAND STANDARDS REFERENCE DOCUMENTS

AS1170 Minimum design loads on structures (known as the SAA Loading Code)
AS1170.4 Part 4: Earthquake loads
AS/NZS1200 Pressure equipment
AS1210 Pressure vessels
AS1271 Safety valves, other valves, liquid level gauges, and other fittings for boilers and unfired pressure vessels
AS1319 Safety signs for the occupational environment
AS1345 Identification of the contents of pipes, conduits and ducts
AS1530.4:1990 Methods for fire tests on building materials
AS1668 The use of mechanical ventilation and air-conditioning in buildings
AS1668.2 Mechanical ventilation for acceptable indoor-air quality
AS/NZS 1677.1 Part 1: Refrigerant classification
AS/NZS2022:2003 Anhydrous ammonia—Storage and Handling
AS1939 Degrees of protection provided by enclosures for electrical equipment (IP Code)
AS2129 Flanges for pipes, valves and fittings
AS3873 Pressure equipment—Operation and maintenance
AS/NZS 3788 Pressure equipment—In-service inspection
AS4024 Safeguarding of machinery
AS4024.1 Part 1: General principles
AS4041 Pressure piping
AS/NZS 4331 Metallic flanges
AS/NZS 4331.1 Part 1: Steel flanges
AS/NZS 4331.2 Part 2: Cast iron flanges
AS-ISO9705:1993 Fire Tests – Full scale room test for surface products

ANSI/ASME
B31.5 Refrigeration piping
Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code)

AIRAH
DA9 Load estimation
APPENDIX 3 - EMERGENCY RESPONSE PLAN REVIEW IN ACCORDANCE WITH THE STORAGE AND HANDLING OF DANGEROUS GOODS, CODE OF PRACTICE NO 27, 8 DECEMBER 2000

<table>
<thead>
<tr>
<th>Site and Hazard Detail</th>
<th>MFB/CFA Comment and Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Name, location, postal address and nature of operations</td>
<td>These details should be clearly detailed at the start of the Emergency Plan.</td>
</tr>
<tr>
<td>2 Detailed map of the facility and surrounding area detail</td>
<td>Dangerous goods storage areas</td>
</tr>
<tr>
<td></td>
<td>Fire protection equipment (includes hydrants, hose reels, sprinkler systems, boosters etc)</td>
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<tr>
<td></td>
<td>Evacuation areas (min. 2)</td>
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<td>Drainage</td>
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<tr>
<td></td>
<td>Utilities and shut off points</td>
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<tr>
<td></td>
<td>All buildings and external storage areas</td>
</tr>
<tr>
<td></td>
<td>Access points to site</td>
</tr>
<tr>
<td></td>
<td>Surrounding occupancies</td>
</tr>
<tr>
<td>3 Inventory of Schedule 2 materials</td>
<td>Max quantities likely to be kept on site (VWA notifiable quantities)</td>
</tr>
<tr>
<td>4 Min &amp; Max number of persons expected at the facility</td>
<td>Out of hours/weekend shifts should also be detailed if relevant.</td>
</tr>
<tr>
<td>5 Infrastructure likely to be affected by an incident</td>
<td>Utilities, trial lines, schools, hospitals, shopping centres etc</td>
</tr>
<tr>
<td></td>
<td>The larger the quantity of Anhydrous Ammonia kept on site the larger the potential for off site impact to be extended.</td>
</tr>
<tr>
<td>6 Emergency Planning assumptions</td>
<td>The identification of potential incidents that may as a result of the dangerous goods that are kept at the site and identified as a result of a hazard identification and risk assessment process eg vapour release small/large, liquid release small/large, fire etc.</td>
</tr>
<tr>
<td>7 Description of measures to control the consequences of each hazard and major incident</td>
<td>Detail the procedures that the company has planned for and will implement in times of an emergency. Actions should be developed from the potential incidents as identified in point 6 and be based upon the levels of fire protection and training/specialist knowledge that exists at the site. Start up and shut procedures should also be documented.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Command Structure and Personnel</th>
<th></th>
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<tbody>
<tr>
<td>8 Details of emergency contact personnel</td>
<td>Provide the contact numbers for at least 2 people. Consideration should be given to out of hours availability and level of site expertise.</td>
</tr>
<tr>
<td>9 Allocation of personnel for implementing the plan</td>
<td>Detail who/what position is responsible for the activation of the plan. Consideration should be given to identification of roles during an emergency eg: helmets, for wardens etc and the activation of the plan out of normal working hours.</td>
</tr>
<tr>
<td>10 Arrangements for mutual aid between adjacent facilities</td>
<td>Consider your site for needs for additional resources in times of an emergency. That Do additional arrangements need to be formulated for additional neutralisers, places for shelter of staff etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notifications</th>
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<tbody>
<tr>
<td>11 Procedures for early warning to the emergency services of an incident</td>
<td>Detail how an alarm is raised. Is the alarm manually or automatically raised etc</td>
</tr>
<tr>
<td>12 Details of on-site and off-site warning systems</td>
<td>What warning systems exist at the site eg: hooters, sirens, warning lights, radios etc</td>
</tr>
<tr>
<td>13 Contact details for emergency services</td>
<td>List within the plan all emergency services numbers that may be required eg 000 for fire. Be clear on who is responsible to contact the emergency services. Always follow up an alarm generated call with a manual call to 000.</td>
</tr>
<tr>
<td>14 Details of on-site communication systems</td>
<td>What is at the site eg: two way radio, PA system, telephone etc</td>
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</table>

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<thead>
<tr>
<th>Resources</th>
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<tbody>
<tr>
<td>15 Details of emergency resources on site</td>
<td>What is available for use during an emergency eg: MSDS, Breathing Apparatus, Hose reels, Hydrants, sprinkler systems neutralisers, etc.</td>
</tr>
<tr>
<td>16 Arrangement for obtaining additional external resources</td>
<td>List contact numbers for suppliers of any identified resources that may need to be accessed during an emergency.</td>
</tr>
<tr>
<td>Procedures</td>
<td>MFB/CFA Comment and Recommendation</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
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</tr>
<tr>
<td>17 Procedures for safe evacuation and muster of personnel</td>
<td>• These procedures are developed from the sites risk assessment. Procedures should be developed and detailed as to when and how evacuation is undertaken. The procedures should include assembly areas, warden structure/positions, accounting method communications and if the site provides wind indications to guide safe direction decisions during evacuation.</td>
</tr>
<tr>
<td>18 Details of control points and procedures for essential services</td>
<td>• Preferably detailed on a site plan. Detail all the shut offs and valves for electricity, water, gas, fire mains etc. The main king valve and all valves that may need to be accessed to initiate shut down/isolation of the Ammonia plant should be clearly indicated.</td>
</tr>
<tr>
<td>19 Procedures for containment of any incident</td>
<td>• Detail any procedures that are developed to contain an incident until emergency services arrive eg drainage control, chemical spill control.</td>
</tr>
<tr>
<td>20 Procedures for decontamination following an incident</td>
<td>• Detail procedures for decontamination of staff or equipment that may be required resulting from exposure to Anhydrous Ammonia. MSDS are a good source of guidance.</td>
</tr>
</tbody>
</table>
APPENDIX 4 - MANIFEST AND NOTIFICATION GUIDE

Purpose

This guide provides clarification on the dangerous goods information required for a Manifest and for the Notification to the Authority (WorkSafe Victoria), as stated in the Dangerous Goods (Storage and Handling) Regulations 2000 and the Dangerous Goods Code.

Background

Where a premises stores and handles dangerous goods in quantities that exceed “Manifest Quantity” it follows that a Manifest must be prepared. Once a Manifest is required, this also requires the occupier of the premises to Notify the Authority (WorkSafe Victoria) of the dangerous goods on site.

Reading Regulation 427 (1) and Regulation 506 (1) in isolation may lead to the conclusion that only quantities of dangerous goods that exceed Manifest Quantity” need to be included in the Manifest and Notification. This is not correct as the Manifest Quantity is a trigger point to have a Manifest and to ‘Notify’ the Authority.

Once the trigger point has been reached Regulation 506 (2) (v) and (vi) apply. This means that ALL dangerous goods on site must be ‘Notified to the Authority and included in the Manifest.

Dangerous Goods that need to be listed in a Manifest and Notification.

Having identified that the premises stores and handles dangerous goods in quantities that exceed “Manifest Quantity” then all dangerous goods on the premises must be declared on the Manifest and on the Notification.

As an example, premises that use anhydrous ammonia as the coolant in their refrigeration system will need know the water capacity of the receiver of the system.

For receivers with a water capacity of 500 litres or more, Notification is mandatory. The Notification must include all dangerous goods on the premises and may include such items as:-

- packages of Methylated Spirits, Kerosene and Turpentine (flammable liquids)
- Aerosol cans of various products including lubricants
- LP gas cylinders
Additional Legislative Requirements

The following regulations under the Dangerous Goods (Storage and Handling) Regulations 2000 need to be met for sites storing and handling dangerous goods exceeding manifest levels. The regulations refer to maintenance of the manifest and notification to the Authority (WorkSafe Victoria).

427    Manifest to be maintained

(1) **Premises** where dangerous goods are stored and handled in quantities that exceed the relevant quantities specified in the column headed "Manifest Quantity" in the table in Schedule 2 are prescribed **premises** for the purposes of section 30 of the **Act**.

(2) A manifest is in the prescribed form for the purposes of section 30 of the **Act** if it contains the information specified in Schedule 3.

506    Notification to Authority

(1) An occupier of **premises** where dangerous goods are stored and handled in quantities that exceed the relevant quantities specified in the column headed "Manifest Quantity" in the table in Schedule 2, must ensure that the Authority is notified of the presence of those dangerous goods.

(2) A notification to the Authority under subregulation (1) must—

(a) be given within 14 days after the obligation to notify arises; and

(b) include the following information—

(i) the name of the occupier; and

(ii) the address of the **premises** where the dangerous goods are stored and handled; and

(iii) the occupier’s contact details; and

(iv) the nature of the principal activities involving the dangerous goods; and

(v) the **Class** and the maximum quantity of the dangerous goods stored and handled in **bulk** or as **packaged dangerous goods**; and

(vi) descriptions and details and the maximum quantity of any C1 **combustible liquids** stored and handled in **bulk** or as **packaged dangerous goods**; and

(vii) the product name and the maximum quantity of **goods too dangerous to be transported**.

(3) The occupier must ensure that the Authority is provided with further notification, containing the information required under subregulation (2), every 2 years, or at such longer intervals as are specified by the Authority.
Other Key Regulator

The Environment Protection Authority Victoria (EPA) is the regulator of environmental protection, and strictly controls the discharge of waste oils, waste solvents, and other related hazardous material from entering the storm water system.

Local Government is the regulator of Buildings and works and administers the Building Control Act

Legislative Requirements

The Dangerous Goods (Storage and Handling) Regulations 2000.

Types of Premises who may need to Notify

- Sites with anhydrous ammonia refrigeration systems including,
- Warehouses
- Manufacturing sites
- Cool stores
- Abattoirs

Referenced Material

Dangerous Goods Act 1985
Dangerous Goods (Storage & Handling) Regulations 2000
Code of Practice for Dangerous Goods Storage and Handling 2000
APPENDIX 5 – AMMONIA ACCIDENTAL RELEASE MEASURES

- Evacuate the area immediately.
- Call '000'
- Call service provider.
- Stop leak if you can do so without risk to human life.
- Isolate and evacuate the leak or spill area immediately for at least 50m in all directions.
- Keep area isolated until gas has dispersed.
- Note that although ammonia gas is lighter than air, sudden release may generate an aerosol of liquefied ammonia which may cling to the ground for long distances.
- Keep unnecessary people away; isolate hazard area and deny entry.
- Stay upwind, out of low areas.
- Ventilate closed spaces before entering.
- Evaluate affected area to determine whether to evacuate or control-in-place by closing windows and doors, shutting off outside air intakes (exhaust fans etc.).
- Ammonia may ignite in the presence of open flame and sparks.
- Keep all sources of ignition away from spill/release and eliminate all open flames in vicinity of indoor spills or release vapour. Narrow lower to upper combustion range (16%-25%) makes ignition difficult.
- With accredited training, self-contained breathing apparatus (SCBA) and fully encapsulated vapour protective clothing should be worn for isolating spills and leaks with no fire. Refer to point 9.10 above.
- Downwind areas can be protected by water fog nozzles positioned downwind.
- Approach from upwind.
- Contain liquid spills with bunds.
- Notify local water authority that ammonia is leaking into the sewer/storm water.
- Never spray water directly onto liquid ammonia spill, mixing of water and liquid ammonia will increase ammonia vaporization rate.
- Ammonia can also be neutralised by using Carbon Dioxide and Citric Acid. The effectiveness of using CO₂ as a neutralising agent depends on the amount of moisture in the air. In low temperature rooms this level may be too low and moisture will need to be introduced into the room together with CO₂. The water can be introduced via a steam nozzle if available or by a fine water mist. Carbon dioxide is most effective when introduced soon after the leak, before the ammonia has had a chance to settle in the poorly ventilated corners of the room (including within packaging materials). Depending on the size of the spill, it may be necessary to inject CO₂ into the contaminated area daily for several days to remove all the ammonia fumes. The total amount of CO₂ needed will depend on the size of the room and the concentration of ammonia. Kramer (1981) recommends that no more than 1kg of CO₂ per 6m³ of storage area be used on any one injection.
However seek expert advice.

NEVER TRY TO SAVE PROPERTY OR PRODUCT BY PUTTING NEIGHBOURS, YOURS OR OTHER PEOPLES LIVES AT RISK, WAIT FOR THE FIRE SERVICES TO ARRIVE BEFORE DOING ANYTHING FURTHER.
APPENDIX 6 - EXTRACT FROM AS/NZS 3788:1996 PRESSURE EQUIPMENT INSERVICE INSPECTION AND AS 3920.1- PRESSURE EQUIPMENT MANUFACTURE

AS/NZS 3788: 1996 references the following clauses for pressure equipment in service inspection in relation to ammonia refrigeration vessels, ammonia piping and relief valves.

AS 3920.1 Pressure vessels and pressure piping most applications to hazard level "B" (ammonia)

4.4 Periodic Inspection

4.4.1 General, Boilers and pressure vessels and pressure piping, Inspection may be both internal and external.

4.4.2 First service inspection, Column 3, table 4.1 – 11.2 Group 2 refrigerant (ammonia) = 1 year

"New pressure equipment shall be inspected internally and externally after its first year of service, the frequency of subsequent inspections may then be determined"

"The internal examination may be deferred if the owner is satisfied that safety is not compromised"

4.4.3 Frequency of periodic inspection

4.4.3.1 Inspection periods, Table 4.1, Column 4, external inspections = 2 years

"These periods may be shortened by the owner because of adverse operating conditions or extended by the owner where favourable operating conditions justify such extension.

4.4.3.2 External inspections may be extended in accordance with Clause 4.4.3.7 beyond those shown in Table 4.1, Column 4, but shall not exceed the internal inspection period" ie 12 years

4.4.3.3 Internal inspections,

(a) Maximum nominal period Column 5 = 12 years (dependant on history of plant)

(b) Extended period Column 6 = 12 years may only be used after at least one or more ‘nominal periods’ have elapsed.

(c) Further extended periods shown in column 8, may be exceeded after discussion with the inspector, and the following can be shown documentation of past inspections, technical justification for extension, inspection may cause a hazard.

4.4.3.7 Extension of inspection periods, may be extended after establishing the following,

(a) The wastage rate of deterioration of the equipment.

(b) The equipment remains in the same service and operating conditions remain unchanged.

4.5 Pressure relief devices
4.6.4 In-service visual inspection, to be carried out at least annually to check for external damage and blockage in the outlet.

4.6.6.4 Scheduled testing and maintenance, relief valves shall be tested at periods not exceeding the internal inspection period or five years whichever is the less. The testing period may be extended up to the internal inspection period, provided weatherproof external protection prevents dust, rain or other contamination affecting the valve performance.

8.1 General

8.2 Pressure equipment register, each item shall be identified by a number and be displayed on the item. In the case of piping the equipment shall be readily identifiable via plant documentation, drawings etc. The register shall include notification of the next inspection date.

8.3 Pressure equipment data, this section lists data that shall be contained in the plant documentation and supplied at the time of purchase.

8.4 Pressure equipment history; file to contain details of maintenance and inspection history including pressure relief valve tests, repairs and significant deviations from normal operating conditions.

8.5 Pressure piping, it is not usual practice to maintain a file on each pipe, design, construction, test and inspection of overall system is to be documented. This is to include, Identification number, fluid, pipe size, design conditions, hazard level, inspection date, summaries and hanger settings.

This summary is for quick reference only, for full details the complete standard should be consulted.
APPENDIX 7 - TRAINING

Informative - The European has a standard, EN 13313 - 'Refrigerating systems & heat pumps - competence of personnel". It deals more comprehensively with the requirements of training, assessment and maintenance of competent personnel".

Informative - In the European Standard EN378 the following has been noted

- Competence – ability to perform satisfactorily the activities within an occupation – levels of competence are defined in EN13313
- Occupancies – 4.2 of the definitions. Occupancies are classified in respect to the safety of the persons, who may be directly affected in case of abnormal operation of the refrigeration system. Considerations of safety in refrigerating systems take into account the site, the number of people occupying the site and the categories of occupancy. Machinery rooms are regarded as unoccupied.

There are three classes of occupancy defined:

- **Class A** – General Occupancy – A location where people may sleep or where the number of people present is not controlled or to which any person has access without being personally acquainted with the personal safety precautions. Examples – hospitals, prisons, nursing homes, theatres, supermarkets, transport terminal, hotels, lecture halls, dwellings, restaurants, ice rinks.
- **Class B** – Supervised Occupancy – Rooms, parts of buildings or buildings, where only a limited number of people may be assembled, some of them being necessarily acquainted with the general safety precautions. Examples – laboratories, places for general manufacturing, office buildings.
- **Class C** – Occupancy with authorized access only – An occupancy which is not open to the public and where only authorized persons are granted access. Authorised persons shall be acquainted with general safety precautions of the establishment (eg. Industrial production facilities). Examples – cold stores, refineries, abattoirs, non-public areas in supermarkets, manufacturing facilities eg. For food ice, ice cream, chemicals.

- It also has a section for more than one category of occupancy – Where there is the possibility of more than one category of occupancy, the more stringent requirements apply. If occupancies are isolated, eg sealed partitions, floors, and ceilings, then the requirements of the individual category of occupancy apply. NOTE – Attention is drawn to the safety of adjacent premises and occupants in areas adjacent to a refrigerating system.
APPENDIX 8

www.worksafe.vic.gov.au

APPENDIX 9 – GLOSSARY OF TERMS

AIRAH - Australian Institute of Refrigeration, Air Conditioning and Heating Inc
AS/NZS - Australian/New Zealand Standard
BCA - Building Code of Australia
CFA - Country Fire Authority
EIB - Emergency Information Book
EIC - Emergency Information Container
EPS - Expanded Polystyrene
EXN - Non Sparking
HAZMAT - Hazardous Material
IDLH - Immediately Dangerous to Life and Health
LEL - Lower Explosive Limit
MFB - Metropolitan Fire Brigade
MSDS - Material Safety Data Sheet
OHS - Occupational Health and Safety
PIR - Polysicocyanurate
PPC - Personal Protective Clothing
PPE - Personal Protective Equipment
PPCS - Polystyrene/Phenolic composite foam
PPM - Parts per million
P&ID - Piping and Instrument Diagrams
RTO - Registered Training Organisation
SCBA - Self Contained Breathing Apparatus
TEFC - Totally Enclosed Fan Cooled
TWA - Time Weighted Average
UPS - Uninterruptible Power Supply

APPENDIX 10 – USEFUL LINKS


Guidance on Sandwich Panel Systems can be found on the following link.


AIRAH – www.airah.org.au