



MEAT INDUSTRY STANDARD: AMMONIA & REFRIGERANT MANAGEMENT



Contents

1. Introduction	4
1.1. Basic principles	5
2. Roles & Responsibilities	7
2.1. Duties of the PCBU	7
2.2. Responsibilities by role.....	7
3. Identify Hazards and Assess the Risk	12
3.1. Assess the risk.....	12
3.2. Post Assessment Actions.....	13
3.3. Workplace Exposure Standard	13
4. Implement Controls.....	15
4.1. Hazard Control Programmes	15
4.2. Recommended Controls.....	16
4.3. Risk Management Controls.....	16
4.4. Role Management Controls	20
4.5. Design controls	21
4.6. Engineering Controls	21
4.7. Detection & Warning Controls.....	24
4.8. Mechanical Integrity & Safe Operation Controls.....	26
4.9. Ignition Risk Controls.....	28
4.10. Managing Work Controls.....	28
4.11. Signage and labelling controls	30
4.12. Procedural Controls.....	32
4.13. Documentation & Reporting Controls.....	33
4.14. Personal Protective Equipment (PPE) Controls	34
4.15. Worker Competency Controls.....	36
4.16. Management Audit & Review Controls.....	38
4.17. Emergency Management Controls (Recovery).....	40
5. Planning Work	46
5.1. Consultation and Co-ordination	46
5.2. Permit to Work	46
5.3. Job Safety Analysis (JSA)	48
6. Reference Documents	49
6.1. Relevant legislation & regulations	49
6.2. Codes, Standards & Guidance	51
7. Appendices	54

AMMONIA & REFRIGERANT MANAGEMENT

7.1.	Appendix 1: Short & Long Term Mechanical Integrity Checks (Example)	55
7.2.	Appendix 2: Ammonia Safety Internal Assessment (example).....	58

1. Introduction



Ammonia and Other Refrigerants

Ammonia (and other refrigerants) have been identified as probably the most significant hazard for the meat industry, not because of the risk of seriously injuring or killing a single worker, but the risk to large numbers of people.

Ammonia is a highly toxic and reactive chemical. A major ammonia leak is potentially disastrous because ammonia readily evaporates when exposed to air and can create explosive fire hazards - concentrations of ammonia in air between 16 and 28% are flammable and can pose a risk of explosion. Inhalation can cause severe irritation of the nose and throat or even death. The gas irritates or burns the skin. Direct contact with the liquefied gas can chill or freeze the skin with blistering and scarring.

Meat processing uses large quantities of ammonia and other refrigerants. At the same time, many plants have old refrigeration systems which increases the risks.

This standard lays out the basic processes for clarifying roles and responsibilities, identifying hazards, assessing risks, and implementing controls to eliminate or minimise hazards.

Refrigeration systems at a plant are highly technical, and design and other decisions about the refrigeration system must be made by an appropriate refrigeration specialist, and are not dealt with in this document.

This standard draws on international experience and merges this with the relevant New Zealand regulations coming into force under the Health and Safety at Work Act 2015.

Please note that these are minimum standards and companies may (and are encouraged to) go beyond any or all of the standards in order to control risks 'so far as is reasonably practicable'.

This is a working document. This document and the subsequent family of documents will evolve over time for example to reflect changes in industry practice and regulation.

Note: This document represents **guidance only** for managers and supervisors in managing workplace health and safety in the meat industry. It is not legal advice and does not replace or amend an individual or collective employment agreement or a PCBU health and safety policy.

Neither the Meat Industry Association Inc or its members, take responsibility for the results or any actions taken on the basis of the information contained in these Standards, or for any error or omissions.

AMMONIA & REFRIGERANT MANAGEMENT



The Law (Legislation)

While the Health and Safety at Work 2015 and its safety regulations have been integrated into this Standard there are specific requirements to help manage the risks associated with manufacturing, using, handling or storing hazardous substances in the workplace and to protect the health and safety of workers.

Currently, they are set under the [Hazardous Substances and New Organisms \(HSNO\) Act 1996](#). These requirements have been transferred to the [Health and Safety at Work Act 2015](#) and a new set of [Hazardous Substances Regulations](#) that will come into force on **1 December 2017**.

Until 1 December 2017 the current [Hazardous Substances and New Organisms Act](#) remains in force in its current form.

This document is based on the **current** regulatory requirements and may be updated prior to the new regulations coming into force.

While this standard is intended to outline policy and procedure for use within meat processing operations, it is not a comprehensive document covering all aspects of ammonia safety or hazardous substances management. The applicable Regulations, Standards, Approved Codes of Practice and Best Practice Guidance must be adhered to.



Further information

See Reference Documents listed at the rear of this document in section 6 and refer to WorkSafe's website:

<http://www.worksafe.govt.nz/worksafe/information-guidance/guidance-by-industry/hsno>

1.1. Basic principles

As part of normal operations, meat processing facilities use a number of hazardous substances including refrigerants such as ammonia. If this risk is not controlled appropriately, there is potential for a major uncontrolled release, fire, or explosion which presents serious danger to our workers and potentially the wider community.

From a personal safety perspective, exposure to refrigerants including ammonia can cause immediate harm or may have long term health effects. It is therefore essential that refrigerants are used, stored and transported correctly to ensure minimum exposure and to prevent adverse events occurring.

The purpose of this Standard is to provide guidance to the meat industry on recommended management controls to ensure safe operations in and around the refrigeration plant and equipment at operational sites.

Specifically, this Standard provides guidance on controls to:

- 1) protect people and plant against the effects of an ammonia and other refrigerants
- 2) prevent conditions which could lead to ammonia and other refrigerant releases, and/or fire and explosion events

AMMONIA & REFRIGERANT MANAGEMENT

3) mitigate of the efforts of an unintentional release of ammonia and other refrigerants
4) prevent unplanned downtime resulting in loss of production or product
5) provide guidelines for future projects that involve ammonia and other refrigerants

2. Roles & Responsibilities

2.1. Duties of the PCBU

The PCBU must manage risks to health and safety associated with using or working with ammonia or other refrigerants that are reasonably likely to cause injury to the person or any other person if not controlled appropriately. The PCBU must ensure that any work that involves the potential for harm (risk) related to the use of ammonia or other refrigerants is controlled and made safe, so far as reasonably practicable.

To fulfil their duties the PCBU should ensure:

- Provision of training in procedures related to working with ammonia or other refrigerants; and
- Provision of all safety equipment, devices and/or systems to protect safety of all workers and the community when using ammonia or other refrigerants; and
- A system of controlling the work to ensure procedures are followed and the work is completed as planned and authorised; and
- A method of ensuring emergency management procedures are in place to manage any uncontrolled events related to the use of ammonia or other refrigerants and protect all workers and the neighbouring community.

The company is responsible for assigning someone to ensure the PCBU complies with its health and safety duties towards workers at a site – depending on the company, this can be the senior manager at that site.

2.2. Responsibilities by role

Role	Responsibilities
PCBU	As above
Officers	Officers must exercise due diligence to make sure that the PCBU complies with its health and safety duties.
General Manager	<p>The General Manager must ensure:</p> <ul style="list-style-type: none"> • This Standard is kept up to date and distributed to all relevant staff • The requirements of this standard are adhered to • So far as is reasonably practicable, that all risks are managed according to the hazard control hierarchy, detailed in the Health and Safety at Work Act 2015 and its accompanying regulations • That there are no acts or omissions by designated personnel responsible for managing the ammonia plant could result in putting the health and safety of workers and other persons at risk • That there is an identified person/s responsible for the Ammonia Refrigeration System and Process Safety Management • Own the Hazard and Risk Management process for the ammonia operations.

AMMONIA & REFRIGERANT MANAGEMENT

Role	Responsibilities
Engineering Manager	<p>The Engineering Manager shall:</p> <ul style="list-style-type: none"> • Ensure appropriate access control is installed and maintained on ammonia plant rooms • Ensure that any access controlled door is automatically unlocked in the event of an emergency • Ensure that Lock Out / Tag Out procedures are followed within the business • Ensure that Preventative Maintenance is carried out in a timely and complete manner • Ensure safety showers and eyewashes are in place, working and accessible • Purchasing and providing PPE as requested • Ensure that firefighting equipment is fit for purpose • Ensure that stationary containers are structurally sound and their condition maintained • Ensure that all secondary containment is structurally sound and their condition maintained (e.g. double skinned vessels) • Be aware of current NZ legislation, codes and standards as they apply to ammonia, and stay informed of any changes that are being applied. • Ensure that the Ammonia Refrigeration System meets the requirements of NZ legislation, engineering Standards, NZ Standards and Ammonia Control Plans • Ensuring an assessment/audit of the current ammonia plant installation is completed • Ensuring any daily operational checks and mechanical integrity tests (short & long term) are completed at the documented scheduled intervals.

AMMONIA & REFRIGERANT MANAGEMENT

Role	Responsibilities
Refrigeration Manager/Plant Leader	<p>Refrigeration Manager/Plant Leader is responsible for:</p> <ul style="list-style-type: none"> • The control of any workers who are working on or around the refrigeration plant • Ensuring workers are informed and competent to react in the event of an ammonia event • The PPE use, availability and suitability in the ammonia area, both for routine tasks and for emergency response • Maintaining the ammonia plant in a safe, operational state • Any work on safety systems, ensuring it maintains the integrity of the system during and after the work • Ensuring that all work is done to meet the company's Engineering Standard, specifically including: <ul style="list-style-type: none"> – Signage – Labelling – Safety systems • The prevention programmes within the risk management process • Maintaining a non-hazardous environment rating for the ammonia plant (if achieved) • Keeping the Hazardous Substance Register up to date with the quantities of all hazardous substances in the ammonia area • Ensuring safety reviews are conducted to: <ul style="list-style-type: none"> – ensure that modifications are installed in accordance with approved design standards, – ensure that new procedures are developed prior to start-up of a modified facility, – ensure existing procedures are modified accordingly, and that all workers (including contractors and subcontractors) are trained on the procedures • Documenting and updating the hazard and risk registers as appropriate • Any modification or significant change to operating parameters must be documented and consulted with operators and relevant contractors

AMMONIA & REFRIGERANT MANAGEMENT

Role	Responsibilities
Refrigeration Manager/Plant Leader (cont'd)	<ul style="list-style-type: none"> • Owning process safety management for the ammonia plant, specifically: <ul style="list-style-type: none"> – Operational procedures. – Assessing the training needs of workers who will be working on or around the ammonia plant and equipment – Ensuring workers who will be working on or around the ammonia plant and equipment are trained and competent. – Inductions for the area – Managing contractors in the area – Management of initial start-up of plant after extended non-operational periods – Integrity of the plant – Permits – Change management – Incidents logged and investigated • Completing any necessary risk assessment, HAZOPs or Process Hazard Analysis (PHAs) • Ensuring Hazard and Risk assessment is reviewed within the agreed timeframe • Ensuring PHA and modification and change control has a desktop review applied annually and a comprehensive review applied once every three years • Maintaining awareness of current NZ legislation, codes and standards as they apply to ammonia, and staying informed of any changes that are being applied • Checking and logging emergency ammonia PPE every three months.
Health and Safety Manager/Advisor	<p>The Health and Safety Manager/Advisor are responsible for:</p> <ul style="list-style-type: none"> • Providing assistance, advice and guidance on hazard and risk management requirements • Coordinating training and skills development as directed • Ensuring that a clear hierarchy of responsibilities exists in the event of a serious failure involving ammonia • Ensure that internal and external responders are informed and aware of the planned response to a serious failure involving ammonia • Performing/organising assessment/audits as required.
Environmental Manager/Advisor	<p>The Environmental Manager shall:</p> <ul style="list-style-type: none"> • Ensure that the site meets, holds and maintains compliance for storage & disposal of ammonia • Ensure Location Test Certificates and Stationary Containment Certificates are sought, issued and held (if required).

AMMONIA & REFRIGERANT MANAGEMENT

Role	Responsibilities
All workers	<p>Workers are responsible for taking all reasonable and necessary precautions for their own health and safety when working within the refrigeration plant and ensuring:</p> <ul style="list-style-type: none">• They never perform any task where there is a risk of harm to themselves or other workers (seek further advice from a Supervisor or Manager before commencing)• All refrigeration hazard controls followed correctly and consistently and safe work practices they have been trained in are followed• The reporting of any uncontrolled hazards they see to their immediate supervisor• The use of safety equipment provided. If protective safety devices are provided, these must be used• The reporting of any refrigeration incidents using their site's incident reporting system.

3. Identify Hazards and Assess the Risk



Hazard

The need for ammonia and refrigerant safety management exists to prevent or minimise the consequences of a catastrophic release of ammonia or other harmful refrigerant.

The outcome of such an event would generate toxicity, fire and explosion hazards to both workers and the environment, as well as interruption to the business.

The PCBU must identify all those situations in which workers (or others) could be harmed as result of handling or an uncontrolled release of a refrigerant such as ammonia. This may occur including during routine work, as well as non-routine activities, breakdown and maintenance, or be introduced by contractors, etc.

Identifying hazards related to the refrigeration system involves finding all of the situations that could potentially cause harm to workers (or others). It is imperative that all hazardous substances used in normal operations within the refrigeration facility are identified to enable the assessment of the risk and appropriate controls to be applied.

Specifically, the following must be considered:

- The hazardous properties of the refrigerant
- Any potentially hazardous reaction (chemical or physical) between the refrigerant and another substance or mixture, including a substance that may be generated by the reaction
- The nature of the work to be carried out with the refrigerant
- Any structure, plant or system of work that:
 - Is used in the use, handling, generation or storage of the refrigerant
 - Could interact with the refrigerant at the workplace.
- Potential for loss of refrigerant (scope of emergency, stakeholders off-site, worst case scenarios)
- Requirements to bring releases back under control (equipment, resources)

Always read the Safety Data Sheet and research other sources such as standards or guidance documents on the process.

3.1. Assess the risk

Once the hazards related to the use of refrigerants have been identified, the risks need to be assessed.

Risk Assessments must be undertaken:

- For all hazardous substances including refrigerants whether used, stored or transported within the PCBU's operations
- Where an event has involved hazardous substances including refrigerants
- When the process requires modification.

The makeup of the risk assessment team should include as a minimum the Site Manager, refrigeration engineer, refrigeration plant operation workers, worker representative/s and health and safety

AMMONIA & REFRIGERANT MANAGEMENT

resources. Persons undertaking Risk Assessments must have the abilities to interpret sometimes complex technical information.

All Risk Assessments in relation to any **hazardous substance including refrigerants** must also consider in particular:

Consider:
<ul style="list-style-type: none">• The routes of entry by which the chemical can affect health
<ul style="list-style-type: none">• The physical form and concentration
<ul style="list-style-type: none">• The chemical and physical properties of the substance
<ul style="list-style-type: none">• Who could be exposed, and when this could occur (assessing work schedules, including maintenance, inspection, cleaning, etc)
<ul style="list-style-type: none">• How often is exposure likely to occur and for how long?
<ul style="list-style-type: none">• Layout of the workplace (inc. location of storage and possibility of unauthorised access to areas)
<ul style="list-style-type: none">• Workplace Exposure Limits
<ul style="list-style-type: none">• Sources of ignition
<ul style="list-style-type: none">• Volume of the substance
<ul style="list-style-type: none">• Range of uses of the substance - the assessment must consider the entire lifecycle of the substance, from delivery and receipt, to storage, handling, preparation, dilution, mixing, use, and disposal, both under normal and uncontrolled release (or spillage) conditions
<ul style="list-style-type: none">• Variety of tasks - the assessment must take into account any unusual activities that are foreseeable or are likely to occur, for example, cleaning up an uncontrolled release (or spill), maintenance, cleaning the chemical storage area, fixing a breakdown
<ul style="list-style-type: none">• Individual susceptibilities – including atopic persons, sensitisations, lifestyle issues including smoking, drug and alcohol use and age. These may be identified through pre-employment health screening and health monitoring
<ul style="list-style-type: none">• Training and competency of persons in may required procedure, particularly those that are unusual or non-typical, including use of PPE.

3.2. Post Assessment Actions

Where a risk assessment identifies deficiencies, appropriate resources must be deployed in a timely manner to implement corrective actions commensurate with the identified risks.

Where a deficiency has been identified through a risk assessment, appropriate temporary controls are to be implemented in the period prior to the implementation of permanent controls.

3.3. Workplace Exposure Standard

The Workplace Exposure Standards (WES) exposure limits for hazardous substances are set by WorkSafe NZ. They are a guide as part of a hazardous substance control programme and are enforceable under the Act for the purpose of protecting persons in a workplace from the adverse effects of hazardous substances.

- The absence of a specific exposure standard for a substance must not be considered an indication that exposure need not be controlled

AMMONIA & REFRIGERANT MANAGEMENT

- WES always relate to personal air sampling results
- WES must never be exceeded.

Workplace Exposure Standards (WES) exposure limits for Anhydrous Ammonia

WES-TWA:	25 ppm, 17 mg/m ³ . (8 hour, time weighted average exposure limit)
WES-STEL:	35 ppm, 24 mg/m ³ . (15 minute short term exposure limit)



Further information

For more information about the Workplace Exposure Standards (WES) refer here:

<http://www.worksafe.govt.nz/worksafe/information-guidance/all-guidance-items/workplace-exposure-standards-and-biological-exposure-indices/workplace-exposure-standards-and-biological-indices-2016.pdf>

4. Implement Controls

Refrigerants such as ammonia are hazardous substances and the PCBU should **eliminate the risks**. Good design is essential and provides the most effective opportunity to eliminate risk, for example by designing the plant so the hazard is eliminated or human interaction is eliminated. Even where this cannot be done the safety of the users should be a foremost consideration and the plant and equipment designed to promote safety (rather than safety systems designed to accommodate the plant and equipment) wherever possible.

Where elimination is not possible, the risk must be minimised:

- **Substitute** - Substituting the hazardous substance must be considered where elimination is not possible. Substitution is the replacement of a hazardous chemical with a chemical that is less hazardous and presents lower risks, for example:
 - Substituting a less volatile material to control a vapour hazard may cost less than the installation and maintenance of a mechanical ventilation system
 - Substituting a highly flammable liquid with one that is less flammable or combustible.
- **Isolate**- Use work equipment or other measures to prevent hazardous substances being able to contact workers, for example, enclosed processes; and
- **PPE, ventilation and other controls** - Where the risk of harm from hazardous substances cannot be eliminated the use work equipment or other measures to minimise the risk of harm (i.e. personal protective equipment, ventilation, etc). Please note that this is a far lower level of protection and requires a high level of competency and must be performed under authorisation only.

4.1. Hazard Control Programmes

Where it is impossible to eliminate the hazard there must be a comprehensive hazard control programme implemented that includes the following as a minimum:

Typical programme components:
• Hazard identification
• Risk assessment and control
• A permit to work
• An emergency response plan
• Appointment of a person or persons who is trained to ensure that adequate communication, support, first-aid and rescue services are available where required
• The provision of PPE including appropriate respiratory devices
• Appropriate training and competency standards.

Once control measures are in place, they must be regularly monitored and reviewed. The following must be considered.

Consider:
• Have control measures been implemented as planned?
• If control measures have not been implemented, why not, and what is happening in the meantime?

AMMONIA & REFRIGERANT MANAGEMENT

<ul style="list-style-type: none">• Are the control measures being used correctly?
<ul style="list-style-type: none">• Are the control measures working?
<ul style="list-style-type: none">• Have the control measures isolated or minimised the risk from the hazard as intended?
<ul style="list-style-type: none">• Have the control measures made any new hazards?
<ul style="list-style-type: none">• Have the control measures made any existing hazards worse?

A PCBU must ensure through effective supervision and monitoring that the control measures are effective and are maintained. There must be regular reviews of the risks and controls.

4.2. Recommended Controls

The following controls detailed in this section are examples of controls that may be found in the critical risk/safety/quality management systems of facilities where the risks of ammonia and/or other refrigerants are well controlled. Many of these controls are mandated in regulation or standards. All are highly recommended.

The controls have been grouped in sections for ease only. However, some of the controls are also closely linked to controls under other headings. Some of the control names may appear repetitive however controls defined here include critical processes and activities as well as the harder physical/engineering controls. Some controls could be listed under alternative headings instead.

This is not an exhaustive list and business may implement further controls in order to manage risks as they see fit.

4.3. Risk Management Controls

4.3.1. Typical controls

Control	Description
Audit Risk Management	<p>Risk Management is being applied and maintained for the Ammonia/Refrigerant plant, and is performed before installation and/or alterations of the facility.</p> <p>The Risk Management Plan must be documented and retained (including HAZOPs).</p> <p>An assessment should also be conducted of person(s) or teams responsible for conducting risk assessments so that their competence to perform the task is assured.</p>
Critical Risk Group	<p>An Ammonia/Refrigerant steering group should be formed and meet at regular intervals.</p> <p>The purpose of the group is to ensure the requirements of the MIA Standard, any Company safety/engineering standard(s) and risk management program are achieved.</p>
Change Management System	<p>A documented Change Management Procedure should be in place to clearly articulate and inform all stakeholders of any new additions or modifications to refrigeration plant, equipment or changes to processes or procedures.</p>

AMMONIA & REFRIGERANT MANAGEMENT

Control	Description
Ignition Risk analysis & Hazardous Area Assessment	A hazardous area assessment relating to ignition risk should be completed for all areas or rooms where equipment contains refrigerants. This includes ammonia plant rooms, pipe routes and chillers.
HAZOP and Process Hazard Analysis (PHA)	Complete formal HAZOP/PHA assessments before installation of any new equipment, or making changes to existing equipment/processes in the Refrigeration System.
Risk Assessment of Plant	Conduct a formal risk assessment of the existing Refrigeration System, with the outcomes being detailed in the plant improvement plan (and Risk Management Plans updated as required).
Risk Management Program	Have in place a Risk Management Programme. The business should have a documented risk management plan formed from the risk assessment.
Process Safety Information	Process Safety Information for the Refrigeration System is held as required. See section 4.3.2.
Safety Case	A Safety Case detailing the actions required to manage the risks associated with Refrigeration System. External advice may be required to determine if a safety case is required (in addition to a risk management plan). Safety cases are reviewed by the relevant regulator.
Reporting Abnormal Conditions	A clear and well understood process to escalate any deviation from expected condition and have abnormal conditions repaired.
Workplace Monitoring	A process for the identification and on-going monitoring of identified hazards, situations, areas or conditions where refrigerants pose a potential environmental or health risk.

4.3.2. Process Safety Information

For the purposes of this Standard 'Process safety Information' refers to the properties of ammonia and/or other refrigerants used, the process and the equipment that use the refrigerant.

Information that should be held by each business includes:

Property type	Description
Refrigerant properties	<ul style="list-style-type: none"> Properties of the refrigerant including: <ul style="list-style-type: none"> Physical data of the refrigerant Physical data Reactivity data Permissible Exposure Limits Toxicity information Corrosivity data

AMMONIA & REFRIGERANT MANAGEMENT

Property type	Description
Equipment properties	<ul style="list-style-type: none"> Equipment Properties including: <ul style="list-style-type: none"> Materials of construction Piping and instrument diagram (P&ID's) Electrical classification Relief system design and design basis Ventilation system design Design codes and standards employed Material and energy balances for processes built after May 26, 1992 Safety system (for example interlocks, detection or suppression systems)
Process Properties	<ul style="list-style-type: none"> Process Properties including: <ul style="list-style-type: none"> A block flow diagram or simplified process flow diagram Process chemistry and its properties Maximum intended inventory Safety upper and lower limits for such items as temperatures, pressures, flows or compositions An evaluation of the consequences of deviations, including those effecting the safety and health of the employees.

4.3.3. Ignition Risk

A hazardous area assessment relating to ignition risk must be been completed for all areas or rooms where equipment contains ammonia or other refrigerants (depending on risk – refer to the substance property information of the refrigerant). This includes plant rooms, pipe routes, and chillers.

For more information also see section 4.9.

4.3.4. Hazardous Area Assessment

Plant rooms may be zoned as hazardous areas which requires a higher level of control, inspection and ongoing assessment.

In order to be classified as a non-hazardous (NH) area a number of robust management systems must be in place. These systems include:	
Mechanical Ventilation	Protection by ventilation, which provides both protection against toxic build up and build up to explosive levels during normal operation.
Ammonia gas detection	Ammonia gas detection to continually monitor if gas is present in the room and alarms when ammonia is present.
Electrical isolation	Isolation of electrical supply when certain pre-set levels of ammonia are present.
Control doors	All engine room doors are to be kept closed to keep any leaks contained.

AMMONIA & REFRIGERANT MANAGEMENT

Ammonia isolation
valves

Manual isolation valves for the pipework provided.



Photo 1. Audible and visual alarms with appropriate signage

AMMONIA & REFRIGERANT MANAGEMENT

4.4. Role Management Controls

4.4.1. Typical controls

Control	Description
NZ legislative requirements & standards	Ensure a person is identified as responsible for having the Refrigeration System reviewed to ensure that it meets the requirements of NZ legislation and NZ Standards. Specialist expertise required for validation.
Assessment of Resource Availability	Ensure that an assessment is made of the management of resources which can be prioritised and made available for managing high risk situations or environments, related to any refrigerant, so that the hazard can be eliminated or minimised as quickly as possible.
Accountability, Responsibility or Delegation	A set of clearly identified roles and responsibilities (within each individual business) in relation to the Refrigeration System Process Safety Management and Risk Management Programmes documented within this Standard to be documented.
Process Safety Management	A person is identified as responsible for ensuring the Process Safety Management System is implemented.



Best Practice Advice

Ensure that roles and responsibilities of all workers and stakeholders are clearly understood. Document the refrigeration safety management process from top to bottom and assign responsible persons for each element. This really helps to make sure tasks are not overlooked and gives each person clarity around their responsibilities.

AMMONIA & REFRIGERANT MANAGEMENT

4.5. Design controls

4.5.1. Typical controls

Control	Description
Design Pressure	Ensure that Design Pressure for all equipment is above the vapour pressure of refrigerant at the maximum expected ambient temperature at the site.
Design Standard	Ensure that all plant installations, relocation or modifications comply with Engineering Standards.
Design Verification	<p>Ensure that compliance to design standards are audited by a Recognised Inspection Body and documented throughout the installation phase of refrigerants and hazardous substance storage and transport systems, and that the procedures are signed off at the completion of the project to verify that all standards have been met and are appropriately documented. A Certificate of Inspection is required before going into service.</p> <p>These standards are to be made readily available so that future maintenance or installations are able to be completed to the same documented standards.</p>
Materials Suitability	Ensure that the materials of construction used are compatible, and certification is provided by the designer and supplier for plant installations, relocation or modifications.
Pressure Equipment	<p>Ensure that pressure equipment that contains refrigerant is designed to recognised standards.</p> <p>Pressure Equipment means a boiler, boiler piping, compressor, fired heater, gas turbine, hot water boiler, piping component, pressure fittings, pressure piping, pressure vessel, pump, steam engine, or steam turbine, the purpose of which is to contain all or any of the following:</p> <p>(A) gases at pressures exceeding 50 kPag; or</p> <p>(B) liquids at pressures exceeding 50 kPag; or</p> <p>(C) steam.</p> <p>It includes all items and safety devices that are necessary to maintain the safety of the kind of pressure equipment, whether the kind of pressure equipment stands alone or is part of an operating system.</p>

4.6. Engineering Controls

4.6.1. Typical controls

Control	Description
Isolation Valves (King Valves)	<p>Key isolation valves (also called King Valves) are available to isolate the system in an emergency situation. Isolation valves must be easily identifiable.</p> <p>Another device may be applicable (other than key isolation valves) to ensure isolation of the refrigerant can be achieved.</p>

AMMONIA & REFRIGERANT MANAGEMENT

Control	Description
Release Protection System	An automated plant shut down system compliant to standards exists and is working as intended.
Venting System	A venting system compliant with standards.
Pressure Relief Valves	<p>Relief Valves from all refrigerant equipment are vented appropriately. Relief valves must be correctly sized.</p> <p>There must be a system for regular inspection and replacement of relief valves.</p>
Emergency Exit Doors	Emergency exit type doors that can be opened both from outside and inside, opening outwards and self-closing, to allow for quick and effective evacuation of buildings in case of a refrigerant emergency.
Security/Access	Refrigeration System Plant Rooms are secured and access is only provided to authorised people to eliminate unwanted human/equipment Interaction.).
Refrigeration Plant/Traffic Interaction	Manage Refrigeration System Plant/Traffic Interaction to eliminate contact with filling/filled equipment. This may require the installation of devices such as bollards and barriers.

AMMONIA & REFRIGERANT MANAGEMENT



Photo 2. Bollard protection of ammonia receiver



Photo 3. Isolation Valve (or King Valve) identification

AMMONIA & REFRIGERANT MANAGEMENT

4.7. Detection & Warning Controls

4.7.1. Typical controls

Control	Description
Ammonia Alarm Manual Call Points	Ammonia Alarm Manual Call Points are yellow (or the same as for fire alarms) and should be located in and at the exits of all rooms with equipment containing ammonia (or other refrigerants), where the gas could escape.
Ammonia Detection	<p>Any room or area that contains ammonia or refrigerant should be fitted with an appropriate detection system.</p> <p>Different concentrations may apply to detection system triggers.</p>
Ammonia Detection Systems Level	Ammonia detectors initiate an ammonia evacuation alarm of the appropriate area at an ammonia concentration of not more than 35 ppm.
Ammonia Detection Systems Testing	Ammonia detection and alarm activation must be verified at least annually. This includes verification of the gas detector calibration, and testing of the alarms at an ammonia concentration of not more than 35 ppm.
Ammonia Evacuation Alarms	Ammonia Manual call points and automated gas detection systems activate a visual flashing light visible from all locations in the room where the event occurs, and activates an audible alarm inside the room with a different tone and note from a fire alarm.

AMMONIA & REFRIGERANT MANAGEMENT



Photo 4. Ammonia alarm strobe



Photo 5. Emergency shutdown (external)



Photo 6. Emergency exit from plant room



Photo 7. Emergency Shower

4.8. Mechanical Integrity & Safe Operation Controls

4.8.1. Typical controls

Control	Description
Daily Mechanical and Electrical Integrity Checks	A system to conduct Daily Mechanical Integrity Checks on refrigeration plant and equipment.
Mechanical System Critical Integrity Checks (Short & Long-Term)	A system to conduct Monthly, Quarterly and Annual System Critical Checks.
Data Logging and Reporting	Ensure that records are generated and kept of: <ul style="list-style-type: none">• Safe operating statistics/limits.• Systems that show operating conditions versus limits.
Preventative Maintenance	Ensure that a formalised preventative maintenance process is in place to ensure that the ammonia refrigeration system is maintained at appropriate levels to ensure its integrity and function.
Housekeeping	Ensure that it holds written procedures and applies them to ensure housekeeping requirements are met to minimise the impact on the introduction of new hazards and risks.

4.8.2. Preventative Maintenance

Mechanical integrity of any refrigeration plant is maintained by planned preventative maintenance.

The assets within the refrigeration plant should be listed as individual items within a maintenance system which contains their individual maintenance history, key engineering parameters, and allows planned work to be programmed in on that specific component of equipment.

AMMONIA & REFRIGERANT MANAGEMENT

4.8.3. Mechanical System Critical Integrity Checks

Short Term Integrity Checks	<p>Short term integrity checks should be carried out daily on key aspects of the refrigeration plant.</p> <p>Appendix 1: Short & Long Term Mechanical Integrity Checks (Example)</p> <p>The following schedules in Table 1 and Table 2 provide an example of a preventative maintenance approach to mechanical integrity testing for an ammonia plant. Other programmes may achieve the same aim. At all times the programme should meet the requirements of regulations and standards. External advice may assist in developing a suitable programme.</p> <p>Table 1 on page 55 identifies the activities that are considered critical for the integrity of the safety systems of the ammonia plant. They can be systems, programmes or individual items of equipment.</p>
Long Term Integrity Checks	<p>Long term integrity checks of the plant are to be carried out on key aspects of the ammonia plant at scheduled intervals.</p> <p>Table 2 on page 56 identifies the activities that are considered critical for the integrity of the safety systems of the ammonia plant. They can be systems, programmes or individual items of equipment.</p>



Photo 8. Good housekeeping in plant room

4.9. Ignition Risk Controls

4.9.1. Typical controls

Control	Description
Electrical Ignition Risk	Ensure that all electrical equipment in Ammonia Machinery rooms (enclosure in which equipment such as pumps and compressors are housed) meets the requirements of the hazardous area rating for the area, or its power supply is through a circuit breaker that can be isolated by activating push buttons located in a safe location outside the area.
Electrical Ignition Risk (Non-occupied Machinery Rooms)	Ensure that in unmanned Ammonia Machinery rooms the detector(s) shall isolate all electrical circuits, other than emergency lighting and ventilation by circuit breakers located in a safe space, when the concentration exceeds 20% of the LEL.

4.10. Managing Work Controls

4.10.1. Typical controls

Control	Description
LOTO/Isolation	Ensure that procedures for isolation and lock-out tag-out aspects of the ammonia refrigeration system areas during maintenance or abnormal operations.
Permit to Work	Ensure that High Risk Activities in relation to the Ammonia Refrigeration System are being managed.
Contractor Management System	Ensure there is a Contractor Management System to ensure effective management of all contractual works.
Pre-Start-Up Safety Review	Ensure that pre-start-up safety reviews are conducted to verify that: <ul style="list-style-type: none">• modifications are installed in accordance with approved design standards,• new procedures are developed prior to start-up of a modified business,• ensure existing procedures are modified accordingly, and• all of our workers (including contractors and subcontractors) are trained in the procedures.

AMMONIA & REFRIGERANT MANAGEMENT



Photo 9. A typical Permit station



Photo 10. Isolation Padlocks

AMMONIA & REFRIGERANT MANAGEMENT

4.10.2. Managing Contractors

Contractors may require additional management because they may be unfamiliar with the site, work at different times, bring their own specialist vehicles and mobile plant onto site, and their health and safety responsibilities and duties in relation to other workers may be unclear.

When contractors are engaged, the site manager should establish their competence before they do any work. The same health and safety standards that apply to workers also apply to contractors on site. They are likely to need specific job and familiarisation training and/or supervision.

There will be overlapping duties and both the PCBU (meat processor) and the PCBU (contracting firm) have a duty to consult, cooperate and coordinate with each other. Both should agree the safety arrangements before any contractor employees commence work.

The PCBU (meat processor) should give the PCBU (contracting firm) appropriate information about, for example:

- The workplace
- The routes to be used
- The vehicles and equipment on site
- Risks from activities on the site and controls in place
- Penalties if they fail to follow safe working practices.

4.11. Signage and labelling controls

4.11.1. Typical controls

Control	Description
Signage	Clear signage displayed at all entrances to the ammonia plant rooms and any rooms that have equipment containing ammonia. The signage is to be in HAZCHEM format, note the substance (e.g. ammonia), its UN number, its emergency actions code, and relevant contact details - supplier or business contacts.
Labelling storage and pipe work	<p>Ammonia compounds, storage tanks and pipe work have the appropriate signage and labels in place as per New Zealand law, regulation and/or standards/codes of practice.</p> <p>Minimum signage and labels requirements for storage compounds and tanks shall include the name, direction of flow and anything that is required as per the pipe labelling standard.</p>

AMMONIA & REFRIGERANT MANAGEMENT



Photo 11. Ammonia pipe labelling



Photo 12. Plant room signage

4.12. Procedural Controls

4.12.1. Typical controls

Control	Description
SOP - Plant Operation	Written standard operating procedures for each operating phase involving the ammonia refrigeration system.
SOP - Defective Equipment	Standard operating procedures include details on what action needs to be taken if defective equipment is identified.
Safety and Emergency Systems Impairment	Documented procedures for Safety and Emergency Systems Impairment for the Refrigeration System.

4.12.2. Procedures – Plant Operation

The PCBU should have written standard operating procedures for each operating phase involving the refrigeration system. As a minimum, these should include:

Normal operations	• Start up
	• Operation
	• Shut down
Temporary operations	• Start up
	• Operation
	• Shut down
	Procedures should include detailed requirements for holding periods, safety bypass features etc
Routine maintenance	• Shut down
	• Operation/Maintenance tasks
	• Pre-Start Up Safety Reviews (following modification)
	• Start up
Emergency operations	• Start up
	• Operation
	• Shut down

AMMONIA & REFRIGERANT MANAGEMENT

4.13. Documentation & Reporting Controls

4.13.1. Typical controls

Control	Description
Document Control	A process is in place to manage Refrigeration System documents including, but not limited to risk assessments, material test certificates, pressure tests, training, emergency drills, events, records for inspection, records for maintenance. Records to be retained and available for future use.
Five Year Event History	Identify and document ammonia events in the five-year event history. Events are to be categorised as follows: Very High, High, Moderate and Low
Licences and Certifications	Maintain and hold the appropriate licences and certifications to ensure compliance with New Zealand regulatory requirements.
Piping and Instrumentation Diagrams (P&IDs)	Ensure that Refrigeration Systems have up to date Piping and Instrumentation Diagrams (P&IDs).

4.13.2. License and certifications

There are many licenses and certifications required for refrigeration equipment. All records from the inspections that produce documentation such as certification or records must be maintained.

Examples of certification and record that should be maintained include (but is not limited to):	
Equipment	<ul style="list-style-type: none">• Material Test Certificates• Calibrations
Pressure	<ul style="list-style-type: none">• Certificate of Design Verification• Certificate of Inspection
Hazardous Areas	<ul style="list-style-type: none">• Periodic inspection certificate (at least 4 yearly)
HSNO / Location Test Certificate	<ul style="list-style-type: none">• Cylinders of Ammonia in excess of 100 kg stored on site for longer than 18 hours, will trigger the need for a Location Test Certificate.• Anhydrous Ammonia stored in a receiver is exempt from certification, under Schedule 3, Regulation 9 of the Hazardous Substances (Dangerous Goods and Scheduled Toxic Substances) Transfer Notice, 2004.

AMMONIA & REFRIGERANT MANAGEMENT

4.14. Personal Protective Equipment (PPE) Controls

4.14.1. Typical controls

Control	Description
PPE Assessment and Inspection	<p>Regular inspection of PPE equipment is conducted to insure its integrity, and that an assessment is made of whether the PPE is fit for purpose and most appropriate.</p> <p>The inspection will examine the SOP associated with PPE to ensure staff are aware and trained in the appropriate use of PPE to ensure the equipment functions as it is designed to and is therefore most effective.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
PPE Available	<p>Ensure that sufficient, fit for purpose personal protective equipment is available.</p> <p>Emergency equipment is to be identified and protected so that it is ready for use when required.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
PPE Equipment Registers	<p>A PPE equipment register in place of all PPE that may be used for the management of Ammonia.</p> <p>Minimum components of the register shall include but not be limited to equipment type, individual equipment identifier/label and storage location.</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
PPE Procedure	<p>A procedure is in place for the inspection, maintenance and replacement of PPE whether issued to an individual or a work station.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
PPE Training	<p>Ensure training on the correct type and usage of personal protective equipment is provided to all personnel that may or are required to use PPE when handling ammonia.</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>

AMMONIA & REFRIGERANT MANAGEMENT



Photo 13. Emergency respirators in place

AMMONIA & REFRIGERANT MANAGEMENT

4.15. Worker Competency Controls

4.15.1. Typical controls

Control	Description
Training Need Identification	<p>A process is in place to identify roles/personnel who may be required to operate or work with a system involving ammonia.</p> <p>The business to identify the training needed by these roles/personnel.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
Training Provision	<p>Any worker, including contractors and subcontractors, working with the ammonia system is trained in specific safeguards and SOPs of the elements of the system that they work with and understand the appropriate limits.</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
Contractors Training Check	<p>Technicians/engineers contractors engaged meet competency and qualification requirements.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
Induction Management Process	<p>A robust process is in place to ensure that all individuals (either staff, contractors or visitors) who access the ammonia facility are correctly inducted to the site and area, or are escorted by someone who is, and any anomalies to this process are raised as events in the incident reporting system.</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
Induction for workers	<p>Ensure appropriate and timely induction processes are implemented for ALL workers including employees, contractors and subcontractors, which will include the general site induction and a work area specific induction (i.e. departmental induction).</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
Induction - Visitors	<p>Processes are in place to educate and manage visitors to ensure they are aware of any risks, site restrictions and emergency procedures.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>

AMMONIA & REFRIGERANT MANAGEMENT

Control	Description
Ammonia handling/transport licences	<p>A process is in place to ensure that workers (including contractors and subcontractors) who may or are required to handle/transport Ammonia, hold and maintain the correct licences/competencies as per NZ law, regulation and/or standards/codes of practice.</p> <p>The business to also have a process in place to check the validation period and status of all licence holders transporting Ammonia.</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>

4.15.2. Contractor competency

All contractors are considered like any other worker while on the site and should be subject to the full site and departmental induction (refrigeration plant) programme when working within the refrigeration plant.

Contractors dealing with intrusive work inside the ammonia vessels or pipework will also hold the following.

Refrigeration contractor qualifications, including:
<ul style="list-style-type: none"> Level 4 trade certificate in Refrigeration
<ul style="list-style-type: none"> Approved handler (as appropriate)
<ul style="list-style-type: none"> Approved filler (as appropriate)
<ul style="list-style-type: none"> Electrical Service Technician (EST) registration (as appropriate)

4.15.3. Transport/handling

Carriers of ammonia and/or other refrigerants are required to hold dangerous goods licenses in order to carry these dangerous goods under Land Transport Rule. All transport drivers and their Managers should be alerted to expiry dates of Licences and endorsements using their Company's internal management systems or by using a system such as DriverCheck. This is not the responsibility of MIA Members to check however MIA members should seek verification from each transport supplier that they use in order to ensure that this occurs.

4.15.4. Safe work procedures

A safe work procedure describes the steps involved in safely undertaking a task. It may also include any particular training, instruction and the level of supervision required. For example, a safe work procedure to ensure that truck drivers exit their vehicles prior to loading and stand in a demarcated and approved safe area for the duration of loading activity.

If relying on administrative controls such as procedures, it may be necessary to provide a high level of supervision to ensure that the safe work procedure is being adhered to.

AMMONIA & REFRIGERANT MANAGEMENT

4.16. Management Audit & Review Controls

4.16.1. Typical controls

Control	Description
Audited Documentation	<p>Ensure that internal and/or external audits are completed to insure the readily available supply of relevant documentation associated with the Risk Management of Ammonia, including the Standard Operating Procedures, reporting and investigation of incidents and near misses, and completed registers (SDS).</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
Audited Maintenance inspection	<p>Ensure that preventive maintenance procedures are audited to ensure that regular, documented inspections of ammonia equipment, storage devices, secondary containers, ignition sources, spill equipment and PPE are completed, which ensure their functional integrity.</p> <p>The audit shall also take note of appropriate lock-out procedures used to safely perform maintenance and inspections.</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
Internal reviews of safety systems	<p>Ensure that ammonia safety controls implemented within the business are regularly reviewed and assessed. The purpose is to locate evidence that controls are in place and working, identify positives and any gaps for further corrective action and improvement.</p> <p>A guide has been developed to use as the basis of a regular internal assessment of critical controls. This guide is found in section 7.1</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
Inspection of Licences and Certificates	<p>Ensure that a system is in place to ensure that licenses are held, maintained and refreshed to ensure compliance.</p> <p>Annual inspection of certificates and compliance documents shall be completed to ensure the Plant remains to a safe standard and that the plant obtains and complies with any new legislation or reform.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
Process Safety Management Assessment	<p>Verify that the Process Safety Management practices are adequate and are being followed, by audit.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>

AMMONIA & REFRIGERANT MANAGEMENT

Control	Description
Regulatory Compliance Validation	<p>A process to review the regulatory compliance of the company in accordance with NZ requirements. External validation will be required.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
Induction and Training Quality Assessment	<p>An annual assessment is completed that confirms that the induction process is being carried out and covers all appropriate hazards and responses, and that all staff who work in the Ammonia area are trained and assessed competent in their work and how to respond to events.</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
ACAP Risk Prioritisation	<p>An Asset Condition and Assessment Process (ACAP) system to process and prioritise capital expenditure to the highest risks on an annual or more regular basis.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
PTW Inspection	<p>Ensure that internal inspections and external audits examine:</p> <ul style="list-style-type: none"> the use of Permit-to-Work documentation in their entirety and that a PTW procedure has been implemented when undertaking installation, maintenance or repair. <p>The audit should also check the person(s) supplying PTW to ensure that they are qualified and have the correct knowledge to be making risk management decisions.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
Signage Audit	<p>Ensure that internal inspection and external audits are completed to ensure that existing and new signage complies with design standards and that they remain fit for purpose, clear and legible.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>

AMMONIA & REFRIGERANT MANAGEMENT

4.17. Emergency Management Controls (Recovery)

4.17.1. Typical controls

Control	Description
Emergency Planning and Response	<p>An emergency response procedure in relation to all potential emergency situations that could arise from abnormal operational situations or conditions, with training provided to those involved.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
Testing of Emergency Response	<p>Ensure that the emergency response plan/s are tested to ensure they function well, and are amended when any issues effecting efficiency are identified.</p> <p>Applies to: All refrigerants and associated systems as required (based on risk, regulation and standards).</p>
Event Management & Investigation	<p>An event management procedure and system which captures:</p> <ul style="list-style-type: none">• Near Accidents• Ammonia Releases• Ammonia Events (personal injury)• Suggestions• Data Analysis over time and plant Escalations <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
Illuminated windsocks	<p>Windsocks are illuminated so that any ammonia release during night time operations will allow workers to effectively evacuate up wind.</p> <p>Other refrigerants: Same to be in place for other refrigerants as required (based on risk, regulation and standards).</p>
Emergency showers	<p>Eye wash and emergency showers should be present, one outside the exit door and another inside the plant room. Typically, a safety shower and eye wash station should not be more than 25 metres or 10 seconds away from a potential hazard. A tepid fluid should be supplied.</p>

AMMONIA & REFRIGERANT MANAGEMENT



Photo 14. Windsock



Photo 15. Muster station signage

4.17.2. Stakeholders for emergency planning

When planning for an uncontrolled ammonia (or other hazardous substance) there are a number of stakeholders who should be considered. In particular, the local emergency services should be aware of ammonia and other refrigerant risks if they respond to an emergency.

Consider:	
Workers on site	<ul style="list-style-type: none">• Risks to safety• Roles and responsibilities in an emergency
Site Management	<ul style="list-style-type: none">• Risks to safety• Roles and responsibilities in an emergency.
Off-site management (Corporate)	<ul style="list-style-type: none">• Roles and responsibilities in an emergency.
Internal responders	<ul style="list-style-type: none">• Risks to safety• Roles and responsibilities in an emergency.
Emergency services	<ul style="list-style-type: none">• Risks to safety• Roles and responsibilities in an emergency• Capabilities that exist within each service
Visitors	<ul style="list-style-type: none">• Risks to safety
Community	<ul style="list-style-type: none">• Risks to safety

4.17.3. Levels of emergency

When planning emergency response for a potentially catastrophic event the Coordinated Incident Management System (CIMS) protocols are recommended as the terms and structures used will fit the structures put in place by external emergency services.

Levels of emergency can be summarised as:
Level 1: Response by internal Emergency Response Team (ERT) without external assistance
Level 2: External assistance and site Incident Management Team (IMT) activated

AMMONIA & REFRIGERANT MANAGEMENT

Level 3: Multi-Agency and IMT response activated

4.17.4. Types of release

There are four types of release that can occur on your refrigeration system.

- High Pressure Vapour
- High Pressure Liquid
- Low Pressure Vapour
- Low Pressure Liquid

All of the release categories can occur in both your engine rooms as well as your refrigerated spaces.

Specific emergencies that are likely to occur are difficult to define steps for evacuation as there are so many variables however emergencies that can occur can be easily defined as:

Minor Leaks

Minor leaks do not affect areas outside its immediate location. Typical releases of this nature involve:

- Compressor shaft seal leakages (Low Pressure Vapour)
- Valve gland leaks (High pressure liquid vapour, Low pressure liquid vapour)

Major Leaks

Major leaks affect areas outside the immediate location. Typical releases of this nature involve:

- Flange separation (High pressure liquid, Low pressure liquid)
- Pipe corrosion (High pressure liquid, Low pressure liquid)
- Component failure (High pressure liquid, Low pressure liquid)



Photo 16. Firefighters shower after an ammonia leak

AMMONIA & REFRIGERANT MANAGEMENT

4.17.5. Concentration markers

The table¹ below indicates some effects of ammonia at various concentrations (ppm). Other refrigerants may have similar guidelines. It is very important to understand the potential risks at various concentrations.

Concentration (PPM)	Effects	Performance
25	Ammonia easily detected by most people	8 hours' exposure standard (TWA)
35	Inexperienced persons are repulsed by the pungent odour	15 min exposure standard (STEL)
50	Very distinct smell will want to naturally vacate area	Wear respiratory protection
100	No serious danger but very unpleasant. Irritation to eyes sinuses and respiratory system	Wear respiratory protection
250	Serious irritation to eyes sinuses and respiratory system	SDS level to wear positive pressure, Self-contained breathing apparatus
300	Serious irritation to eyes sinuses and respiratory system	Immediate danger to life and health (IDLH), Confined space procedures apply, wear SCBA with splash suit where liquid splash potential exists following risk analysis
2000	Serious Irritation to eyes sinuses and respiratory system, Bronchospasm Pulmonary edema	15 min or less may result in death, wear SCBA with Level four (4) gas suit following risk analysis
>5000	Respiratory arrest, Pulmonary edema	Lethal in seconds Manage pressure where safe to do so and wait for decline in concentration. Do not enter visible aerosol cloud.

¹ Reproduced from fact sheet available at <http://www.ammonia.co.nz/resources> (Emergency Response Poster)

AMMONIA & REFRIGERANT MANAGEMENT

4.17.6. Developing an emergency plan

Each site must have a plan for managing any uncontrolled refrigerant releases. Each site's plan will be different based on identified scenarios, including the worst case. The plan needs to be specific to ammonia (or other refrigerant used) and be developed with all stakeholders (refer 4.17.2) well in advance of any event! There is no time to develop an emergency plan once an event has already occurred. The plan should be built around risks identified on a specific site.

The plan should take into account and contain detail on the following as a minimum:	
•	Points of system weakness
•	Worst case scenario if any or all points of weakness fail (i.e. total loss)
•	Roles and responsibilities in an emergency
•	Thresholds for escalation of management of emergency event. See 4.17.3 (Ammonia specific)
•	How initial response is to be managed (e.g. isolation, "Shelter in place", evacuation or a combination)
•	Safe muster points (which may be different to usual muster areas for fire/earthquake)
•	How each potential threat can be managed
•	Access to technical expertise (internal/external)
•	Local community alerts required (will the release endanger the community?)
•	Local community evacuation/protection (what services are required?)
•	Logistical support for above
•	Welfare considerations (site/community)
•	Access to medical support (and response timeframes)
•	Protection of emergency services personnel who respond (who may not be familiar with the risks associated with refrigerant releases!)
•	Potential long-term shutdown of process capability
•	Infrastructure damage
•	Public panic
•	Media management
•	Effect of change in weather conditions (e.g. wind / heavy rain)

AMMONIA & REFRIGERANT MANAGEMENT

4.17.7. Shelter in Place/Evacuation procedures

The ammonia (or other refrigerant) emergency plan may include instructions on how people should behave in an emergency. Examples of these are included below. The risk assessment should be used to identify the best course of action for workers (and or community members as appropriate) for each identified situation and they need to be aware of the correct procedure well in advance. In the examples below distances are marked as “xx” however this should be calculated based on dispersion modelling as part of the risk assessment.

Shelter in place procedure (example only)

If you are in a building within the xx metre zone described on panel 3 then **Shelter in place:**

- Go inside immediately (if not already)
- Shut all doors and windows and close all curtains and blinds.
- Shut off all ventilating, heating and cooling systems.
- Stay on the side of your building that is furthest away from the Refrigeration plant/storage.
- Tape or seal (a damp towel works well) any gaps in or around windows, doors and ventilation ducts if fumes are detected and become uncomfortable.
- Listen to your local radio station for information or check for updates online
- Stay inside until the all-clear is given.
- If you're outside when you hear the ammonia siren and can't immediately go inside then

Evacuation procedure (example only)

- Stay upwind of the Refrigeration plant/storage
- Proceed to one of the Safe Muster Points identified (People will arrive there to help you)
- Do not go back into the xx metre evacuation zone until you receive the official all-clear.
- Always follow the direction of emergency services
- The Safe Points (safe muster areas) are:
 - Safe Muster Point 1: (Specify location)
 - Safe Muster Point 2: (Specify location)
- Stay at the safe muster point until the all-clear is given or further instructions are provided by the incident Controller

4.17.8. Testing the emergency plan

The ammonia (or other refrigerant) emergency plan must be tested to ensure that processes and systems will work when needed. Exercises should test both desktop processes and practical emergency management activities for each level of emergency. Workers and emergency services should participate in planning and testing of emergency response. There are a number of external training providers/emergency scenario facilitators who can assist with this.



Best Practice Advice

In an actual emergency all stakeholders must be able to trust the effectiveness of the emergency plan and its embedded processes.

Test, test and test again!

5. Planning Work

Working with hazardous substances such as refrigerants must be well planned. The planning stage should be used to identify the hazards and consider the precautions to be taken. Safety, planned at the start of the process, will always be more cost-effective than safety introduced midway during the work.

Management (including Officers of PCBU's) must lay a solid foundation for safety by adopting safe systems of work and employees must co-operate to ensure that their actions do not compromise safety. When planning the work consider the following:

Consider:
<ul style="list-style-type: none"> • The physical properties of all hazardous substances
<ul style="list-style-type: none"> • The risks associated with the work (for any party)
<ul style="list-style-type: none"> • The work and the work method
<ul style="list-style-type: none"> • The duration and frequency of exposure and the number of workers exposed
<ul style="list-style-type: none"> • Competency of all workers associated with the work


5.1. Consultation and Co-ordination

It is a legislative requirement that there is consultation with all stakeholders when undertaking a risk assessment. This requirement entails involvement of key stakeholders at the identify, assess, control and review stages of the risk assessment process. The consultation process is important as it allows workers to provide input and raise potential safety concerns about the work they undertake and the hazards they may be exposed to.

Persons with overlapping duties should exchange information about the risks associated with the work and work together in a co-operative and co-ordinated way so that all risks are eliminated or minimised so far as is reasonably practicable.

The PCBU will consult, co-ordinate and communicate with all relevant stakeholders.

5.2. Permit to Work

	<p>Best practice advice</p> <p>Some jobs involving hazardous substances such as refrigerants are particularly hazardous.</p> <p>This includes entry into vessels which hold or have held hazardous substances or maintenance or repair activities such as welding on any vessel that holds or has held hazardous substances.</p> <p>For these types of high risk work the Permit to Work (PTW) system should be used.</p>
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AMMONIA & REFRIGERANT MANAGEMENT

The Permit should cover:

- The location and description of the task to be carried out
- Hazards that may be encountered
- Isolation requirements
- Work procedures and conditions
- Communication requirements
- Risk control measures
- PPE
- Emergency response

The Permit to Work should be signed by:

- The individuals undertaking the work
- Their immediate supervisor
- The standby personnel (if applicable)

The Permit to Work shall not be granted until:

- A JSA has been completed
- Measures to control the identified risks have been established
- The competency of workers has been verified
- Emergency procedures have been determined and are in place
- There is provision of standby person/s (standby person/s must be able to initiate emergency procedures) if applicable.
- All potentially hazardous services have been isolated.
- A Certificate has been issued.

A copy of the Permit to Work should remain on-site for the duration of the work. Before return to business as usual following completion of works the person in direct control of the work must sign the Permit to Work indicate the work has been completed.

The Permit to Work shall be kept on record at the site along with the JSA for a period no less than 1 year.



Best practice advice

The Permit to Work must be provided to the person responsible for direct control of the work and kept on prominent display to facilitate signing and clearance.

The information and risk control measures listed on the Permit to Work must be reconfirmed whenever it becomes evident that the duration of the task will involve a change of the person to whom the Permit to Work was issued or a break in continuity of the tasks that may have changed the conditions under which the Permit to Work was issued.

5.3. Job Safety Analysis (JSA)

Where a Permit to Work is required, a JSA must be developed by a competent person in consultation with all participating employees to identify, assess and control the hazards prior to work commencing. In addition to the JSA a Permit to Work must be issued to the person who will have direct control of the work to be carried out.

The JSA should take into account the following as a minimum:

- If the work can be carried out without removal or disabling of a safeguard
- The range of methods by which the work can be conducted
- The hazards and risks involved with the actual method selected and the plant and equipment proposed to be used
- Emergency response procedures/plan
- The competence of the persons to undertake the work

The JSA should be retained for at least 5 years from the last date that any changes were made.



Photo 16. A typical Permit station

6. Reference Documents



Further information

- New Zealand's key work health and safety legislation is the Health and Safety at Work Act 2015 (HSWA) and regulations made under that Act. Compliance with all statutory requirements with the HSWA Act 2015 and other applicable acts and/or regulations is mandatory.
- New Zealand 'Codes of practice' (CoP or ACoP) are documents that offer an approved method of achieving compliance with regulatory requirements. A code of practice will tell you how to meet the Act or regulation requirements and controls in a way that is legally defensible. They are not mandatory and you can adopt other ways of meeting the requirements instead.
- 'Good Practice Guidelines' (GPG) are a guide to what WorkSafe New Zealand considers good practice. Health and safety inspectors may use these guidelines when visiting workplaces or conducting investigations.
- Other types of guidance including webpages, fact sheets or brochures (including international guidance material) is provided for information only. Compliance to these forms of guidance may have little bearing under the law.

6.1. Relevant legislation & regulations

Compliance with all statutory requirements for the country where the equipment is being installed and operated in is mandatory. This includes requirements associated with contracting work, equipment and system design, supply, testing and installation.

6.1.1. Safety general

Health and Safety at Work Act 2015 (HSAW Act 2015)

<http://www.legislation.govt.nz/act/public/2015/0070/latest/DLM5976660.html>

Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999

<http://www.legislation.govt.nz/regulation/public/1999/0128/latest/DLM284452.html>

Health and Safety at Work (General Risk and Workplace Management) Regulations 2016

<http://www.legislation.govt.nz/regulation/public/2016/0013/latest/DLM6727530.html>

AMMONIA & REFRIGERANT MANAGEMENT

6.1.2. Building

NZ Building Act 2004 and Building Regulations

<http://www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html>

For more information on regulations refer to the Building Code Handbook

<https://www.building.govt.nz/building-code-compliance/building-code-and-handbooks/building-code-handbook/>

6.1.3. Energy & Electrical

NZ Building Code Compliance Documents (B2, C3, E2, G4, G1, G12, H1 AS and VM)

<https://www.building.govt.nz/building-code-compliance/>

NZ Electricity Act 1992 and

<http://www.legislation.govt.nz/act/public/1992/0122/latest/DLM281858.html>

Electricity (Safety) Regulations 2010

<http://www.legislation.govt.nz/regulation/public/2010/0036/64.0/DLM2763501.html>

NZ Building Code Section G9 – Verification Method G9/VM1

<https://www.building.govt.nz/building-code-compliance/g-services-and-facilities/g9-electricity/>

Local Electrical Supply Authority requirements, as applicable (contact your local authority)

Gas Act 1992

<http://www.legislation.govt.nz/act/public/1992/0124/latest/DLM285412.html>

Gas (Safety and Measurement) Regulations 2010

<http://legislation.govt.nz/regulation/public/2010/0076/latest/DLM2359501.html>

6.1.4. Hazardous substances

The Land Transport Rule: Dangerous Goods 2005

http://nzta.thomsonreuters.co.nz/DLEG-NZL-LTSA-T.LTR-45001_1.pdf

<http://www.transport.govt.nz/assets/Import/Documents/Transporting20Dangerous20Goods.pdf>

Hazardous Substances and New Organisms Act 1996 (HSNO Act)

<http://www.legislation.govt.nz/act/public/1996/0030/latest/DLM381222.html?src=qs>

Hazardous Substances (Compressed Gas) Regulations 2004

<http://www.legislation.govt.nz/regulation/public/2004/0043/latest/DLM244063.html>

Hazardous Substances (Identification) Regulations 2001

<http://www.legislation.govt.nz/regulation/public/2001/0124/latest/DLM44231.html>

AMMONIA & REFRIGERANT MANAGEMENT

Note: This may not be an exhaustive list. Refer to a subject matter expert for more detail or with any query about requirements.

6.2. Codes, Standards & Guidance

The entire refrigeration plant, including any ancillary equipment, shall comply with the requirements of the latest editions and amendments of the following standards and codes as applicable:

6.2.1. Refrigeration systems & handling

AS/NZS 5149 – Refrigerating Systems and Heat Pumps

AS/NZS 1677.2 – Refrigerating Systems - Safety requirements for fixed applications (Note: mostly superseded by AS/NZS 5149)

AS/NZS 2022 – Anhydrous Ammonia Storage and Handling

AS/NZS Refrigerant Handling Code of Practice 2007 parts 1 and 2

6.2.2. Hazardous atmospheres & electrical

AS/NZS 60079 parts 0-29 – Explosive Atmospheres

NZS 3000 – Electrical Installations – Buildings, Structures and Premises

AS 1482 – Electrical Equipment for Explosive Atmospheres

NZS 6200 – General Requirements for Electrical Apparatus and Material

6.2.3. Pressure equipment & piping

AS/NZS 1200 series – Pressure Equipment

AS/NZS 1210 – Pressure Vessels

AS/NZS 1204 – Structural steels - Ordinary weldable grades

AS 4458 – Pressure Equipment – Manufacture

ASME B31 – Pressure Piping

AS 4041 – Pressure Piping

NZS 4302 – Heat Rejection Equipment

AS 1074 and/or BS 1387 – Chilled Water Piping

Worksafe – Code of Practice for Pressure Equipment (excluding boilers) 2001

AMMONIA & REFRIGERANT MANAGEMENT

6.2.4. Ventilation & water

NZS 4303 – Building Ventilation

AS/NZS 3666 – Air-handling and water systems of Buildings – Microbial control

NZS 4302 - Hygiene in Air and Water Systems

6.2.5. Buildings, construction and structural

NZS 4219 – Seismic Performance of Engineering Systems in Buildings

NZS 1170 (series) - Structural design actions

NZS 5807 – Colour Coding Identification of Contents of Pipework

AS/NZS 1554 (series) – Welding of steel structures

AS/NZS 2980 – Qualification of Welders for the Fusion Welding of Steel

AS 1650 and NZS/AS 3679 – Galvanising

NZS 4203 – General Structural Design and Design Loadings for Buildings

NZS 3404 – Steel Structures Standard

AS/NZS 1111 – ISO Metric Hexagon Commercial Bolts and Screws

AS/NZS 1112 – ISO Metric Hexagon Nuts, including thin Nuts, slotted Nuts and castle Nuts

AS/NZS 1252 – High Strength Steel Bolts with associated Nuts and Washers for Structural Engineering

6.2.6. Other hazards

NZS 6801 – Measurement of Noise

NZS 6802 – Assessment of Environmental Noise

NZS 9201 part 24 – General Bylaws for Food Safety

Worksafe - Approved Code of Practice for Cranes 2001

Worksafe - Approved Code of Practice for Management and Removal Of Asbestos 2016

Worksafe - Best Practice Guidelines for the Safe Use of Machinery 2014

6.2.7. International Standards & Guidance

BS 7005 – Design and Manufacture of Carbon Steel Unfired Pressure Vessels for use in Vapour

AMMONIA & REFRIGERANT MANAGEMENT

BS 5970 – Thermal Insulation of Pipework and Equipment

BS 3122 parts 1 and 2 as well as NZS 9309 – Performance Testing of Refrigeration Compressors

ASME – Refrigeration Pipework B31.3, B31.5 and AS 4041 – Pressure Piping

ASTM A269 - Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

ASTM A270 – Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing

ASME 9 - Welding code for steel refrigerated pipework

BS 4360 – Weldable Structural Steels

BS 729 – Specification for Hot Dip Galvanized Coatings on Iron and Steel

ARI 275 – Application of Sound Rating Levels of Outdoor Unitary Equipment

7. Appendices

AMMONIA & REFRIGERANT MANAGEMENT

7.1. Appendix 1: Short & Long Term Mechanical Integrity Checks (Example)

The following schedules in Table 1 and Table 2 provide an example of a preventative maintenance approach to mechanical integrity testing for an ammonia plant. Other programmes may achieve the same aim. At all times the programme should meet the requirements of regulations and standards. External advice may assist in developing a suitable programme.

Table 1. Short Term Integrity Checks

Type of Equipment	Type of Inspection	Carried out by	Frequency (minimum)	Items requiring attention (minimum)
Ammonia Refrigeration Systems	System Alarms	Boiler Operator	Hourly	Ammonia refrigeration and chilled water alarms
	Operational inspection	Engineer	Daily	Operating Pressure Operating Temperature Oil & Refrigerant Levels Oil & Refrigerant Leaks Operation of Oil Return Any Noise/Vibration
Compressors	Operational inspection	Operator / Maintenance Engineer	Weekly	Operating Pressure and Temperature readings
				Oil Levels, Oil & Refrigerant Leaks
				Operation of Oil Return
				Noise and Vibration
Vessels and heat exchangers	Operational inspection	Operator / Maintenance Engineer	Weekly	Check External Condition
				Conditions of heat transferring liquids
				Correct Operation of Control Valves
				Oil Draining (Log/register should be kept)
				Inspect sight glasses

AMMONIA & REFRIGERANT MANAGEMENT

Table 2. Long Term Integrity Checks

Type of Equipment	Type of Inspection	Carried out by	Frequency (minimum)	Items requiring attention (minimum)
Ammonia Refrigeration Systems	Major inspection & maintenance	Operator / Maintenance Engineer	3 monthly	Operational Controls, Drive Conditions including guarding
		Operator / Maintenance Engineer	6 monthly	Test Functional Operation of All safety cut-outs
		Maintenance engineer	Annually or to manufacturer's instructions	Drive alignment
				Foundation & Mounting bolts
				Oil Change, Isolating valve operation
				Clean/Change Filters/Strainers & Oil Returns
Vessels and heat exchangers	Operational inspection	Operator / Maintenance Engineer	Monthly	Purging air & non condensable gases
				Inspect sight glasses & level controls
				Exchanger surfaces
		Maintenance Engineer	6 monthly	Check associated equipment e.g.: fans, impellers and guards
				Test safety cut out controls high levels etc.
	Annual Inspection	Maintenance supervisor or Engineering manager	Annually or after extended period out of service	Detailed inspection of external condition, vessels or insulation
		Maintenance Engineer	Annually or after extended period out of service	Tube bundles
				Associated equipment e.g.: fans, impellers, controllers, safety provisions
				Clean filters/strainers and inspect control valves

AMMONIA & REFRIGERANT MANAGEMENT

Type of Equipment	Type of Inspection	Carried out by	Frequency (minimum)	Items requiring attention (minimum)
				Insulated vessels - inspect vessel or test if insulation unsound
	Independent full inspection	Recognised Inspection Body - see http://www.worksafe.govt.nz/worksafe/about/what-we-do/engineering-plant-equipment/inspection-bodies	Annually	Pressure vessel inspection
		SPX	10 year cycle	PHE refurbish, gasket replacement & pressure test
Control & Sensing Devices	Operational Inspection / maintenance	Dragar	6 monthly	Test Function & Operation of all sensing devices
		Maintenance supervisor	Annually	Test function of all safety cut outs
Control / Block Valves	Operational Inspection / maintenance	Maintenance Engineer	6 monthly	Control / make-up valves for function & operation.
			Annually	Test Control / Block valves for function: Overhaul or replace as necessary
Valves	Inspection / maintenance	Operating or maintenance staff	6 Monthly	Check spindles, glands and external condition of all stop valves
			5 yearly	Test all stop valves for function: Overhaul or replace as necessary
Pressure relief devices	Inspection / maintenance	Maintenance supervisor or safety staff	12 monthly	Inspect external condition including vent lines
			2 yearly	Renew all bursting discs
			5 yearly	Renew or retest all relief valves
Piping	Inspection / maintenance	Maintenance supervisor or Engineering manager	Annually	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

AMMONIA & REFRIGERANT MANAGEMENT

7.2. Appendix 2: Ammonia Safety Internal Assessment (example)

This assessment provides guidelines for a formal internal review report. This would be best completed by a person who understands process safety and safety management systems and is familiar with conducting reviews and/or internal audits that require a significant amount of fact finding and verification. The purpose of this guideline is to ensure that key systems are being looked at regularly and in depth so that areas of improvement are identified (which may not occur in a more superficial review). This does not in any way replace any external audits or reviews that the Company may have scheduled.

Category	Considerations
High Risk Situations	<ul style="list-style-type: none">• In the event of a high-risk situation involving ammonia:<ul style="list-style-type: none">– what internal resources (people, equipment, systems) would you be able to make available to control the event?– what external resources (people, equipment, systems) would you be able to make available to control the event?• Are the current resources, roles and responsibilities within the Company sufficient to control the risk of a significant or catastrophic event occurring involving ammonia o?
Regulatory compliance	<ul style="list-style-type: none">• List all external assessments that (in full or in part) reviewed the regulatory compliance of the Ammonia plant carried out this year<ul style="list-style-type: none">– Identify any areas of concern highlighted in the reports with ISO 5149.1-4.2016 (Refrigerating Systems & Heat Pumps; Safety and Environmental Requirements).– Identify any areas of concern highlighted in the reports with AS/NZS 5149.– Identify any areas of concern highlighted in the reports with AS/NZS 60079.10.1 (Classification of areas – Explosive gas atmospheres), in relation to the Health and Safety Act.– Confirm that these standards are still relevant and of high importance to Ammonia compliance (seek expert advice if required).– Identify any other areas of concern highlighted in the reports (e.g.: NZ Building Act, NZ Electricity Act, AS/NZS 1210 (Pressure Vessels), etc.).– Pressure Equipment in-service inspections and Certification for compliance with PECPR Regulations in line with AS/NZS 3788:2006

AMMONIA & REFRIGERANT MANAGEMENT

Category	Considerations
Process safety systems	<ul style="list-style-type: none"> • Review all requirements outlined in this standard with attention to the headings below. Document which requirements are being met and which require further action and/or improvement. <ul style="list-style-type: none"> – Preventative Maintenance – Employee Participation – Process safety information – Process hazard analysis – Operating procedures – Contractor Management – Pre-start up safety reviews – Change Management – Incident Investigations
Induction & training	<ul style="list-style-type: none"> • Induction Assessment: <ul style="list-style-type: none"> – Attend an Ammonia area induction, and identify: – any hazards & risk responses that shall be added to the induction. – any hazards & risk responses that shall be altered within the induction to make it clearer. – comment on the overall quality of the induction, covering timeliness, clarity, engagement, and materials provided.
	<ul style="list-style-type: none"> • Operator Training: <ul style="list-style-type: none"> – Review the training received by staff expected to operate and monitor the Ammonia plant, and comment on: – what training has been provided within the assessment period? – is the content of the training offered appropriate for people who will be interacting with Ammonia? – specifically, are the response procedures in the event of an incident covered well? – are the correct staff receiving the training?

AMMONIA & REFRIGERANT MANAGEMENT

Category	Considerations
	<ul style="list-style-type: none"> Maintenance Training: Review the training received by staff expected to perform maintenance or carry out alterations to the Ammonia plant. Comment on: <ul style="list-style-type: none"> what training has been provided within the assessment period? is the content of the training offered appropriate for people who will be interacting with Ammonia? specifically, are the response procedures in the event of an incident covered well? are the correct staff receiving the training?
	<ul style="list-style-type: none"> Contractors: Review the contractors who have interacted with the Ammonia plant over the assessment period. Comment on: <ul style="list-style-type: none"> have they been inducted into the site and Ammonia area? what qualifications do they possess? is their level of training appropriate to allow them to work on the Ammonia plant?
Permit to Work	<ul style="list-style-type: none"> Document any internal assessments undertaken (and their findings) that relate to the Permit to Work process.
	<ul style="list-style-type: none"> Document any external assessments undertaken (and their findings) that relate to the Permit to Work process.
	<ul style="list-style-type: none"> Review three recent or notable permit-able works carried out in the Ammonia area for: <ul style="list-style-type: none"> documentation. process. risk ratings/mitigation appropriateness. any events/incidents raised as a result of the work
	<ul style="list-style-type: none"> Review three recent or notable permitable works carried out in the Ammonia area for: <ul style="list-style-type: none"> who issued them. their level of knowledge around the risks of that work.

AMMONIA & REFRIGERANT MANAGEMENT

Category	Considerations
Emergency Response	<ul style="list-style-type: none"> When was the last test of emergency response plans carried out for Ammonia, for each level of response, and what was the scope for each? <ul style="list-style-type: none"> Level 1: Response by ERT without external assistance Level 2: External assistance and site IMT activated Level 3: Multi-Agency and IMT response activated
	<ul style="list-style-type: none"> List any outstanding actions from the review of these emergency response plan tests?
	<ul style="list-style-type: none"> List the areas of ammonia safety that were covered in those events. Highlight any areas (e.g.: PPE availability, plant shut down/isolation, release control, personnel injury and recovery, external response, etc.) that have not been covered recently, and should be included in future response tests.
	<ul style="list-style-type: none"> Regarding internal responders: <ul style="list-style-type: none"> outline the trained responders that are available to assist in an event. what is their competency? what level of coverage is available over each production shift?
	<ul style="list-style-type: none"> Regarding external responders: <ul style="list-style-type: none"> outline the trained responders that are available to assist in an event. what is their competency (find out)?
Installation assessment	<ul style="list-style-type: none"> Outline the external audits in the ammonia area that have included signage within their scope, and any actions to have come out of those audits in relation to signage.
	<ul style="list-style-type: none"> Perform an inspection of the signage in the ammonia area, ensuring that it is sufficient, fit for purpose, clear and legible.
	<ul style="list-style-type: none"> Perform an inspection of the ammonia plant. Outline the areas that are reviewed for compliance, and any actions needed to bring those areas that fail up to standard.
	<ul style="list-style-type: none"> Perform an inspection of the Ammonia plant, focusing on “design requirements” within the Ammonia Standard. Outline the areas that are reviewed for compliance, and any actions needed to bring those areas that fail up to standard.

AMMONIA & REFRIGERANT MANAGEMENT

Category	Considerations
	<ul style="list-style-type: none"> Perform an inspection of the Ammonia plant, focusing on the Electrical standards. Outline the areas that are reviewed for compliance, and any actions needed to bring those areas that fail up to standard.
Documentation	<ul style="list-style-type: none"> Licences & Certifications – Refer to section 4.13 and confirm that the required licences and certifications are held and current. Document where they are being held, and when they will need to be refreshed.
	<ul style="list-style-type: none"> Select any one section under Process Safety Management. Consider documentation required, look for and comment on: <ul style="list-style-type: none"> completeness of the documentation required. correctness of the documentation against actual processes/use. availability of the documentation for the appropriate staff.
PPE	<ul style="list-style-type: none"> Ammonia PPE in place: <ul style="list-style-type: none"> List any ammonia PPE held, along with the quantity, location and users
	<ul style="list-style-type: none"> Internal PPE assessment: <ul style="list-style-type: none"> Document any internal inspections undertaken (and their findings) that relate to ammonia PPE External PPE assessment: <ul style="list-style-type: none"> Document any external inspections undertaken (and their findings) that relate to ammonia PPE
	<ul style="list-style-type: none"> PPE SOPs: <ul style="list-style-type: none"> Document any standard operating procedures in place that cover any aspect of ammonia PPE (e.g.: selection, usage, testing, maintenance etc.).
	<ul style="list-style-type: none"> PPE Training: <ul style="list-style-type: none"> Identify all stream of training undertaken on ammonia PPE by any group or individuals Identify any gaps

AMMONIA & REFRIGERANT MANAGEMENT

Category	Considerations
Risk management	<ul style="list-style-type: none"> • Review the Risk Assessment for the refrigeration plant <ul style="list-style-type: none"> – Ensure that the Risk Management Assessment remain valid and matches the installation and operations. Identify any outstanding actions, or changes needed. – Identify the leader and participants of the last assessment, and comment on their qualifications and competence at making the risk assessment. – Was the team a multi-disciplinary team, and if so, what areas were lacking?
	<ul style="list-style-type: none"> • Review section 4.3 of the Ammonia Standard. Ensure that: <ul style="list-style-type: none"> – Documented mitigation actions match that outlined in the Risk Assessment. – The mitigation actions are being carried out operationally. – Identify any gaps or opportunities in the outlined mitigations
	<ul style="list-style-type: none"> • Review corrective actions (from any refrigeration event investigations) for the past period. <ul style="list-style-type: none"> – identify all Ammonia related events – review the effectiveness of the actions generated from the investigation – outline any remedial actions that are still required to rectify those events. – Identify the leader and participants of the assessment of risk for each event, and comment on their qualifications and competence at making the risk assessment.