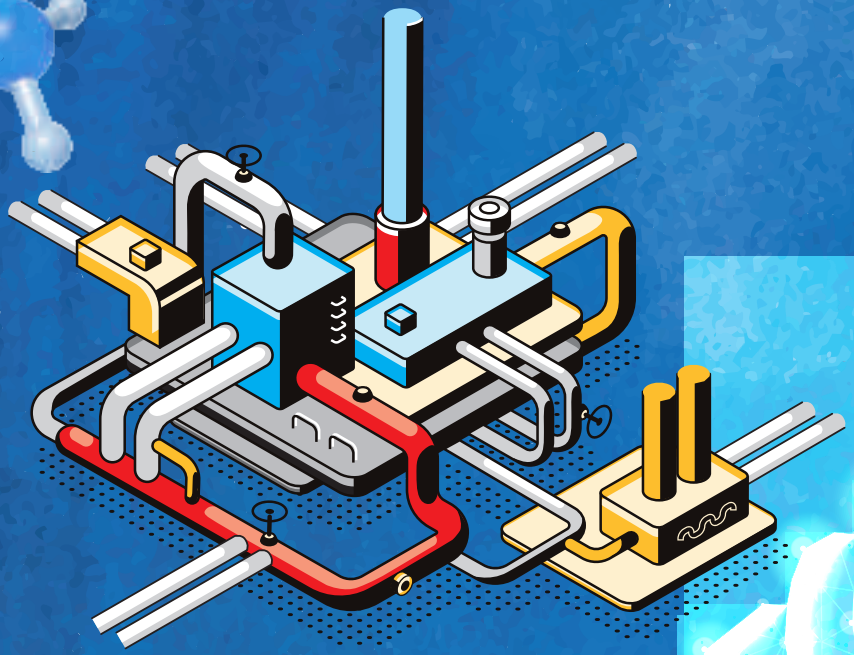
JABATAN KESELAMATAN DAN KESIHATAN PEKERJAAN
MALAYSIA

GUIDELINES ON SAFE MANAGEMENT OF AMMONIA REFRIGERATION SYSTEM



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MALAYSIA

GUIDELINES ON SAFE MANAGEMENT OF AMMONIA REFRIGERATION SYSTEM 2020

PREFACE

These guidelines may be cited as the Guidelines on Safe Management of Ammonia Refrigeration of System.

The guidelines are formulated to ensure that workplaces that use ammonia refrigeration systems are controlled in terms of operations and maintenance by employers, owners, users, self-employed and those who have control over the system.

All employers are requested to adopt and adapt these guidelines as a source of reference in managing of ammonia refrigeration system at workplace and to fulfill one of the general duties under the Occupational Safety and Health Act 1994 and the Factories and Machinery Act 1967.

The guidelines will be reviewed from time to time. Employers and occupational safety and health practitioners are encouraged to give their comments in writing to the Department of Occupational Safety and Health, Malaysia so that the guidelines can be continuously improved.

I would like to thank and acknowledge those who have contributed in the development of the guidelines.

Director General
Department of Occupational Safety and Health
Ministry of Human Resource, Malaysia
2020

ACKNOWLEDGEMENTS

The Department of Occupational Safety and Health Malaysia would like to thank the following distinguished individuals for their most valuable contributions during the drafting of this guideline. The Guidelines on Safe Management of Ammonia Refrigeration of System as been prepared by the technical committee comprising of;

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This guideline has been endorsed by the Department's Policy Review Committee chaired by the Director General of The Department of Occupational Safety and Health (DOSH).

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ABBREVIATION

AIA	Authorized Inspecting Authority
CF	Certificate of Fitness
CHRA	Chemical Health Risk Assessment
CIMAH	Control of Industrial Major Accident Hazard
CLASS	Classification, Labelling and Safety Data Sheet
DOE	Department of Environment
DOSH	Department of Occupational Safety and Health
ERP	Emergency Response Plan
IMS	Incident Management System
NADOPOD	Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease
NDE	Non-Destructive Examination
NH_3	Ammonia
OEM	Original Equipment Manufacturer
OSH	Occupational Safety and Health
P&ID	Piping and Instrumentation Diagram
PEL	Permissible Exposure Limit
PPE	Personal Protective Equipment
ppm	Parts per Million
PPM	Planned Preventive Maintenance
psig	Pound per Square Inch
TWA	Time-Weighted Average
UPV	Unfired Pressure Vessel

1 INTRODUCTION

Ammonia has been used as a refrigerant in industrial applications for many years. It continues to be the refrigerant of choice in various applications and has seen increased use in building services and process applications. Ammonia is an excellent natural refrigerant and offers significant environmental and operational benefits over its synthetic rivals. However, recently, the number of incidents that involves industrial ammonia refrigeration system has increased year by year where some cases have led up to injuries and fatalities among workers, students, and the members of the public. **Refer Appendix 1 for Case Study on Incidents Involving Ammonia Refrigeration System.**

1.1 Purpose

Hence, these guidelines are developed for related industries to promote safe management of ammonia refrigeration system for industrial application at the workplace. Generally, these guidelines provide the minimum information and recommendations on how employers and employees can control the operation and maintenance of the system in order to reduce and manage its risk accordingly.

Apart from that, these guidelines also explain the duty of all stakeholders such as owners, employers, employees, designers, manufacturers and suppliers as prescribed under the Factories and Machinery Act 1967 and the Occupational Safety and Health Act 1994 including all related regulations.

1.2 Application and Scope

These guidelines apply to all the workplaces that utilize ammonia as a refrigerant in their refrigeration system. The use of the refrigeration system at a workplace may vary from one workplace to another such as for ice production, cold storage, food processing and building services.These guidelines also apply to new and existing installations of refrigeration system whether it is for permanent or temporary usage.

2 LEGISLATIONS

The legislation that stipulates the provision of general duties of employers and self-employed persons to their employees, plant, and substance; and the provision of general duties of designers, manufacturers and suppliers can be found in the Factories and Machinery Act 1967, the Occupational Safety and Health Act 1994 and their respective regulations.

2.1 Factories and Machinery Act 1967

Provisions pertaining to safe system of plant and work are under:

i. Part II, Safety, Health and Welfare;

ii. Section 19, Certificate of Fitness;

iii. Section 21, Duties of Occupier;

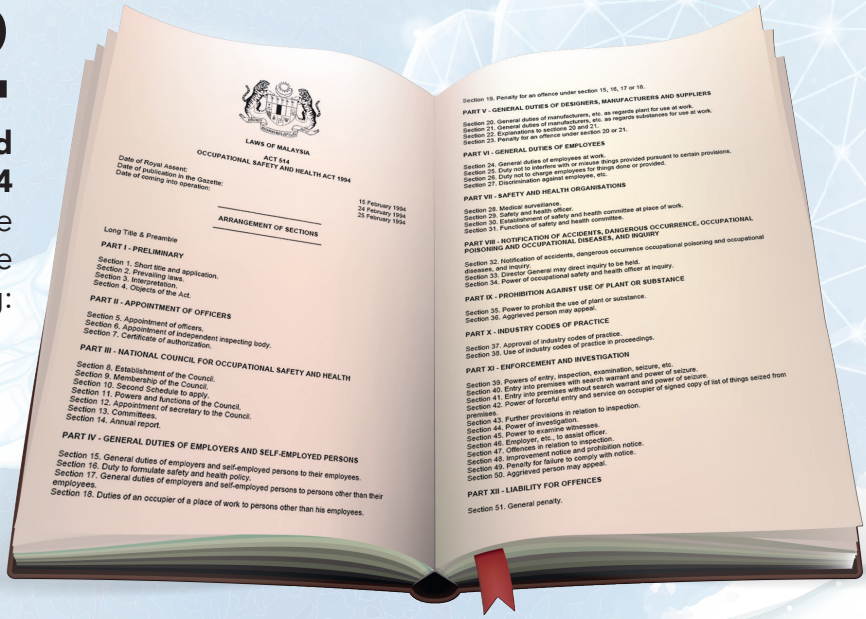
iv. Section 22, Provisions Relating to Health;

v. Section 25, Provision Relating to Welfare;

vi. Part V, Section 34- 46 Notice of Occupation of Factory, and Registration and Use of Machinery.

2.2 Occupational Safety and Health Act 1994

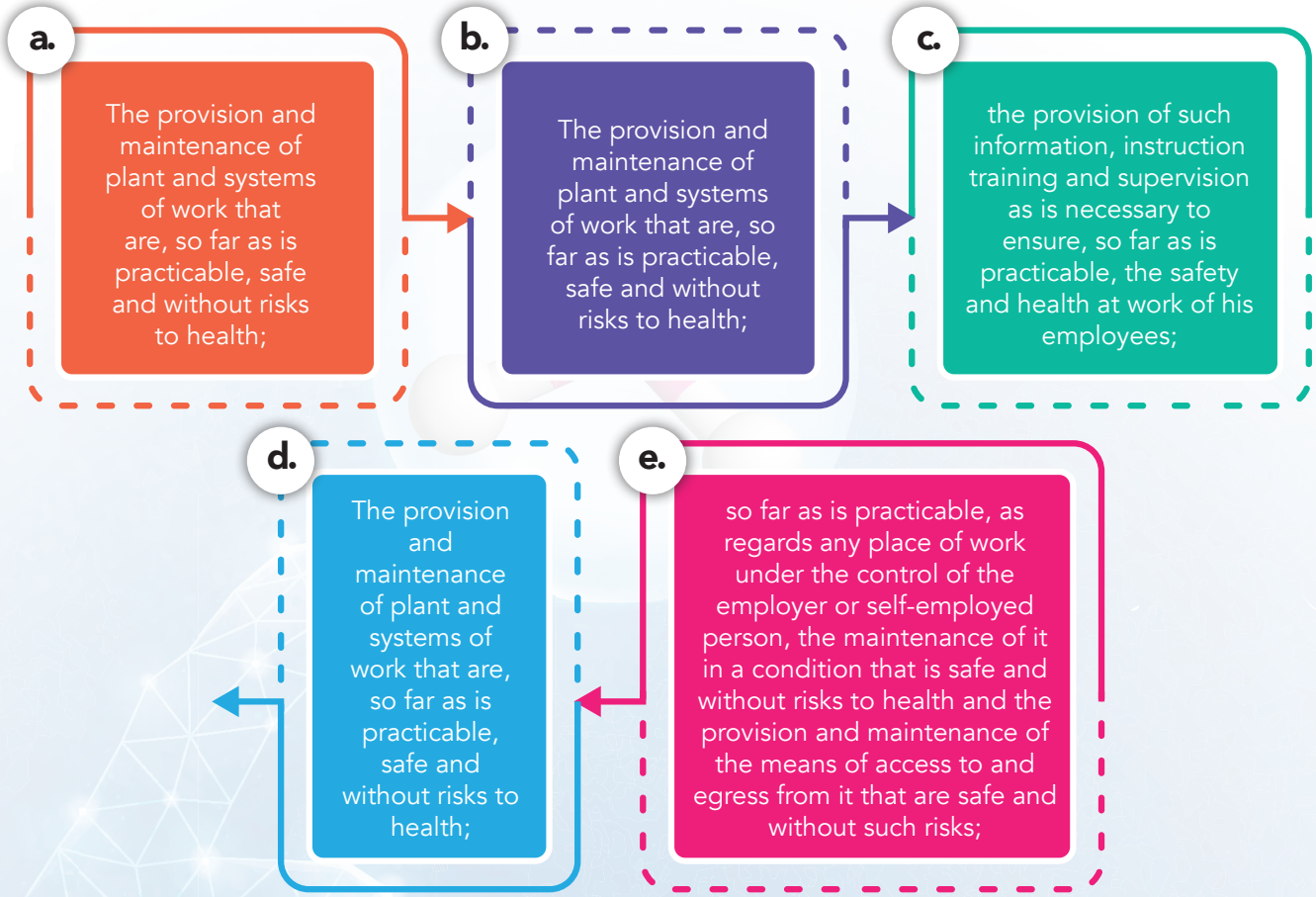
Provisions pertaining to safe system of plant and work are under the following:



2.2.1 General duties of employers and self-employed persons to their employees. Section 15:

(1) It shall be the duty of every employer and every self-employed person to ensure, so far as is practicable, the safety, health and welfare at work of all his employees.

(2) Without prejudice to the generality of subsection (1), the matters to which the duty extends include in particular-



(3) For the purposes of subsections (1) and (2)-

(a) "employee" includes an independent contractor engaged by an employer or a self-employed person and any employee of the independent contractor; and

(b) the duties of an employer or a self-employed person under subsections (1) and (2) extend to such an independent contractor and the independent contractor's employees in relation to matters over which the employer or self-employed person-

(i) has control; or
(ii) would have had control but for any agreement between the employer or self-employed person and the independent contractor to the contrary.

2.2.2 General duties of designers, manufactures and suppliers

Section 20: General duties of manufacturers, as regards for plant for use at work.

(1) It shall be the duty of a person who designs, manufactures, imports or supplies any plant for use at work-

a.

to ensure, so far as is practicable, that the plant is so designed and constructed as to be safe and without risks to health when properly used;

b.

to carry out or arrange for the carrying out of such testing and examination as may be necessary for the performance of the duty imposed on him by paragraph (a); and

c.

to take such steps as are necessary to secure that there will be available in connection with the use of the plant at work adequate information about the use for which it is designed and-has been tested, and about any condition necessary to ensure that, when put to that use, it will be safe and without risks to health.

(2) It shall be the duty of a person who undertakes the design or manufacture of any plant for use at work to carry out or arrange for the carrying out of any necessary research with a view to the discovery and, so far as is practicable, the elimination or minimisation of any risk to safety or health to which the design or plant may give rise.

(3) It shall be the duty of a person who erects or installs any plant for use by persons at work to ensure, so far as is practicable, that nothing about the way in which it is erected or installed makes it unsafe or a risk to health when properly used.

2.2.3 General duties of manufacturers, etc. as regards substances for use at work:

(1) It shall be the duty of a person who formulates, manufactures, imports or supplies any substance for use at work-

a.

To ensure, so far as is practicable, that the substance is safe and without risks to health when properly used;

b.

To carry out or arrange for the carrying out of such testing and examination as may be necessary for the performance of the duty imposed on him by paragraph (a); and

c.

To take such steps as are necessary to ensure that there will be available in connection with the use of the substance at work adequate information about the results of any relevant test which has been carried out on or in connection with the substance and about any condition necessary to ensure that it will be safe and without risks to health when properly used.

(2) It shall be the duty of a person who undertakes the manufacture or supply of any substance for use at work to carry out or arrange for the carrying out of any necessary research with a view to the discovery and, so far as is practicable, the elimination or minimisation of any risk to safety or health to which the substance may give rise.

2.3 Regulations related

a. Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996

b. Occupational Safety and Health (Use and Standards of Exposure of Chemical Hazardous to Health) Regulations 2000

c. Occupational Safety and Health (Classification, Labelling and Safety Data Sheet of Hazardous Chemicals) Regulations 2013

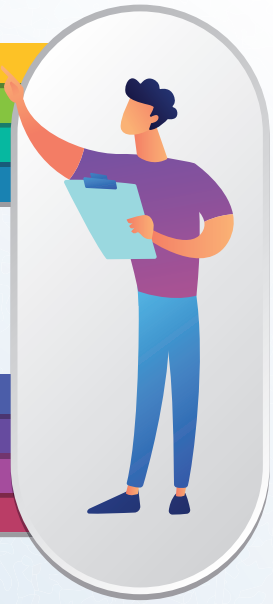
d. Occupational Safety and Health (Noise Exposure) Regulations 2019

e. Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations 1970

f. Factories and Machinery (Safety, Health and Welfare) Regulations 1970

g. Factories and Machinery (Steam Boiler and Unfired Pressure Vessel) Regulations 1970

h. Occupational Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease) Regulations 2004



3 DUTIES AND RESPONSIBILITIES

In general, five parties are involved directly to ensure the safety of using ammonia as a refrigerant.

3.1 Designer.

a. To ensure compliance with legislations as highlighted in Paragraph 2.0.

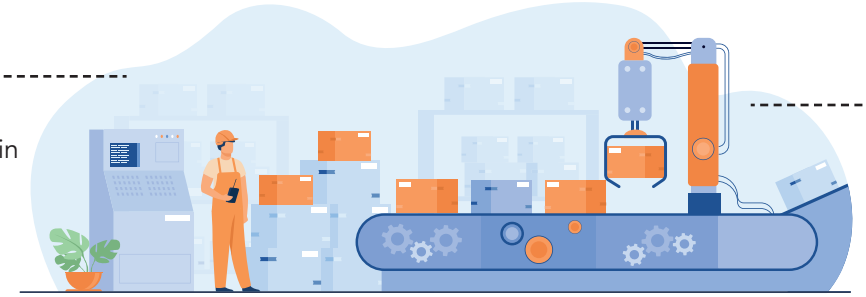
b. To ensure, so far as is practicable, that the refrigeration system is designed to be safe and without risks to health when properly used.

c. To resolve all technical maintenance issues.

d. To design all maintenance programs.

3.2 Manufacturer.

a. To ensure compliance with legislations as highlighted in Paragraph 2.0.



b. To ensure, so far as is practicable, that the refrigeration system is constructed as to be safe and without risks to health when properly used.

c. To set up operation of the refrigeration system in accordance with current good manufacturing practices and standard operating procedures.

3.3 Supplier/Installer of the refrigerant system.

a. To test, commission, and maintain the refrigeration system according to the manufacturer's specification/ recommendation/manual or relevant standard.

b. To carry out running test for the refrigeration system before using it.

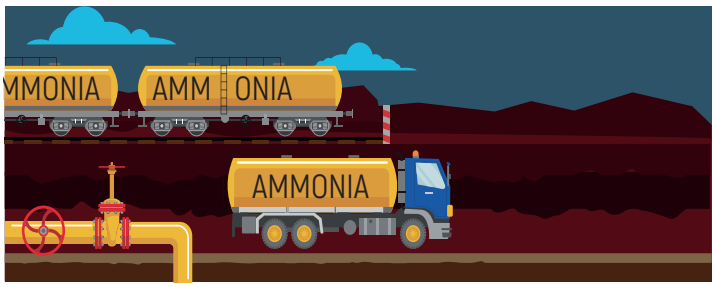
c. To issue instructions on the proper use of the system to the employer and employees who are then required to follow the instructions.

d. To provide and maintain a system of work that is safe and without risks to health.

3.4 Supplier of ammonia.

a. To supply ammonia with a proper label and Safety Data Sheet as per the provisions of CLASS Regulations 2013. See **Appendix 2** for **the Example of Safety Data Sheet for Anhydrous Ammonia.**

b. To develop Safe Operating Procedure for ammonia filling activities.



c. To obtain permission from the owner prior to charging in the ammonia refrigerant.

d. To provide training to ammonia handler.

3.5 Owner.

a. To conduct a risk assessment for the overall operation of the refrigeration system. See **Appendix 3** for the **Example Of Risk Assessment.**

b. To engage or to appoint/assign a trained person for periodic examination and maintenance of the refrigeration system. **A trained person is someone who has undergone training related to ammonia refrigerant system operation, maintenance and has the knowledge and skills to ensure the system operates safely and without risk to health.**

c. To ensure that the trained person carries out periodic maintenance and inspection according to manufacturer requirement, preferably every month.

d. To ensure that any certificated machinery has a valid Certificate of Fitness.

e. To ensure any repair and modification works on Unfired Pressure Vessels to be conducted by a registered Competent Firm.

f. To keep maintenance and operational records readily available upon request from the authority. Any relevant documents including the Piping and Instrumentation Diagram (PID), approved drawing, certificate of fitness, manual operation, maintenance, and operational records should be properly kept and readily available upon request from the authority.

g. To conduct Chemical Health Risk Assessment (CHRA) if chemicals hazardous to health are being used.

h. To report immediately any occupational accident, dangerous occurrence and occupational disease and to submit the Report for Occupational Accident / Dangerous Occurrence (JKKP 6) and Report for Occupational Poisoning / Occupational Disease (JKKP 7) form to the nearest DOSH office as per the provisions of NADOPOD Regulations 2014.

i. To provide information, instruction, training, and supervision to ensure the safety and health of employees at work.

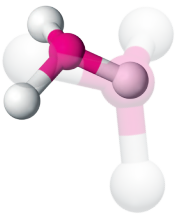
j. To identify and eliminate or minimize any risks to safety and health due to failure in the design of the refrigerant system.

k. To develop Safe Work Procedures for the safe use, operation, and handling of the refrigeration systems and the refrigerants and to ensure any risks to safety and health are properly managed.

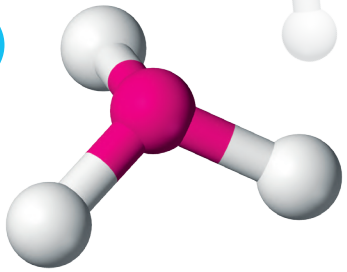
l. To provide emergency response plans and preparedness.

m. To determine the total quantity of the hazardous substance (such as ammonia) used in the refrigeration system and to ensure that the industrial activity involved is in accordance with the provisions of the Occupational Safety and Health (Control of Industrial Major Accident Hazards CIMAH) Regulations 1996. **Refer Appendix 4 for the Example of Calculation for Ammonia Quantity in Refrigeration System.**

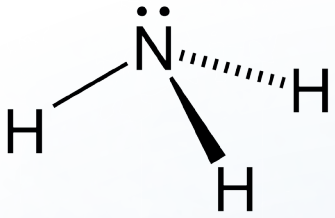
n. To submit Notification of Industrial Activity Form (JKKP 5) to the nearest DOSH office.



4 AMMONIA CHARACTERISTICS AND HAZARDS



Ammonia (NH_3) is a colourless, pungent gas composed of nitrogen and hydrogen. It is the simplest stable compound of these elements and serves as a starting material for the production of many commercially important nitrogen compounds. Ammonia is used in industry and also exists naturally in humans and the environment. Its usage includes the textile industry, the manufacture of synthetic fibers, the catalyst in the production of some synthetic resins, the petroleum refining industry, and the rubber industry.



Ammonia is essential for many biological processes and serves as a precursor for amino acid and nucleotide synthesis. In the environment, ammonia is part of the nitrogen cycle and is produced in soil from bacterial processes. Ammonia is also produced naturally from the decomposition of organic matter, including plants and animals.

4.1 Physical properties

Anhydrous ammonia is a clear liquid that boils at a temperature of -33.33°C (-28°F). In refrigeration systems, the liquid is stored in closed containers under pressure. When pressure is released, the liquid evaporates rapidly, generally forming an invisible vapour or gas. The rapid evaporation causes the temperature of the liquid to drop until it reaches the normal boiling point of -33.3°C (-28°F), a similar effect which occurs when water evaporates off the skin, thus cooling it. This is why ammonia is used in refrigeration systems. Liquid anhydrous ammonia weighs less than water. About 30.3 litres of ammonia weighs the same as 19 litres of water.

Liquid and gas ammonia expands and contracts with changes in pressure and temperature. For example, if liquid anhydrous ammonia is in a partially filled, closed container and is heated from -17.8°C (0°F) to 20.0°C (68°F), the volume of the liquid will increase by about 10 percent. If the tank is 90 percent full at 0°F, it will become 99 percent full at 68°F. At the same time, the pressure in the container will increase from 16 pounds per square inch (psi) to 110 psi. Liquid ammonia will expand by 850 times when evaporating. Anhydrous ammonia gas is considerably lighter than air and will rise in dry air. However, because of ammonia's tremendous affinity for water, it reacts immediately with the humidity in the air and may remain close to the ground.

The odour threshold for ammonia is between 5 - 50 parts per million (ppm) of air. The permissible exposure limit (PEL) is 25ppm or 17mg/m^3 for eight-hour (8-hour) time weighted average airborne concentration. It is recommended that if employees can smell it they ought to back off and determine if they need to be using respiratory protection.

Table 1: Summary of ammonia physical properties

Boiling Point	-33.3°C (-28°F)
Weight per gallon of liquid at -33.3°C (-28°F)	2.58 kg
Weight per gallon of liquid at 15.6°C (60°F)	2.34 kg
Specific gravity of the liquid (water=1)	0.619
Specific gravity of the gas (air=1)	0.588
Flammable limits in air	16-25%
Ignition temperature	651°C (1204°F)
Vapor pressure at -17.8°C (0°F)	16 psi
Vapor pressure at 20.0°C (68°F)	110 psi
Vapor pressure at 37.8°C (100°F)	198 psi
One cubic foot of liquid at 15.6°C (60°F) expands to	24 cubic metre of gas (850 cubic foot)

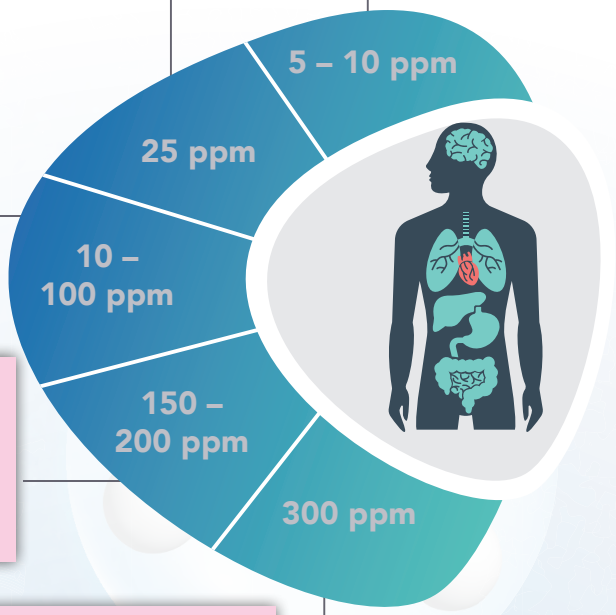
4.2 Chemical properties

Anhydrous ammonia is easily absorbed by water. At 20.0°C (68°F), about 700 volumes of vapour can be dissolved in one volume of water to make a solution containing 34 percent ammonia by weight. Ammonia in water solution is called aqua ammonia or ammonium hydroxide.

Anhydrous ammonia is a non-flammable material. However, ammonia vapour in high concentrations (16 to 25 percent by weight in air) will burn. It is unlikely that such concentrations will occur except in confined spaces or in the proximity of large spills. The fire hazard from ammonia is increased by the presence of oil or other combustible materials. Anhydrous ammonia is an alkali.

Ammonia, especially in the presence of moisture, reacts with and corrodes copper, zinc, and many alloys. Only iron, steel, certain rubbers and plastics, and specific non-ferrous alloys resistant to ammonia should be used for fabrication of anhydrous ammonia containers, fittings, and piping. Ammonia will combine with mercury to form a fulminate which is an unstable explosive compound.

4.3 Effects of Ammonia



Permissible exposure limit (PEL)

Normally can be detected by smell

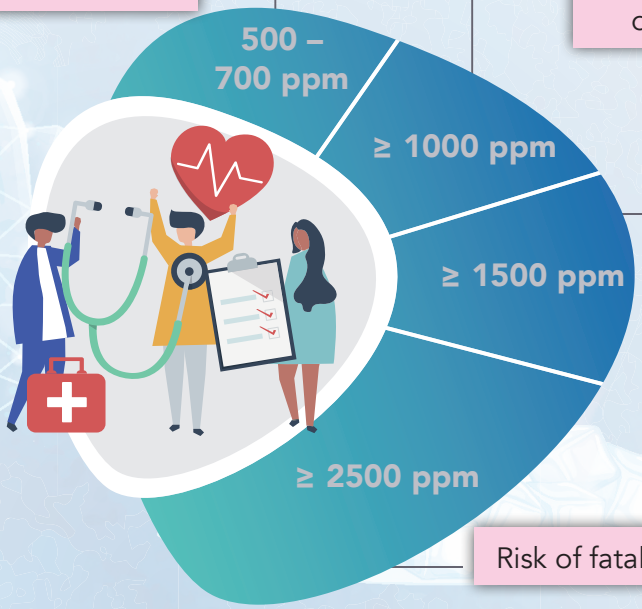
People who are used to it can work without discomfort

Causes irritation of the mucous membranes and the eyes, but normally with no lasting consequences

Immediately Dangerous to Life or Health (IDLH)

- Eyes are affected more quickly, streaming with tears after 30 seconds or less
- Air is still breathable

- Breathing is intolerable
- Vision is impaired but not lost. Eye injuries constitute the most serious hazards at this concentration in terms of possible permanent disability



- Can damage or destroy tissue,
- The instant human reaction is, to quickly evacuate the area

Risk of fatality

Adapted from: Federation 2016, Federation's Technical and Safety Committee, British Engineering Services, Institute of Refrigeration and other stakeholders, with support from the Health and Safety Executive, *Safe management of ammonia refrigeration systems Guidance for the food and drinks industries and other workplaces [Food Storage and Distribution]*

Hazard and precautionary statement for ammonia can be referred in table 2 and 3 respectively.

Table 2: Hazard statement

H280	Contains gas under pressure; may explode if heated
H221	Flammable gas
H331	Toxic if inhaled
H314	Causes severe skin burns and eye damage
H410	Very toxic to aquatic life with long lasting effects

Table 3: Precautionary statements

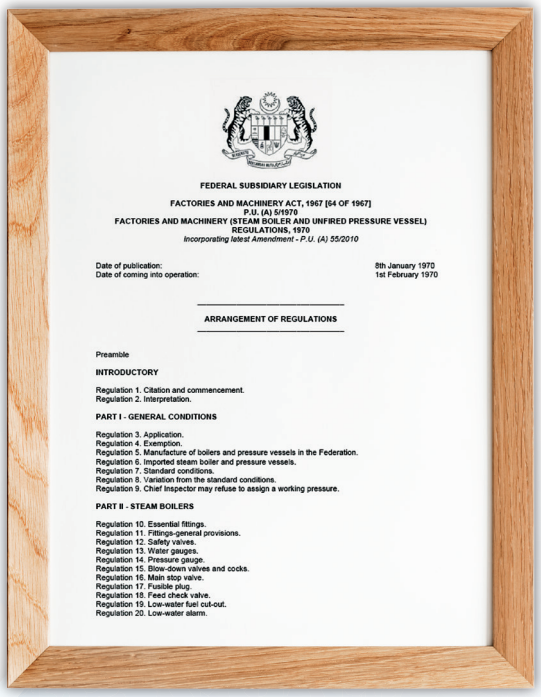
P210	Keep away from heat, hot surface, sparks, open flames and other ignition sources. No smoking.
H260	Do not breathe dust/fume/gas/mist/vapors/spray.
H273	Avoid release to the environment.
H280	Wear protective gloves/protective clothing/eye protection/face protection.
H314	Causes severe skin burns and eye damage.
P303+P361+P353+P315	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. Get immediate medical advice/attention.
P304+P340+P315	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Get immediate medical advice/ attention.
P305+P351+P338+P315	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice/attention.
P377	Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381	In case of leakage, eliminate all ignition sources.
P403	Store in a well-ventilated place.
P405	Store locked up.

5 DESIGN

5.1 General

This section describes the unfired pressure vessel (UPV), its mandatory requirement including those using ammonia as a medium of service.

Under the Factories and Machinery Act 1967, each UPV must have a valid certificate of fitness (CF) before it can be operated. For this purpose, approval for the design of the UPV has to be obtained in advance from the Department of Occupational Safety and Health (DOSH) before it can be fabricated, installed or used, except those exempted under the Factories and Machinery (Exemption of Certificate of Fitness for Unfired Pressure Vessel) Order 2017. The UPV shall pass the inspection by DOSH state offices before the CF can be issued.



FEDERAL SUBSIDIARY LEGISLATION

FACTORIES AND MACHINERY ACT, 1967 [64 OF 1967]
P.U. (A) 5/1970
FACTORIES AND MACHINERY (STEAM BOILER AND UNFIRED PRESSURE VESSEL) REGULATIONS, 1970
Incorporating latest Amendment - P.U. (A) 55/2010

Date of publication: 8th January 1970
Date of coming into operation: 1st February 1970

ARRANGEMENT OF REGULATIONS

Preamble

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Regulation 4. Exemption.
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Regulation 16. Main stop valve.
Regulation 17. Fusible plug.
Regulation 18. Feed check valve.
Regulation 19. Low-water fuel cut-out.
Regulation 20. Low-water alarm.

5.2 Schematic diagram

Figure 1 shows the basic refrigeration system that normally can be found in most industrial application. It consists of four (4) major parts which are the condenser, compressor, evaporator and receiver.

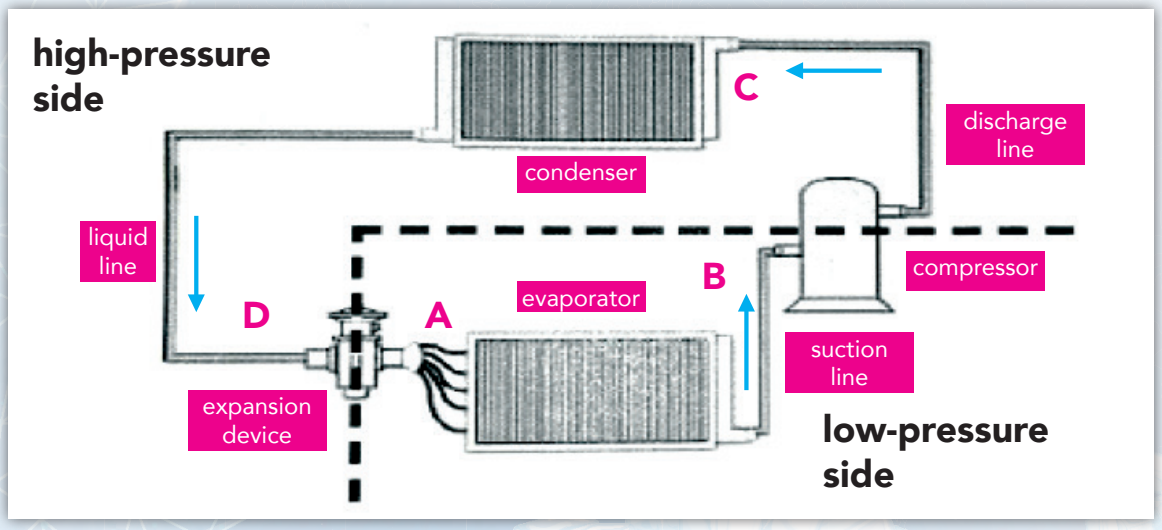
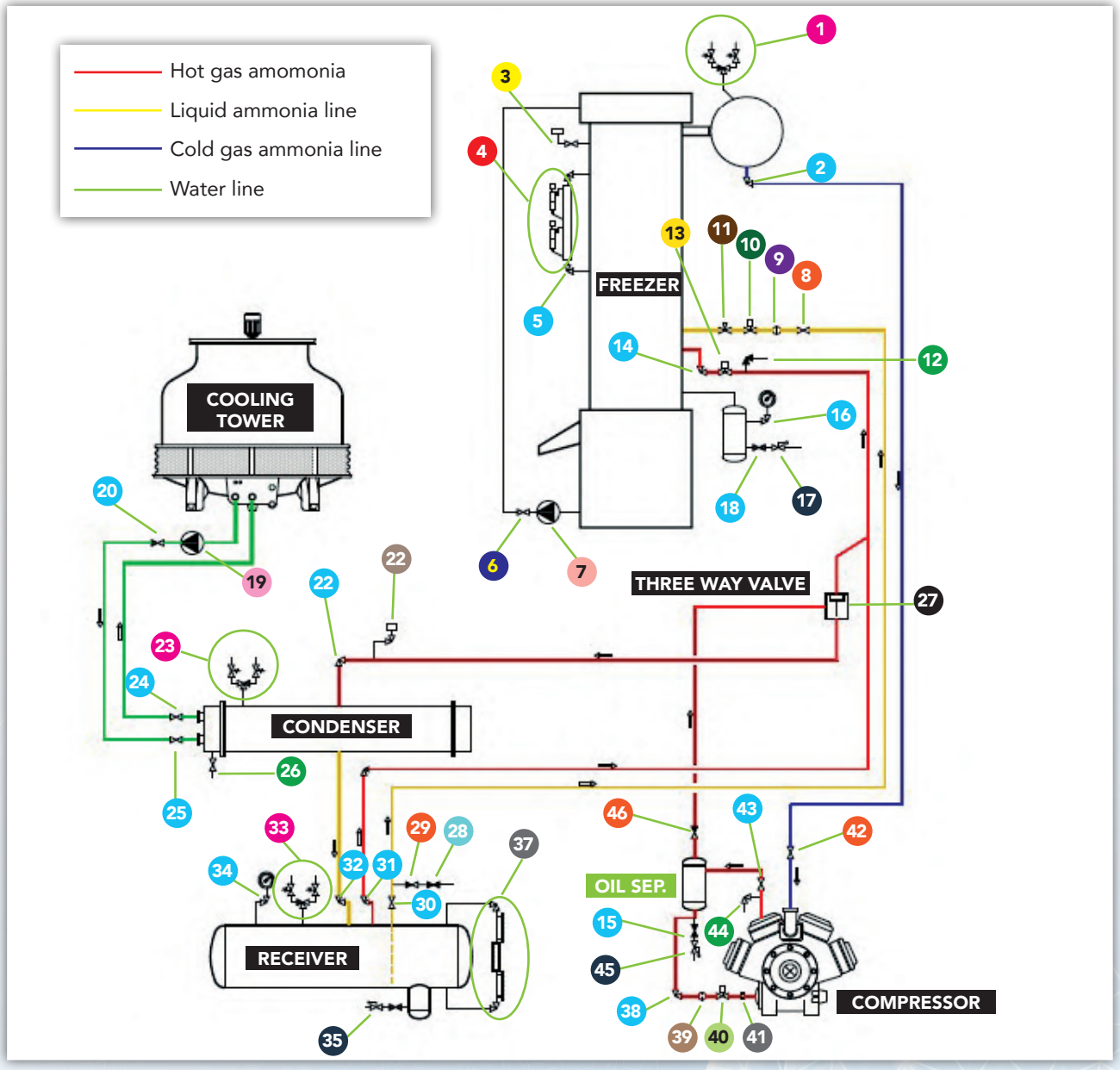


Figure 1: Basic Refrigeration System

[Source: Johnson Controls (S) Pte Ltd]

There are various types of ammonia refrigeration system. Figures 2 and 3 below show the examples of different types of tube ice production system typically used in ice factories.



Safety valve 1 23 33
Angle valve 2 5 14 15 16 18 20 22 24 25 30 31 32 34 36 38 43

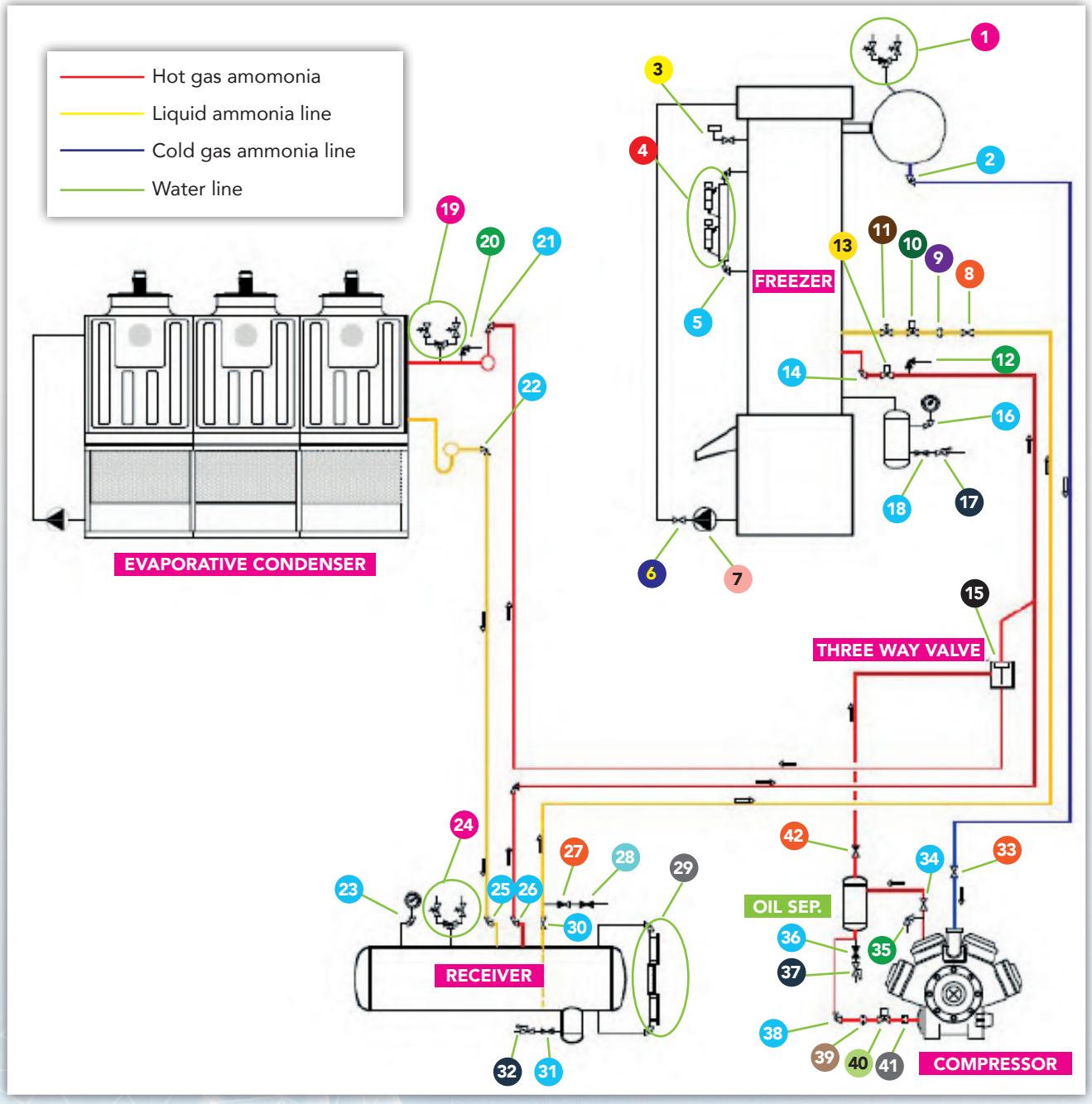
Temperature Sensor 3
Float Switch
- Higher Float Switch 4
- Lower Float Switch
Butterfly Valve 6

Chilled Water Pump 7
Straight Valve 8 29 42 46
Strainer 9
Liquid Solenoid Valve 10
Needle Valve 11
Drain Valve 12 26 44
Hot Gas Valve or Hot Gas Solenoid Valve 13
Oil Drain Valve 17 35 45
Condenser Pump 19
High Pressure Control 21

Three Way Valve 27
Check Valve 28
Orifice 39
Oil Solenoid Valve 40
Sight Glass 37 41

Figure 2: Tube Ice Machine diagram (Ammonia system with shell and tube condenser)

[Source: Manual- Tube Ice, Patkol Public Limited Company]



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- Higher Float Switch
- Lower Float Switch
Butterfly Valve 6
Chilled Water Pump 7
Straight Valve 8 27 33 42
Strainer 9
Liquid Solenoid Valve 10
Needle Valve 11
Drain Valve 12 20 35
Hot Gas Valve or Hot Gas Solenoid Valve 13
Three Way Valve 15
Oil Drain Valve 17 32 37
Check Valve 28
Sight Glass 29 41
Orifice 39
Oil Solenoid Valve 40

Figure 3 : Tube Ice Machine Diagram (Ammonia system with evaporative condenser)

[Source : Manual- Tube Ice, Patkol Public Limited Company]

5.3 Design criteria

The design criteria should be as follows:

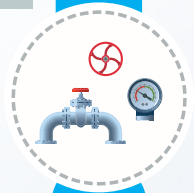
a.

UPV shall be built in accordance with the design codes recognized by DOSH.

b.

In respect of the design, method of construction workmanship and tests, it shall comply with the provisions of one of the codes, rules or specifications set out in the Second or Third Schedule of the Factories and Machinery (Steam Boiler and Unfired Pressure Vessel) Regulations, 1970.

c.



All materials used in the construction of the vessel shall be suitable for ammonia refrigerant at the design temperature and pressure to which the component shall be subjected.

d.

A name plate should be installed on the metal cladding of the insulation for easy inspection in the future.

e.

When a vessel is to contain lethal substances either liquid or gaseous, all butt-welded joints should be fully radiographed. Refer to

[UW-2 (a) and UW-11(a)(1) ASME Sect VIII Div.1 2019 Edition]

f.

Fabrication drawings, pressure vessel calculations, pressure testing certificates and bills of materials shall be inspected by an authorized inspecting authority (AIA) as listed in the Fourth Schedule; Factories and Machinery (Steam Boiler and Unfired Pressure Vessel) Regulations, 1970 if required by DOSH (more than 3000 psig. inches). Please see Appendix 6 for the Worked Example of Pressure Design of Pipe under Internal Pressure

g.

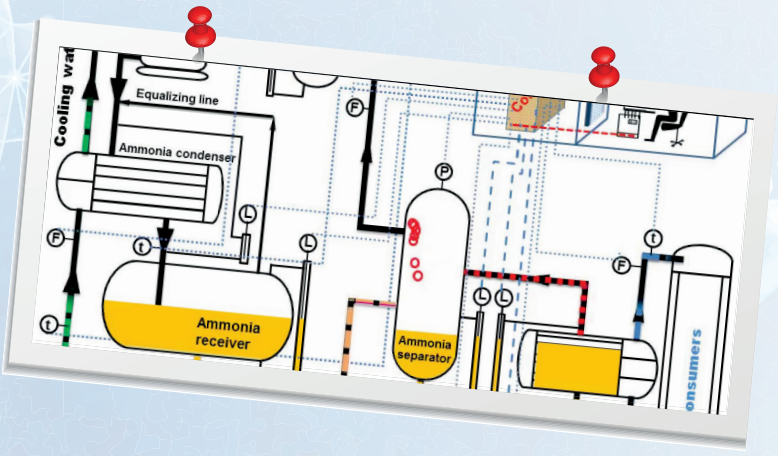
Machine Room Design

i. The machine room should have enough ventilation for releasing the heat from compressor motors.
ii. Ventilation fans can be added if necessary for emergency ammonia leakage or for insufficient ventilation.
iii. It is recommended to install ammonia gas detectors.

6 INSTALLATION

a) The ammonia refrigeration system shall be designed by, and installed under the supervision of, persons who by reason of knowledge, training and experience are competent for the tasks.

b) The refrigeration system installer shall be equipped with the necessary drawings and relevant diagrams, including a refrigeration circuit, flow diagram and electrical circuit diagram.



7 CHECKING AND TESTING

a. The ammonia refrigeration system shall be checked before start-up:

i. All piping, electrical equipment and insulation to be correctly installed.
ii. All protection devices to be tested and set.
iii. The system to be pressure tested
iv. Functional tests of all safety devices including the warning and alarming system to be conducted.

b. The system cannot operate until it has passed all tests and inspections as follows:

i. Non-destructive test performed on any welded part to ensure there is no defect on the part
ii. Pressure test performed to ensure no leaking of refrigerant upon charging.
   (i) Max Test Pressure: 90% of relief valve pressure using nitrogen or 1.1 x of highest operating pressure.
   (ii) Hold pressure the minimum period specified by the manufacturer.
   (iii) All suction and discharge valves must be completely closed
   (iv) Brush or spray all welding joints with soapy water to check for any leaks.
   Refer to
   [ASME B31.5 Refrigeration Piping and Heat Transfer Components]
iii. A vacuum test needs to be performed to remove air and moisture from the piping.
   (i) Vacuum pump to pull down pressure to vacuum condition.
   (ii) Hold pressure according to manufacturer specifications.
   (iii) Charge in ammonia until it reaches above atmospheric pressure.

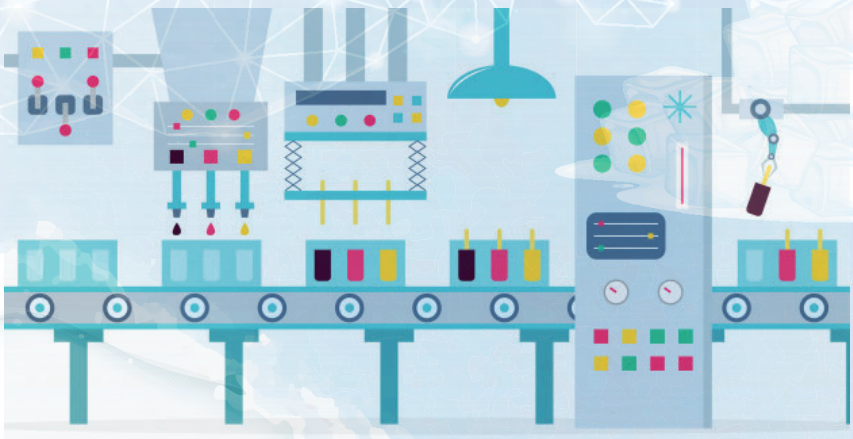
c. The owner and contractor should witness and verify the pressure test and vacuum test.

8 AMMONIA CHARGING

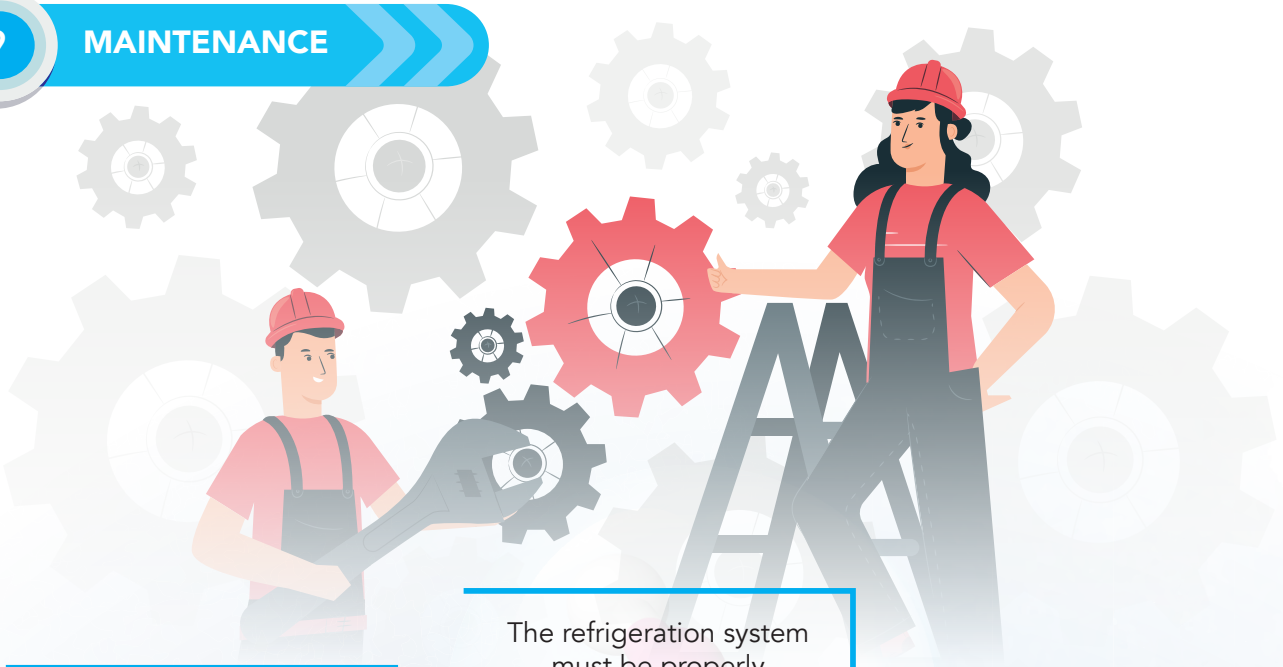
a. Before charging the system with ammonia, it is essential to verify that the machine room on site and any other spaces that contain industrial refrigeration systems are built in accordance with all safety requirements

b. Before the ammonia refrigeration unit can be charged with ammonia, all first aid and safety equipment must be made available and accessible.
   i. Before installation, the installation technician must check that the owner equips and provides the facility with full-face respirators with appropriate chemical cartridges (eg: ammonia/organic vapour/multigas catridge) and protective clothing, including protective gloves, and compressed air breathing sets.
   ii. The items listed in paragraph 8(b)(i) should all be safely and carefully stored in an accessible storage area so they can be utilized when needed.

c. Before charging an ammonia refrigeration system, local emergency authorities and all on-site staff should be made aware that ammonia is being used at that location. Notices and signages also need to be placed in all relevant locations informing personnel that the ammonia system will be charged.



9 MAINTENANCE



a. The owner must ensure the refrigeration system is well maintained. Periodical maintenance should comply with manufacturer recommendations.

b. For repair work where component replacement is required, original equipment manufacturer (OEM) parts shall be used or parts that at least meet with manufacturer's original specifications.

c. The manufacturer or supplier shall give the user sufficient written information concerning the plant's design, construction, examination, operation and maintenance as may reasonably be necessary to enable the user to continue to operate it safely.

d. The refrigeration system must be properly maintained and operated efficiently without any serious risk to safety and health. Subject to para 3.5 (a), the risk assessment conducted may identify critical measures to be put in place and may include any control requirements arising from the maintenance program. Planned maintenance programs may indicate potential risks, thus proper scheduled inspection or maintenance according to manufacturer recommendation may reduce any residual risk.

e Any maintenance work in the plant shall be undertaken by a trained person with sufficient experience, knowledge, training and skills of the systems to ensure any faults from each stage of the process can be identified and rectified before serious consequences occur.

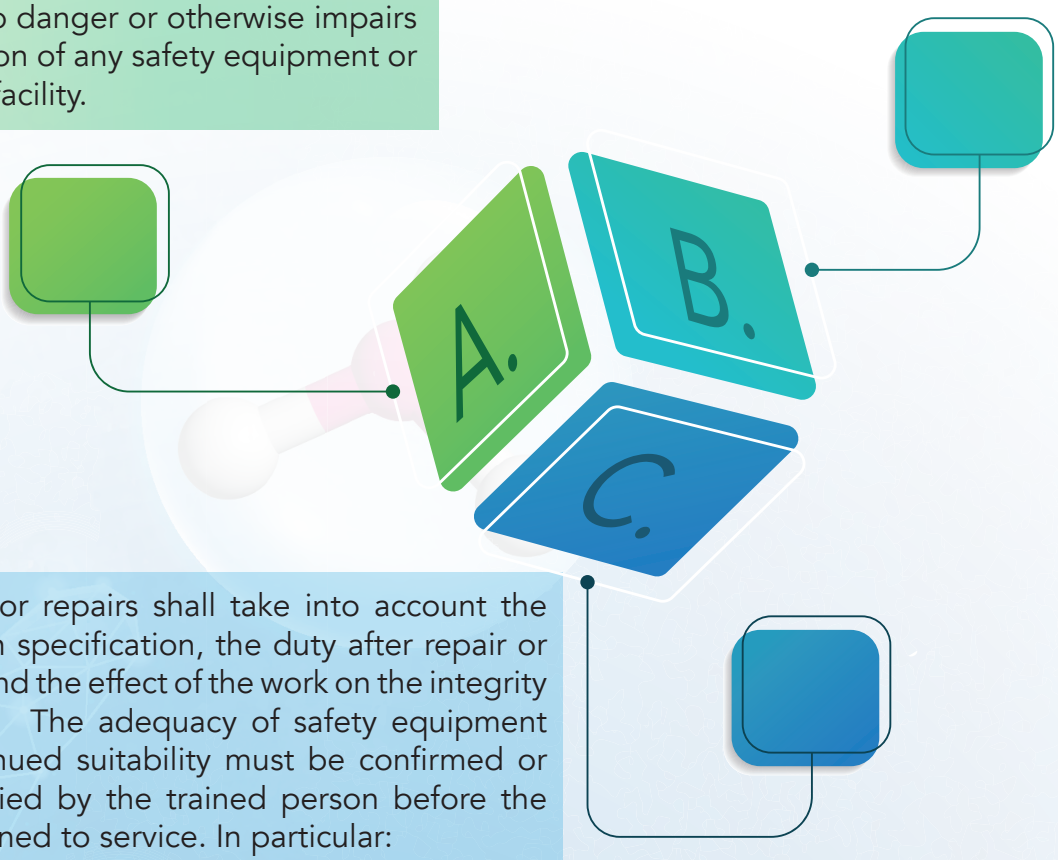
f. Any refrigeration system with compressors, condensers, evaporators and associated components are regularly maintained and periodically inspected by trained/ competent personnel to ensure:

i. Planned Preventative Maintenance (PPM) procedures are in line with the manufacturer's recommendations.
ii. All PPM activities must adapt to technical progress and be revised if necessary.
iii. All safety equipment is correctly installed and well-functioning
iv. Functional tests are regularly carried out to confirm the correct operation of safety equipment.
v. Maintenance and operational records are properly kept and readily available upon request from the authority.

10 MODIFICATION AND REPAIR

The owner or employer who is involved with ammonia-based refrigeration systems operation shall ensure that nothing about the way in which the system may be modified or repaired gives rise to danger or otherwise impairs the operation of any safety equipment or inspection facility.

No modification or repair can be executed without prior approval from the Director General of DOSH.



Modifications or repairs shall take into account the original design specification, the duty after repair or modification and the effect of the work on the integrity of the system. The adequacy of safety equipment and the continued suitability must be confirmed or suitably modified by the trained person before the system is returned to service. In particular:

i. Modification of unfired pressure vessel (UPV) must be notified to and approval obtained from DOSH (refer Regulation 79 Factories and Machinery (Steam Boiler and Unfired Pressure Vessel) Regulations, 1970).
ii. All repairs and modifications shall be carried out according to the appropriate unified codes/standards that apply to the system.
iii. Non-Destructive Examination (NDE) shall be carried out in accordance with the relevant code(s).
iv. Upon modification of the certificated machineries, they need to be retested according to the DOSH approval letter in order to obtain new and valid certificates of fitness (CF).

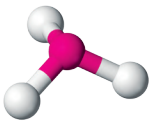
11 TRAINING

An employer needs to conduct a series of effective training scheme with respect to the ammonia refrigeration system used at their workplace. The training shall contain the effect of ammonia on health and environment, the safety aspects during handling the system, safety and health management and emergency response plan. An effective training program can minimize the number of incidents which may lead to injuries and deaths, property damage, legal liability, illnesses, workers' compensation claims, and lost time injury from work. The training programmes shall also be recorded and the training conducted should involve all workers and contractors who work directly or indirectly with the refrigeration system at the workplace.

The table 3 shows the proposal of a minimum basic training matrix for the personnel involved directly or indirectly with the ammonia refrigerant system.

Table 4 : Proposal of minimum basic training matrix

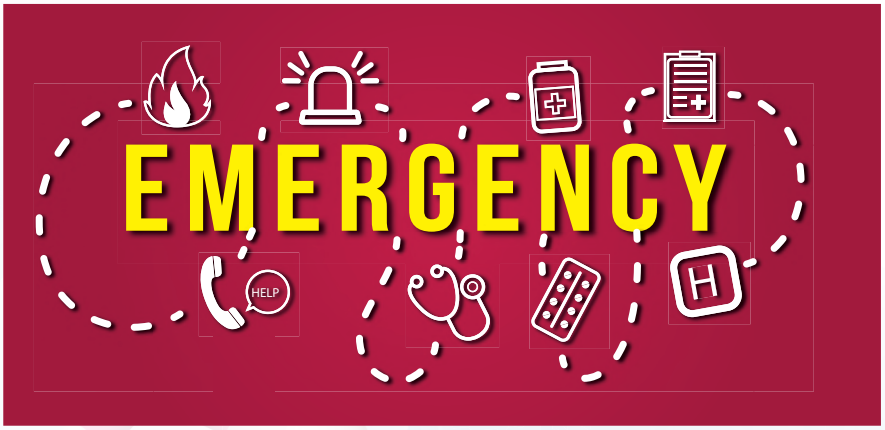
LIST OF TRAINING	OWNER	PLANT MANAGER	SUPERVISOR	WORKER
Acts and Regulations:				
1. Occupational Safety and Health 1994	✕	✕		
2. Factory and Machinery Act 1967	✕	✕		
3. Occupational Safety and Health (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulations 2000	✕	✕		
4. Occupational Safety and Health (Classification, Labelling and Safety Data Sheet of Hazardous Chemicals) Regulations 2013	✕	✕		
5. Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996	✕	✕		
6. Occupational Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease) Regulations 2004	✕	✕		



LIST OF TRAINING	OWNER	PLANT MANAGER	SUPERVISOR	WORKER
Occupational Safety and Health Management				
1. Safety Committee		✓	✓	
2. OSH Management		✓	✓	
3. Risk Assessment		✓	✓	
4. Developing Safe Working Procedure		✓	✓	
5. Safety Audit Committee		✓	✓	
6. Emergency Response Preparedness		✓	✓	
Practical training				
1. PPE Wearing				✓
2. ERP Drills				✓
3. Checklists				✓
4. Manual Study				✓
5. Ergonomic				✓
System maintenance				
1. Daily			✓	✓
2. Weekly			✓	
3. Monthly			✓	
4. Annually			✓	

12 AMMONIA EMERGENCY RESPONSE PLAN

This section provides an overview of emergency response related to ammonia. The existing site or plant emergency response plan should incorporate specific recommendations in handling ammonia leakage emergencies. Should there be any emergency related to ammonia, the response plan triggered should follow the existing protocol at the particular site. The plan should be established in conjunction with local authorities and the Fire and Rescue Department. The plan should address personnel, equipment, countermeasures, and shutdown procedures to effectively combat the emergency situation. The procedures should include assigning personnel, personal protective equipment to be used, establishing team communication, ensuring use of buddy system, setting proper decontamination procedures, conducting reconnaissance operations, establishing an action plan to gather information about the incident and other relevant information, termination and medical follow up.

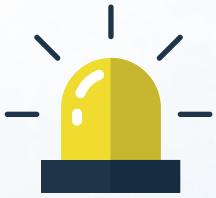


An ammonia release can readily have an impact beyond the boundary of the workplace. Regardless of the size of the workplace, the largest potential release of an ammonia spill or leak must be assessed. It has been reported that almost as many small-scale releases have led to evacuations and injuries as large-scale releases; so it is important that emergency planning covers both small and large-scale releases. The recovery measures should include the following:

Procedures associated with general emergency principles are as follows:

a) Alarm sequence

i. In most workplaces, during an emergency any person should be able to trigger an emergency alarm and alert others in the surrounding, thus allowing the earliest possible action to be taken to manage and mitigate any hazardous situation. Various alarm systems may be used to suit the size of the work environment.



ii. There should be an adequate number of points from which the alarm can be triggered, especially in critical areas e.g. refrigerator, either directly, via a signal or message to a permanently manned location. The alarm should alert the authorized incident or emergency commander, who should assess the situation and activate appropriate emergency procedures. In the areas where there is a high level of noise, it may be necessary to install more than one audible alarm transmitter or flashing lights. Automatic alarms may be appropriate on some sites.

b) Emergency action. If ammonia leakage occurs, immediately:

i. Notify, isolate and secure the spill area:
ii. Evacuate to the immediate evacuation area and notify the emergency response team with information such as location and extent of spill or leak.
iii. Cordon off the area around the spill with barrier tapes. Ensure that the area is safe before the emergency response team enters and reacts to the situation.
iv. Once evacuated to a safe distance (preferably upwind of leakage), observe the area where vapour clouds travel to using windsock.

v. Keep away all persons not involved in the clean-up. Close doors to other areas near the leakage. Post warning signs and barriers to prevent entry to the spillage or leakage area by unauthorized persons.
vi. Turn off any ventilating or air conditioning system that circulates air from the spill area to other parts of the workplace.

vii. Assemble trained emergency response members outside the cordoned area.
viii. Initiate ammonia level measurements.
ix. Determine ammonia levels in and around the leakage area using an ammonia direct reading instrument.
x. Extend the restriction zone as appropriate depending on ammonia levels.

c) Evacuation/search and rescue/first aid measures

The roles and responsibilities for those involved in managing an ammonia incident must be identified depending on the types and levels of emergencies according to the proper designated working environment. For large scale industry or plant with potential for more serious consequences, the establishment of emergency management structures should be conducted by emergency service organizations.

The workplace's incident management system (IMS) must be:
i. compatible with the routine organizational structure
ii. locally based emergency response agency and IMS systems
iii. resourced and sustainable.

Please see **Appendix 7** for the example of **Ammonia Emergency Response Plan Work Flow**

◆ Risk of Health

Inhalation of corrosive ammonia gas can cause irritation and inflammation of the respiratory system, difficulty breathing, nausea, chest pain and vomiting. Irritation or burns may occur after direct skin contact with anhydrous ammonia, solutions or concentrated ammonia gas. Direct contact of ammonia with eyes may cause irritation, tearing, severe injury or blindness.

◆ First Aid Measures

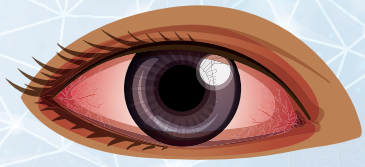
Immediate first aid treatment can help reduce the impact of injuries and prevent further injuries from occurring. Below is outlined some basic first aid measures for inhalation, skin contact and eye contact. In all circumstances, send for medical help, as soon as possible.

• Inhalation

a) Assess the victim's breathing.
b) If breathing has stopped, begin artificial respiration and continue until the victim resumes breathing. If the victim is having difficulty breathing (gasping, coughing), place the victim in the most comfortable position, usually semi-sitting.
c) If an oxygen therapy unit and trained personnel are available, administer oxygen.
d) Ensure that the victim is transported to the hospital in case of a delayed reaction in the form of pulmonary oedema. Any physical exertion, excitement or apprehension increases the chances and severity of a delayed reaction. Keep the victim warm and completely at rest. Reassure the victim while waiting for assistance.

• Skin Contact

a) As soon as the victim resumes breathing, flush the victim's contaminated skin and clothing with large amounts of water for 30 minutes.
b) Remove all contaminated clothing while flushing.
c) Continue flushing until all traces of ammonia have been removed.
d) Dress obvious burns in sterile gauze and bandage them loosely. Apply insulated cold packs to help reduce pain.
e) Call for an ambulance to take the victim to a hospital.



• Eye Contact

a) Flush the eyes immediately with large amounts of running water (preferably lukewarm) if any amount of liquefied ammonia has entered the eyes or if exposure to gaseous ammonia causes persistent eye irritation.
b) Hold the eyelids apart forcibly to ensure full flushing of the eyes and eyelids.
c) After flushing has removed all traces of ammonia, cover both eyes with moistened sterile gauze pads and bandage enough to keep light out.
d) Apply insulated cold packs to help reduce pain.
e) Call for an ambulance to take the victim to a hospital.
f) Do not attempt to neutralize the ammonia with other chemicals or apply oils, ointments or medication to the eyes.

d) Communication with external emergency services. The aims of notification and communication are:

i. To summon for assistance from local emergency services such as the Fire and Rescue Department, police, ambulance, hospital, neighbouring plants etc.

ii. To notify respective organizations such as DOSH, DOE etc.

JABATAN KESELAMATAN DAN KESIHATAN PEKERJAAN MALAYSIA

vii. Any information provided to next of kin should be given in person, preferably by a doctor. A senior supervisor or manager known by the family and a social worker should help where necessary.

iii. To provide a warning to neighbours close to the facility and the public or community in the surrounding area to initiate contingency plans without delay. This allows the industry contingency plan or the state contingency plan to be placed on alert status.

vi. Prompt action is required by the doctor in providing an initial report. Notification to the relevant authorities is on the basis of this initial report

iv. To inform families of injured/deceased employees. The families of casualties need to be informed and helped promptly.

v. It is essential that the next of kin of deceased or seriously injured personnel are notified at the earliest opportunity

e) Termination of emergency.

i

Procedures for termination of an emergency should be listed in the emergency procedures. When the Fire and Rescue Department officer's role is completed, he is to hand back control to the company Emergency Commander who will then carefully consider the overall situation.

ii

The company Emergency Commander may have complementary actions to resolve the situation before declaring the emergency is over. His next task would be facilitating reorganisation and reconstruction activities so that normal operation can be resumed.

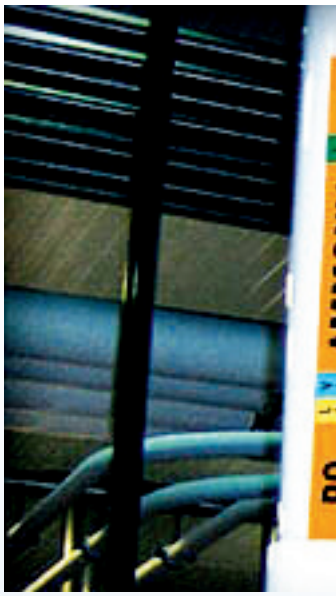
iii

The conditions for the termination of the emergency should be clearly addressed. When these conditions are met, the emergency commander declares that the emergency is over.

iv

Generally, a specific signal or alarm would be given to announce that the emergency is over. Before people and workers are allowed to return to the emergency area or its surroundings, an assessment of health risk is mandatory.

13 RECORD KEEPING



The employer shall ensure that all records and reports are to be maintained in good order and condition, and are to be updated from time to time. All the records and reports should be readily available upon request from the relevant authorities for inspection, investigation and audit. Similarly, these documents should be made available to the manufacturer or trained person so that the maintenance, repair and modification process can be carried out safely. It is also important to have a proper record keeping in order for the employer to carry out continuous improvement for the safe management of the ammonia refrigeration system from time to time. The records can be kept in either hard copy or electronic format. In case of where an employer ceases to carry on business and another person takes over the business, the employer shall hand over all records to the new owner.

It should be the duty of the employer to keep the following relevant records but not limited to: -

A. Designer's/manufacturer's/ supplier's approved documents relating to parts of the system, system design and plant design.

B. Maintenance programme developed by the manufacturer of the system.

C. Safe Working Procedures pertaining to the operation, maintenance, refrigerant handling etc.

D. Risk Assessment Report on the activities related to the refrigeration system.

E. Chemical Health Risk Assessment Report on any chemicals hazardous to health used at the plant.

F. Record of permit system being developed and used at the plant.

G. Agreement between the owner and the supplier/manufacturer, trained person etc. regarding the system's periodical inspection and maintenance

H. Certificates of Fitness by DOSH of any certificated machinery.

I. Record of modification and repair works done throughout the service of the system.

J

Record of maintenance and operation throughout the service of the system.

K

Piping and Instrumentation Diagram of the refrigerant system.

L

Operation Manual by the manufacturer.

M

Legal register including logbook for any findings on the system that were recorded by the authorities, workers, trained persons etc.

N

Record of Training involving the owner or the worker.

O

All documents related to the Emergency Response Plan.

P

All documents (if required) related to the compliance with the provision of the Occupational Safety and Health (Control of Industrial Major Accident Hazards CIMAH) Regulations 1996.

Q

Record of JKKP 5 (Notification of industrial activity)

R

Record for PPE

14 REFERENCES

1. Department of Occupational Safety and Health (1994). Occupational Safety and Health Act and its Regulations.

2. Department of Occupational Safety and Health (1967). Factories and Machinery Act and Its Regulations.

3. http://www.chm.bris.ac.uk/motm/ammonia/Ammonia%20MOTM.html

4. https://www.britannica.com/science/ammonia

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6. Safe Management of Ammonia Refrigeration Systems

7. Chemical Awareness – Ammonia As A Refrigerant By Johnson Controls (S) Pte Ltd

8. Manual – Tube Ice, Patkol Public Limited Company

9. 2016, Federation's Technical and Safety Committee, British Engineering Services, Institute of Refrigeration and other stakeholders, with support from the Health and Safety Executive, Safe management of ammonia refrigeration systems Guidance for the food and drinks industries and other workplaces [Food Storage and Distribution]

APPENDIX 1 :

CASE STUDY ON INCIDENTS INVOLVING AMMONIA REFRIGERATION SYSTEM

CASE 01

Accident case Involving Release of Ammonia Vapours at a Poultry Processing Plant Using Ammonia Refrigerant System

About the Accident

An accident involving an ammonia leak from a piping of a cooling system that supplies ammonia refrigerant to a blast freezer occurred at the end of the pipe connection, releasing large quantities of ammonia within the factory area.

The release of vapour cloud of ammonia gas caused 28 workers to suffer breathing difficulties and three (3) workers were rushed to the hospital for intensive care unit (ICU) treatment. The Fire and Rescue Department personel who arrived at the scene had successfully controlled the release of ammonia from spreading beyond the factory premises by using water blanket method to dilute the discharge of ammonia clouds and halt the source of the leak at the broken pipe.

Background

Type of Industry: Manufacturing (Food Processing)
Work Process: Refrigeration of poultry
Work activity: Operation of ammonia refrigeration system using blast freezer
Victims: 31 workers in the factory (including 3 hospitalized in the ICU)
Type of Injury: Breathing difficulties due to inhaling of gas
Location of injury: Respiratory system
Type of Accident: Leakage and explosion of ammonia gas

Findings

Forensic investigation revealed that the accident was caused by one of the blast freezer units' pipelines used to freeze fresh raw poultry. The cooling process was disturbed by a solenoid safety valve failure which was supposed to stop excessive ammonia supply into the blast freezer, resulting in a ruptured explosion at the end of the ammonia outlet pipe due to the process disturbance. A thorough examination of the cooling system discovered that the reason behind the malfunction of the solenoid valve was caused by leakage of the rubber seal inside the valve body housing due to foreign oil particles found in the pipeline system. The system was equipped with a strainer filter to filter out any impurities trapped in the ammonia refrigerant, but it had failed to function properly as intended, affecting critical components such as the solenoid valve.

Cause of Accidents and Lesson Learnt

The accident clearly shows the failure of the owner and supplier in performing a proper maintenance program for the refrigerant system. Systematic maintenance procedures were not available for safe refrigerator handling to ensure the entire system operating without any risk. There was no checklist for the purpose of inspection on critical components that were provided during the investigation of the accident. The owner of the poultry plant was supposed to have a contract agreement with a competent third-party service provider on the periodic and comprehensive maintenance program so that any critical components could be inspected practically and adequately. The life cycle of any component requiring replacement should be specified in the inspection checklist so that it can be changed before the component's life exceeds the safe operating period.

CASE 02

Accident Case Involving Ammonia Gas Leaks from a Refrigeration System of an Ice Manufacturing Factory

About the Accident

An ammonia gas leak occurred at an ice manufacturing factory, as reported by a factory supervisor on 14th January, 2020, at around 1.00 am. Prompt action was taken by the factory owner to cease the freezer machine operation once they became aware of the hazardous event. The Fire and Rescue Department arrived at the premise at around 7.00 am after receiving a call from people living nearby the area who smelled high concentrations of uncomfortable gas. The dilution process of the ammonia gas was carried out by the Fire and Rescue Department until 11.30am.

The Department of Occupational Safety and Health (DOSH) conducted an investigation at the factory after being notified of the incident. The investigations revealed that the accident was caused by an ammonia gas leak in the freezer tower machine used for ice production. A notice of prohibition for the machinery involved was issued. No injuries were caused by the leak were reported.

Background

Type of Industry: Manufacturing (Production and supply of ice) / Small and medium industry
Work Process: Manufacturing of ice cubes
Work activities: Operation of ice cube refrigeration machine
Victims: None
Type of Injury: N/A
Location of injury: N/A
Type of Accident: Leakage of ammonia gas (dangerous occurrence)

Findings

Records show that the ice manufacturing plant has been operating since 2007. Two units of ice refrigerator systems each with a capacity of 100 tonnes and 30 tonnes respectively (for mass ice cube production) have been installed and were operating in the factory. The one involved with the accident was the 100-tonne machine. Each refrigeration system has components that require design approval and certificates of fitness from DOSH such as ammonia receivers (2 units) and ice tube freezers (2 units) but the owner failed to register the machinery and illegally operated the machinery without any valid certificates of fitness (CF). None of the installation, maintenance and repair of the machinery was carried out by any Competent Firm registered with DOSH. Repair works were carried out on the leaking area (inner freezing tube) by the owner without any notification to DOSH. The machinery were operated without any safe operation procedures and documents such as P&ID diagrams and emergency response plans which were supposed to be developed by the owner for proper safe handling were not available. To make it worse, there were no gas sensors to detect the presence of ammonia in the work area and its surroundings to alert workers. Furthermore, adjacent to the production building were hostels to accommodate the workers. The owner also failed to carry out mandatory chemical risk health assessments.

Cause of Accidents and Lesson Learnt

The leak was found to occur from one of the inner tubes used for the ice formation process (an ice-producing tube) based on a leakage test conducted by the supplier of the refrigeration system. Leakage testing (using foam test) was conducted by pumping in nitrogen gas into the freezer shell body (surrounding the inner tubes) and observing the bubbles of the leaking gas. The identified leak area was an inner tube with plugged ends on both top and bottom ends by welding (previous repair works). However, the owner had failed to provide any records on the repair works except for some work-in progress. It was conducted by a non-competent service provider that was not registered with DOSH. Any repair works are supposed to be notified to DOSH and approval should be received upon repair of any certificated machinery. Any person who intends to operate unfired pressure vessels are supposed to register their machinery by applying for design approval and receive a certificate of fitness from DOSH to ensure the machinery were safely constructed as per design without posing any risks of harm to anyone, especially to their workers. Risk assessment should be conducted as a proactive measure to prevent any unnecessary dangerous occurrences. Emergency response plans and risk assessments can reduce the of serious injury to the workers.

Appendix 2

EXAMPLE OF ANHYDROUS AMMONIA SAFETY DATA SHEET

Making our world more productive

SAFETY DATA SHEET
Ammonia, anhydrous

Issue Date:	16.01.2013	Version: 2.0	SDS No.: 000010021772
Last revised date:	21.07.2020		1/121

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Product name: Ammonia, anhydrous

Trade name: Ammoniak 4.5, Gasart 462 Ammoniak 3.8, Gasart 463 Ammoniak 5.0, Gasart 489 Ammoniak 6.0, Gasart 515 Ammoniak technisch rein

Additional identification

Chemical name:	Ammonia, anhydrous
Chemical formula:	NH3
INDEX No.	007-001-00-5
CAS-No.	7664-41-7
EC No.	231-635-3
REACH Registration No.	01-2119488876-14

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses: Industrial and professional. Perform risk assessment prior to use. Casting operations Explosives manufacture & use Freezing, chilling, and packaging of foodstuffs. Manufacturing of fertilisers and nitric acid. Production of plastics. Refrigerant. Use for electronic component manufacture. Use of gas to manufacture pharmaceutical products. Using gas alone or in mixtures for the calibration of analysis equipment. Using gas as feedstock in chemical processes. Using gas for metal treatment. Washing of textiles or metal parts Water treatment. Use in laboratories Formulation of mixtures with gas in pressure receptacles.

Uses advised against Consumer use.

1.3 Details of the supplier of the safety data sheet

Supplier

ABC SDN. BHD.
123, JALAN 3/56,
JALAN PUTRA
KUALA LUMPUR.

Telephone: +603-2012 3456

E-mail: abc.sdnbhd@sample.com

1.4 Emergency telephone number: Emergency number +603-2012 3456 (during business hours), Poisoning Information Center: +603-2012 3456

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

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Classification according to Regulation (EC) No 1272/2008 as amended.

Physical Hazards		
Flammable gas	Category 2	H221: Flammable gas.
Gases under pressure	Liquefied gas	H280: Contains gas under pressure; may explode if heated.
Health Hazards		
Acute toxicity (Inhalation - gas)	Category 3	H331: Toxic if inhaled.
Skin corrosion	Category 1B	H314: Causes severe skin burns and eye damage.
Serious eye damage	Category 1	H318: Causes serious eye damage.
Environmental Hazards		
Acute hazards to the aquatic environment	Category 1	H400: Very toxic to aquatic life.
Chronic hazards to the aquatic environment	Category 2	H411: Toxic to aquatic life with long lasting effects.

2.2 Label Elements

Contains: Ammonia, anhydrous

Signal Word: Danger

Hazard Statement(s):
H221: Flammable gas.
H280: Contains gas under pressure; may explode if heated.
H331: Toxic if inhaled.
H314: Causes severe skin burns and eye damage.
H410: Very toxic to aquatic life with long lasting effects.

Precautionary Statements
General None.

Prevention:
P210: Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P260: Do not breathe gas/vapors.
P273: Avoid release to the environment.

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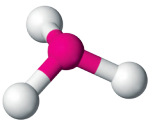

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	P280: Wear protective gloves/protective clothing/eye protection/face protection.
Response:	P303+P361+P353+P315: IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower. Get immediate medical advice/attention. P304+P340+P315: IF INHALED: Remove person to fresh air and keep comfortable for breathing. Get immediate medical advice/attention. P305+P351+P338+P315: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice/attention. P377: Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P381: In case of leakage, eliminate all ignition sources.
Storage:	P403: Store in a well-ventilated place. P405: Store locked up.
Disposal	None.
Supplemental information	EUH071: Corrosive to the respiratory tract.
2.3 Other hazards	Contact with evaporating liquid may cause frostbite or freezing of skin.

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SECTION 3: Composition/information on ingredients

3.1 Substances

Chemical name	Ammonia, anhydrous
INDEX No.:	007-001-00-5
CAS-No.:	7664-41-7
EC No.:	231-635-3
REACH Registration No.:	01-2119488876-14
Purity:	100% The purity of the substance in this section is used for classification only, and does not represent the actual purity of the substance as supplied, for which other documentation should be consulted.
Trade name:	Ammoniak 4.5, Gasart 462 Ammoniak 3.8, Gasart 463 Ammoniak 5.0, Gasart 489 Ammoniak 6.0, Gasart 515 Ammoniak technisch rein

Chemical name	Chemical formula	Concentration	CAS-No.	REACH Registration No.	M-Factor:	Notes
Ammonia, anhydrous	NH3	100%	7664-41-7	01-2119488876-14	Aquatic Toxicity (Acute): 1	#

The concentrations of the components in the SDS header, product name on page one and in section 3.2 are in mol due to regulatory requirements. All concentrations are nominal.
This substance has workplace exposure limit(s).
PBT: persistent, bioaccumulative and toxic substance.
vPvB: very persistent and very bioaccumulative substance.

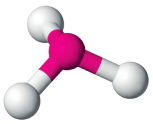
SECTION 4: First aid measures

General: Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.

4.1 Description of first aid measures

Inhalation: Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.

Eye contact: Rinse the eye with water immediately. Remove contact lenses, if present and easy to do. Continue rinsing. Flush thoroughly with water for at least 15 minutes. Get immediate medical assistance. If medical assistance is not immediately available, flush an additional 15 minutes.



Skin Contact:	Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Contact with evaporating liquid may cause frostbite or freezing of skin.
Ingestion:	Ingestion is not considered a potential route of exposure.
4.2 Most important symptoms and effects, both acute and delayed:	Causes severe skin burns and eye damage. Contact with liquefied gas can cause damage (frostbite) due to rapid evaporative cooling. May be fatal if inhaled.

4.3 Indication of any immediate medical attention and special treatment needed

Hazards:	Causes severe skin burns and eye damage. Contact with liquefied gas can cause damage (frostbite) due to rapid evaporative cooling. May be fatal if inhaled.
Treatment:	Thaw frosted parts with lukewarm water. Do not rub affected area. Get immediate medical advice/attention. Treat with a corticosteroid spray as soon as possible after inhalation.

SECTION 5: Firefighting measures

General Fire Hazards:	Heat may cause the containers to explode.

5.1 Extinguishing media

Suitable extinguishing media:	Use water spray to reduce vapors or divert vapor cloud drift. Water Spray or Fog. Dry powder. Foam.
Unsuitable extinguishing media:	Carbon Dioxide. Do not use water jet, as this may cause corrosive liquid to splash.
5.2 Special hazards arising from the substance or mixture:	Fire or excessive heat may produce hazardous decomposition products.
Hazardous Combustion Products:	If involved in a fire the following toxic and/or corrosive fumes may be produced by thermal decomposition: Nitrogen monoxide ; Nitrogen dioxide

5.3 Advice for firefighters

Special fire fighting procedures:	In case of fire: Stop leak if safe to do so. Use of water may result in the formation of very toxic aqueous solutions. Keep run-off water out of sewers and water sources. Dike for water control. Continue water spray from protected position until container stays cool. Use extinguishants to contain the fire. Isolate the source of the fire or let it burn out.

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Special protective equipment for fire-fighters:	Gas tight chemically protective clothing (Type 1) in combination with self contained breathing apparatus. Guideline: EN 943-2 Protective clothing against liquid and gaseous chemicals, aerosols and solid particles. Performance requirements for gas-tight (Type 1) chemical protective suits for emergency teams (ET)

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures:	Evacuate area. Provide adequate ventilation. Consider the risk of potentially explosive atmospheres . In case of leakage, eliminate all ignition sources. Monitor the concentration of the released product. Prevent from entering sewers, basements and workpits, or any place where its accumulation can be dangerous. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. EN 137 Respiratory protective devices - Self-contained open-circuit compressed air breathing apparatus with full face mask - Requirements, testing, marking.
6.2 Environmental Precautions:	Prevent further leakage or spillage if safe to do so. Reduce vapour with fog or fine water spray. Keep run-off water out of sewers and water sources. Dike for water control.
6.3 Methods and material for containment and cleaning up:	Provide adequate ventilation. Eliminate sources of ignition. Wash contaminated equipment or sites of leaks with copious quantities of water.
6.4 Reference to other sections:	Refer to sections 8 and 13.

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SECTION 7: Handling and storage:

7.1 Precautions for safe handling:

Only experienced and properly instructed persons should handle gases under pressure. Avoid exposure - obtain special instructions before use. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Purge system with dry inert gas (e.g. helium or nitrogen) before gas is introduced and when system is placed out of service. Purge air from system before introducing gas. Containers, which contain or have contained flammable or explosive substances, must not be inerted with liquid carbon dioxide. Assess the risk of a potentially explosive atmosphere and the need for suitable equipment i.e. explosion-proof. Take precautionary measures against static discharges. Keep away from ignition sources (including static discharges). Provide electrical earthing of equipment and electrical equipment usable in explosive atmospheres. Use non-sparking tools. Installation of a cross purge assembly between the container and the regulator is recommended. Excess pressure must be vented through an appropriate scrubber system. Refer to supplier's handling instructions. The substance must be handled in accordance with good industrial hygiene and safety procedures. Ensure the complete system has been (or is regularly) checked for leaks before use. Protect containers from physical damage; do not drag, roll, slide or drop. Do not remove or deface labels provided by the supplier for the identification of the container contents. When moving containers, even for short distances, use appropriate equipment eg. trolley, hand truck, fork truck etc. Secure cylinders in an upright position at all times, close all valves when not in use. Provide adequate ventilation. Suck back of water into the container must be prevented. Do not allow backfeed into the container. Avoid suckback of water, acid and alkalis. Keep container below 50°C in a well ventilated place. Observe all regulations and local requirements regarding storage of containers. When using do not eat, drink or smoke. Store in accordance with local/regional/national/international regulations. Never use direct flame or electrical heating devices to raise the pressure of a container. Leave valve protection caps in place until the container has been secured against either a wall or bench or placed in a container stand and is ready for use. Damaged valves should be reported immediately to the supplier Close container valve after each use and when empty, even if still connected to equipment. Never attempt to repair or modify container valves or safety relief devices. Replace valve outlet caps or plugs and container caps where supplied as soon as container is disconnected from equipment. Keep container valve outlets clean and free from contaminates particularly oil and water. If user experiences any difficulty operating container valve discontinue use and contact supplier. Never attempt to transfer gases from one container to another. Container valve guards or caps should be in place.

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7.2 Conditions for safe storage, including any incompatibilities: All electrical equipment in the storage areas should be compatible with the risk of a potentially explosive atmosphere. Segregate from oxidant gases and other oxidants being stored. Containers should not be stored in conditions likely to encourage corrosion. Stored containers should be periodically checked for general conditions and leakage. Keep away from food, drink and animal feeding stuffs. Container valve guards or caps should be in place. Store containers in location free from fire risk and away from sources of heat and ignition. Keep away from combustible material.

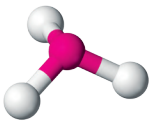
7.3 Specific end use(s): None.

SECTION 8: Exposure controls/personal protection

8.1 Control Parameters

Occupational Exposure Limits

Chemical name	Type	Exposure Limit Values	Source
Ammonia, anhydrous	TWA	20 ppm 14 mg/m3	EU. Indicative Exposure Limit Values in Directives 91/322/EEC, 2000/39/EC, 2006/15/EC, 2009/161/EU, 2017/164/EU (12 2009)
	STEL	50 ppm 36 mg/m3	EU. Indicative Exposure Limit Values in Directives 91/322/EEC, 2000/39/EC, 2006/15/EC, 2009/161/EU, 2017/164/EU (12 2009)
	MAK STEL	50 ppm 36 mg/m3	Austria. MAK List OEL Ordinance (GKV), as ammended (09 2018)
	MAK	20 ppm 14 mg/m3	Austria. MAK List OEL Ordinance (GKV), as ammended (09 2018)



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DNEL-Values

Critical component	Type	Value	Remarks
Ammonia, anhydrous	Workers - Inhalation, Local, short-term	36 mg/m3	respiratory tract irritation
	Workers - Inhalation, Local, long-term	14 mg/m3	respiratory tract irritation
	Workers - Inhalation, Systemic, short-term	47,6 mg/m3	Repeated dose toxicity
	Workers - Inhalation, Systemic, long-term	47,6 mg/m3	Repeated dose toxicity
	Workers - Dermal, Systemic, long-term	6,8 mg/kg bw/day	Repeated dose toxicity
	Workers - Eyes, Local effect		High hazard (no threshold derived)
	Workers - Dermal, Systemic, short-term	6,8 mg/kg bw/day	Repeated dose toxicity

PNEC-Values

Critical component	Type	Value	Remarks
Ammonia, anhydrous	Aquatic (freshwater)	0,001 mg/l	-
Ammonia, anhydrous	Aquatic (marine water)	0,001 mg/l	-

8.2 Exposure controls

Appropriate engineering controls: Consider a work permit system e.g. for maintenance activities. Ensure adequate air ventilation. Provide adequate general and local exhaust ventilation. Keep concentrations well below occupational exposure limits. Gas detectors should be used when toxic quantities may be released. Gas detectors should be used when quantities of flammable gases or vapours may be released. Systems under pressure should be regularly checked for leakages. Product to be handled in a closed system and under strictly controlled conditions. Only use permanent leak tight installations (e.g. welded pipes). Take precautionary measures against static discharges. Do not eat, drink or smoke when using the product.

Individual protection measures, such as personal protective equipment

General information: A risk assessment should be conducted and documented in each work area to assess the risks related to the use of the product and to select the PPE that matches the relevant risk. The following recommendations should be considered. Keep self contained breathing apparatus readily available for emergency use. Personal protective equipment for the body should be selected based on the task being performed and the risks involved. Protect eyes, face and skin from contact with product. Refer to local regulations for restriction of emissions to the atmosphere. See section 13 for specific methods for waste gas treatment.

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Eye/face protection:	Safety eyewear, goggles or face-shield to EN166 should be used to avoid exposure to liquid splashes. Wear eye protection to EN 166 when using gases. Guideline: EN 166 Personal Eye Protection.
Skin protection **Hand Protection:**	Guideline: EN 388 Protective gloves against mechanical risks. Additional Information: Wear working gloves while handling containers Material: Chloroprene rubber. Break-through time: 30 min Glove thickness: 0,5 mm Guideline: EN 374-1/2/3 Protective gloves against chemicals and micro-organisms. Additional Information: Chemically resistant gloves complying with EN 374 should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Material: Butyl rubber. Break-through time: 480 min Glove thickness: 0,7 mm Guideline: EN 374-1/2/3 Protective gloves against chemicals and micro-organisms. Additional Information: Chemically resistant gloves complying with EN 374 should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
Body protection:	Wear fire resistant or flame retardant clothing. Keep suitable chemically resistant protective clothing readily available for emergency use. Guideline: ISO/TR 2801:2007 Clothing for protection against heat and flame -- General recommendations for selection, care and use of protective clothing.Guideline: EN 943 Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles.
Other:	Wear safety shoes while handling containers Guideline: ISO 20345 Personal protective equipment - Safety footwear.
Respiratory Protection:	Reference should be made to European Standard EN 689 for methods for the assessment of exposure by inhalation to chemical agents and national guidance documents for methods for the determination of hazardous substances. The selection of the Respiratory Protective Device (RPD) must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected RPD. Material: Filter K Guideline: EN 14387 Respiratory protective devices. Gas filter(s) and combined filter(s). Requirements, testing, marking. Guideline: EN 136 Respiratory protective devices. Full face masks. Requirements, testing, marking.

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Thermal hazards:	No precautionary measures are necessary.
Hygiene measures:	Obtain special instructions before use. Specific risk management measures are not required beyond good industrial hygiene and safety procedures. Do not eat, drink or smoke when using the product.
Environmental exposure controls:	For waste disposal, see section 13 of the SDS.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance	
Physical state:	Gas
Form:	Liquefied gas
Color:	Colorless
Odor:	Pungent suffocating odor
Odor Threshold:	Odor threshold is subjective and is inadequate to warn of over exposure.
pH:	If dissolved in water pH-value will be affected.
Melting Point:	-77,7 °C Experimental result, Key study
Boiling Point:	-33 °C
Sublimation Point:	Not applicable.
Critical Temp. (°C):	132,0 °C
Flash Point:	Not applicable to gases and gas mixtures.
Evaporation Rate:	Not applicable to gases and gas mixtures.
Flammability (solid, gas):	Flammable Gas
Flammability Limit - Upper (%):	33,6 %(V) Experimental result, Key study
Flammability Limit - Lower (%):	15,4 %(V)
Vapor pressure:	8,5737 bar (20 °C) Experimental result, Key study
Vapor density (air=1):	0,59 AIR=1
Relative density:	0,8
Solubility(ies)	
Solubility in Water:	531 g/l (20 °C)
Partition coefficient (n-octanol/water):	< 1
Autoignition Temperature:	651 °C Experimental result, Key study
Decomposition Temperature:	> 450 °C
Viscosity	
Kinematic viscosity:	No data available.

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Dynamic viscosity:	0,7 mPa.s (48,9 °C)
Explosive properties:	Not applicable.
Oxidizing properties:	Not applicable.
9.2 Other information:	None.
Molecular weight:	17,03 g/mol (NH3)

SECTION 10: Stability and reactivity

10.1 Reactivity:	No reactivity hazard other than the effects described in sub-section below.
10.2 Chemical Stability:	Stable under normal conditions.
10.3 Possibility of hazardous reactions:	Can form a potentially explosive atmosphere in air. May react violently with oxidants.
10.4 Conditions to avoid:	Avoid moisture in the installation. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
10.5 Incompatible Materials:	Air and oxidizers. Moisture. For material compatibility see latest version of ISO-11114. Reacts with water to form corrosive alkalis. May react violently with acids.
10.6 Hazardous Decomposition Products:	Under normal conditions of storage and use, hazardous decomposition products should not be produced. If involved in a fire the following toxic and/or corrosive fumes may be produced by thermal decomposition: The following decomposition products may be produced: Nitrogen monoxide ; Nitrogen dioxide

SECTION 11: Toxicological information

General information:	Inhalation of large amounts leads to bronchospasm, laryngeal oedema and pseudomembrane formation.

11.1 Information on toxicological effects

Acute toxicity - Oral Product	Based on available data, the classification criteria are not met.
Ammonia, anhydrous	LD 50 (Rat): 350 mg/kg Remarks: Experimental result, Key study

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Acute toxicity - Dermal
Product — Based on available data, the classification criteria are not met.

Acute toxicity - Inhalation
Product — Toxic if inhaled.

Ammonia, anhydrous — LC 50 (Rat, 4 h): 2000 ppm

Repeated dose toxicity
Ammonia, anhydrous — NOAEL (Rat(Female, Male), Oral, 28 - 53 d): 250 mg/kg Oral Read-across from supporting substance (structural analogue or surrogate), Key study
LOAEL (Rat, Inhalation, 35 - 75 d): 175 mg/m3 Inhalation Experimental result, Weight of Evidence study

Skin Corrosion/Irritation
Product — Causes severe burns.

Serious Eye Damage/Eye Irritation
Product — Causes serious eye damage.

Respiratory or Skin Sensitization
Product — Based on available data, the classification criteria are not met.

Germ Cell Mutagenicity
Product — Based on available data, the classification criteria are not met.

Carcinogenicity
Product — Based on available data, the classification criteria are not met.

Reproductive toxicity
Product — Based on available data, the classification criteria are not met.

Specific Target Organ Toxicity - Single Exposure
Product — Based on available data, the classification criteria are not met.

Specific Target Organ Toxicity - Repeated Exposure
Product — Based on available data, the classification criteria are not met.

Aspiration Hazard
Product — Not applicable to gases and gas mixtures..

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SECTION 12: Ecological information

General information: Avoid release to the environment. Product is not allowed to be discharged into ground water or the aquatic environment.

12.1 Toxicity

Acute toxicity
Product Very toxic to aquatic life with long lasting effects.

Acute toxicity - Fish
Ammonia, anhydrous — LC 50 (Pimephales promelas, 96 h): 0,75 - 3,4 mg/l (flow-through) Remarks: Read-across from supporting substance (structural analogue or surrogate), Key study

Acute toxicity - Aquatic Invertebrates
Ammonia, anhydrous — LC 50 (48 h): 101 mg/l Remarks: Experimental result, Key study

Toxicity to microorganisms
Ammonia, anhydrous — Depending on local conditions and existing concentrations, disturbances in the biodegradation process of activated sludge are possible.

Toxicity to terrestrial organisms
Ammonia, anhydrous — Study not necessary due to exposure considerations.

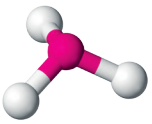
Chronic Toxicity - Fish
Ammonia, anhydrous — LOEC (Fish, 73 Days): 0,022 mg/l

Chronic Toxicity - Aquatic Invertebrates
Ammonia, anhydrous — LC 50 (Daphnia magna, 96 h): 4,07 mg/l (flow-through) Read-across from supporting substance (structural analogue or surrogate), Key study

Toxicity to Aquatic Plants
Ammonia, anhydrous — LC 50 (Algae, algal mat (Algae), 18 Days): 2.700 mg/l

12.2 Persistence and Degradability

Product Not applicable to gases and gas mixtures..



Biodegradation

Inorganic The product is not readily biodegradable.

12.3 Bioaccumulative potential
Product

The substance has no potential for bioaccumulation.

12.4 Mobility in soil
Product

The substance has low mobility in soil.

12.5 Results of PBT and vPvB assessment
Product

Not classified as PBT or vPvB.

12.6 Other adverse effects:

Other Ecological Information

May cause pH changes in aqueous ecological systems. Depending on local conditions and existing concentrations, disturbances in the biodegradation process of activated sludge are possible.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

General information:

Must not be discharged to atmosphere. Consult supplier for specific recommendations.

Disposal methods:

Refer to the EIGA code of practice (Doc.30 "Disposal of Gases", downloadable at http://www.eiga.org) for more guidance on suitable disposal methods. Dispose of container via supplier only. Discharge, treatment, or disposal may be subject to national, state, or local laws. Toxic and corrosive gases formed during combustion should be scrubbed before discharge to atmosphere. Gas may be scrubbed in water. Gas may be scrubbed in sulphuric acid solution.

European Waste Codes
Container:

16 05 04*: Gases in pressure containers (including halons) containing dangerous substances.

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SECTION 14: Transport information

ADR

14.1 UN Number:	UN 1005
14.2 UN Proper Shipping Name:	AMMONIA, ANHYDROUS
14.3 Transport Hazard Class(es)	
Class:	2
Label(s):	2.3, 8
Hazard No. (ADR):	268
Tunnel restriction code:	(C/D)
14.4 Packing Group:	–
14.5 Environmental hazards:	Environmentally Hazardous
14.6 Special precautions for user:	–

RID

14.1 UN Number:	UN 1005
14.2 UN Proper Shipping Name	AMMONIA, ANHYDROUS
14.3 Transport Hazard Class(es)	
Class:	2
Label(s):	2.3, 8
14.4 Packing Group:	–
14.5 Environmental hazards:	Environmentally Hazardous
14.6 Special precautions for user:	–

IMDG

14.1 UN Number:	UN 1005
14.2 UN Proper Shipping Name:	AMMONIA, ANHYDROUS
14.3 Transport Hazard Class(es)	
Class:	2.3
Label(s):	2.3, 8
EmS No.:	F-C, S-U
14.4 Packing Group:	–
14.5 Environmental hazards:	Marine Pollutant
14.6 Special precautions for user:	–

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IATA

14.1 UN Number: UN 1005
14.2 Proper Shipping Name: Ammonia, anhydrous
14.3 Transport Hazard Class(es):
Class: 2.3
Label(s): –
14.4 Packing Group: –
14.5 Environmental hazards: Environmentally Hazardous
14.6 Special precautions for user: –
Other information
Passenger and cargo aircraft: Forbidden.
Cargo aircraft only: Forbidden.

14.7 Transport in bulk according to Annex II of MARPOL and the IBC Code: Not applicable

Additional identification: Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers ensure that they are firmly secured. Ensure that the container valve is closed and not leaking. Container valve guards or caps should be in place. Ensure adequate air ventilation.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture:

EU Regulations

EU. Directive 2012/18/EU (SEVESO III) on major accident hazards involving dangerous substances, as amended.:

Chemical	CAS-No.	Lower-tier Requirements	Upper-tier Requirements
Ammonia, anhydrous	7664-41-7	50 t	200 t

Directive 98/24/EC on the protection of workers from the risks related to chemical agents at work:

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Chemical name	CAS-No.	Concentration
Ammonia, anhydrous	7664-41-7	100%

National Regulations

Council Directive 89/391/EEC on the introduction of measures to encourage improvements in the safety and health of workers at work Directive 89/686/EEC on personal protective equipment Directive 2014/34/EU on equipment and protective systems intended for use in potentially explosive atmospheres (ATEX) Only products that comply with the food regulations (EC) No. 1333/2008 and (EU) No. 231/2012 and are labelled as such may be used as food additives.
This Safety Data Sheet has been produced to comply with Regulation (EU) 2015/830.

15.2 Chemical safety assessment: Chemical Safety Assessment has been carried out.

SECTION 16: Other information

Revision Information: Not relevant.

Key literature references and sources for data: Various sources of data have been used in the compilation of this SDS, they include but are not exclusive to:
Agency for Toxic Substances and Diseases Registry (ATSDR) (http://www.atsdr.cdc.gov/).
European Chemical Agency: Guidance on the Compilation of Safety Data Sheets.
European Chemical Agency: Information on Registered Substances http://apps.echa.europa.eu/registered/registered-sub.aspx#search
European Industrial Gases Association (EIGA) Doc. 169 "Classification and Labelling guide", as amended.
International Programme on Chemical Safety (http://www.inchem.org/)
ISO 10156:2010 Gases and gas mixtures - Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets.
Matheson Gas Data Book, 7th Edition.
National Institute for Standards and Technology (NIST) Standard Reference Database Number 69.
The ESIS (European chemical Substances 5 Information System) platform of the former European Chemicals Bureau (ECB) ESIS (http://ecb.jrc.ec.europa.eu/esis/).
The European Chemical Industry Council (CEFIC) ERICards.
United States of America's National Library of Medicine's toxicology data network TOXNET (http://toxnet.nlm.nih.gov/index.html)
Threshold Limit Values (TLV) from the American Conference of Governmental Industrial Hygienists (ACGIH).
Substance specific information from suppliers.
Details given in this document are believed to be correct at the time of publication.

Making our world more productive

SAFETY DATA SHEET
Ammonia, anhydrous

Issue Date:	16.01.2013	Version: 2.0	SDS No.: 000010021772
Last revised date:	21.07.2020		19/121

Wording of the H-statements in section 2 and 3

H221	Flammable gas.
H280	Contains gas under pressure; may explode if heated.
H314	Causes severe skin burns and eye damage.
H318	Causes serious eye damage.
H331	Toxic if inhaled.
H400	Very toxic to aquatic life.
H411	Toxic to aquatic life with long lasting effects.

Training information: Users of breathing apparatus must be trained. Ensure operators understand the toxicity hazard.

Classification according to Regulation (EC) No 1272/2008 as amended.

Flam. Gas 2, H221
Press. Gas Liq. Gas, H280
Acute Tox. 3, H331
Skin Corr. 1B, H314
Eye Dam. 1, H318
Aquatic Acute 1, H400
Aquatic Chronic 2, H411

Other information: Before using this product in any new process or experiment, a thorough material compatibility and safety study should be carried out. Ensure adequate air ventilation. Ensure all national/local regulations are observed. Whilst proper care has been taken in the preparation of this document, no liability for injury or damage resulting from its use can be accepted.

Last revised date: 21.07.2020
Disclaimer: This information is provided without warranty. The information is believed to be correct. This information should be used to make an independent determination of the methods to safeguard workers and the environment.

SDS_AT - 000010021772

Appendix 3

EXAMPLE OF RISK ASSESMENT

Department	Production	**Risk Assessor**	**Shannon**
Process	Ice Packaging	**RM Team Member 1**	Kamal Abdul
Location	Production line	**RM Team Member 2**	Sanjit Kumar
Assesment Date	4 March 2020	**RM Team Member 3**	Ngeng Weng Yin
Last Assessment/ Review Date	N/A	**RM Team Member 4**	Fakrul

No.	**HAZARD IDENTIFICATION**								
	Work Activity	**Hazard**	**Category of Hazard**					**Event and Consequences**	**Existing Risk Control (if any)**
			Physical	**Chemical**	**Biological**	**Ergonomic**	**Psychosocial**		
1	Sticky Ice loosening process in chute drum using stick	Slippery Working Platform	X					Slip and fall from platform and may fall from height causing bodily injury	
		Awkward posture when handling stick to loosen hard sticky ice				X		Muscle stress and may cause back pain/ Multiskeletal disorder	
		High Working Platform	X					Slip and fall from platform during work process or climbing up the platform and may fall from height causing bodily injury,	
2	Filling of ice into plastic bag	Slippery production line	X					Slip and fall from platform and may fall on the floor causing minor bodily injury	
3	Topping up ammonia gas at receiver	Ammonia leak	X					Burning sensation to eyes and skin	Safe Working Procedures (SWP) Ensure hose is properly tightened before transfer of gas

Approved by		RA Reference No:	Shannon
Signature	_		Kamal Abdul
Name	Francis Kong		Sanjit Kumar
Designation	Production manager		Ngeng Weng Yin
Date	13/3/2020		Fakrul

RISK EVALUATION				RISK CONTROL	RISK RE-EVALUATION				REMARK
Justification of likelihood	Likelihood (L)	Severity (S)	RMN	Additional Risk Control	Likelihood (L)	Severity (S)	RMN	PIC (due date)	
No Past Accident Record. Have never been reported. Workers might be required to stand on the platform at each cycle of the production, for at least 20 minutes for each cycle (high frequency), small working platform and high exposure	5	4	20	Workers are provided with non-slippery safety boots and anti-slippery mat (PU) are installed on top of working platform surface. Continuous monitoring for any development of puddles of water must be cleaned up and included in SWP. Use worker rotation program.	2	4	8	Shamsul (7.3.2002)	
				Conduct initial ergonomic risk assessment. Any requirement for advance assessment must follow the Ergonomic guidelines				Shamsul (7.3.2020)	
	5	4	20	Redesign of chute drum using auto loosen components without the need of workers to be on the platform for the process (excluding ice monitoring process)	2	4	8	Badrul (30.5.2020)	The proposal requires reengineering of machine and cost benefit analysis must be conducted on practicality
No Past Accident Record. Have never been reported. Workers might be required to work in the cold production line for the whole day from 8.00 am to 5.00 pm	4	2	8	Workers are provided with non - slippery safety boots and anti - slippery mat (PU) are installed on top of working platform surface. Continuos development of monitor for any development of puddles of water must be cleaned up and include in SWP. Use worker rotation program.	3	2	6	Shamsul (7.3.2020)	
No Past Accident Record. Have never been reported. Workers required to follow the SWP	3	1	3	Workers are provided with mask. Wear when leak occurs. To tighten hose. Continuous monitoring and include in SWP.	2	1	2	Aqil to purchase (30/5/2020) . Mask and cartridges provided	

Appendix 4

EXAMPLE OF CALCULATION FOR AMMONIA QUANTITY IN REFRIGERATION SYSTEM

1. PREMISE A

If the owner has one (1) unit of an ammonia refrigeration system -

Line A :
Capacity of 100 tonnes ice/day
(using about four (4) tonnes of liquid ammonia)

Therefore, the calculation is as below;

Liquid Receiver	:	4000 kg
Freezer	:	25% x 4000kg
	:	1000 kg
Pipeline	:	1000 kg (same as freezer)
Total ammonia	:	4000 kg + 1000 kg + 1000 kg
	:	**6000 kg (6 tonnes)**
		(Not to comply (NTC) for CIMAH Reg. 1996)

2. PREMISE B

If the owner has two (2) units of ammonia refrigeration system

Line A :
Capacity of 100 tonnes ice/day
(using about four (4) tonnes of liquid Ammonia)

Therefore, the calculation is as below;

Liquid Receiver	:	4000 kg
Freezer	:	25% x 4000kg
	:	1000 kg
Pipeline	:	1000 kg (same as freezer)
Total ammonia	:	**4000 kg + 1000 kg + 1000 kg**
	:	**6000 kg (6 tonnes)**

So, total ammonia **Line A** + **Line B** :

Line A	Line B
6000 kg	1500 kg

7500 kg (7.5 tonnes)

(Not to comply (NTC) for CIMAH Reg. 1996)

If the owner has two (2) units of ammonia refrigeration system

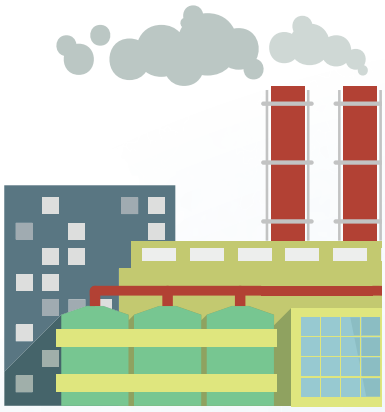
Line B :
Capacity of 40/50 tonnes ice/day
(using about one (1) tonne of liquid Ammonia)

Therefore, the calculation is as below;

Liquid Receiver	:	1000 kg
Freezer	:	25% x 1000kg
	:	250 kg
Pipeline	:	250 kg (same as freezer)
Total ammonia	:	**1000 kg + 250 kg + 250 kg**
	:	**1500 kg (1.5 tonnes)**

3. PREMISE C

If the owner has three (3) units of ammonia refrigeration system

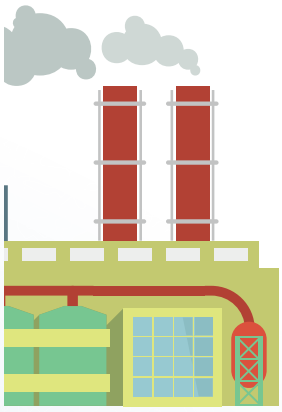


Line A :

Capacity of 100 tonnes ice/day
(using about four (4) tonnes of liquid ammonia)

Therefore, the calculation is as below;

Liquid Receiver	:	4000 kg
Freezer	:	25% x 4000kg
	:	1000 kg
Pipeline	:	1000 kg (same as freezer)
Total ammonia	:	4000 kg + 1000 kg + 1000 kg
	:	**6000 kg (6 tonnes)**



If the owner has three (3) units of ammonia refrigeration system

Line B :

Capacity of 40/50 tonnes ice/day
(using about one (1) tonne of liquid Ammonia)

Therefore, the calculation is as below;

Liquid Receiver	:	1000 kg
Freezer	:	25% x 1000kg
	:	250 kg
Pipeline	:	250 kg (same as freezer)
Total ammonia	:	1000 kg + 250 kg + 250 kg
	:	**1500 kg (1.5 tonnes)**

If the owner has three (3) units of ammonia refrigeration system

Line C :

Capacity of 150 tonnes ice/day
(using about six (6) tonnes of liquid ammonia)

Therefore, the calculation is as below;

Liquid Receiver	:	6000 kg
Freezer	:	25% x 6000kg
	:	1500 kg
Pipeline	:	1500 kg (same as freezer)
Total ammonia	:	6000 kg + 1500 kg + 1500 kg
	:	**9000 kg (9 tonnes)**

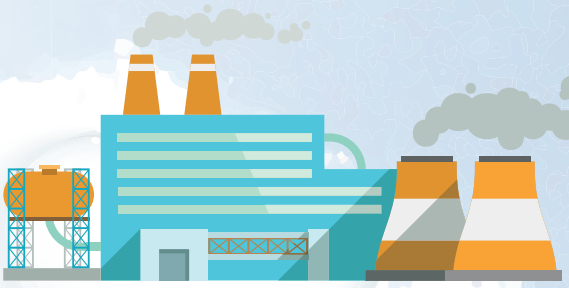
So, total ammonia **Plant A** + **Plant B** + **Plant C**:

Plant A	Plant B	Plant C
6000 kg	1500 kg	9000 kg

16,500 kg (16.50 tonnes)

NOTE: 10% X 100,000 kg = 10,000 kg @ 10 TONNES !!

Non Major Hazard Installation (NMHI) according to CIMAH Reg. 1996



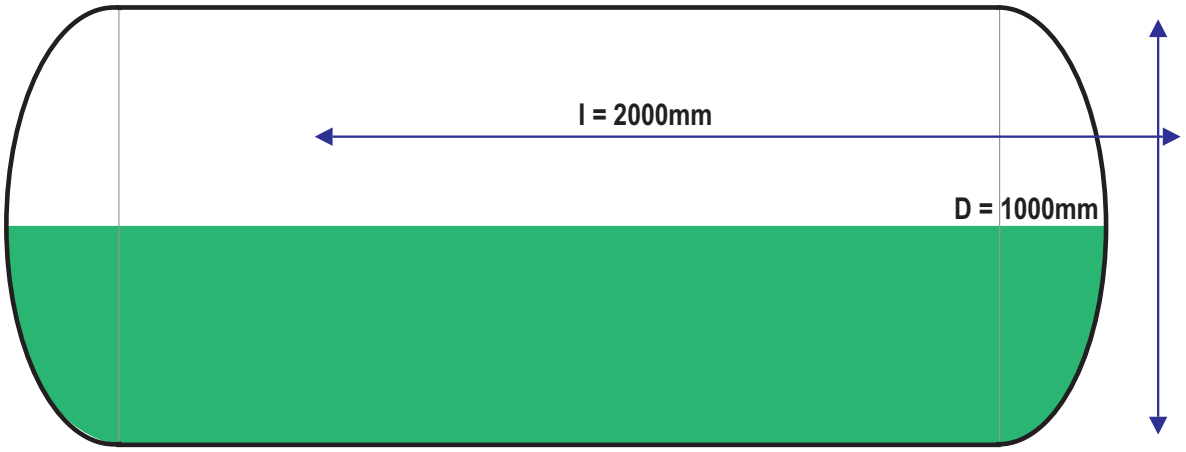
Calculation of total weight of refrigerant ammonia based on total volume of the ammonia refrigerant system

Determine volume of the pressure vessel

Example:

Total volume of pressure vessel = **volume of the shell** + **volume of head**

Volume of the shell $= \frac{\pi D^2}{4} \times l$

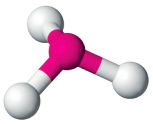


Where as

π = pie constant or 3.412

D = diameter of the shell

l = length shell circumferential weld to circumferential weld



Volume of head

Usually there are 2 common head used in construction of pressure vessel.

Elliptical head
Volume of elliptical head $= 0.13D^3$

Tori-spherical head
Volume of tori spherical head $= 0.1D^3$

Means:
Volume of the shell $= \frac{(3.142)1^2}{4} \times 2$

$= 1.571\ m^3$

Assume this pressure vessel use elliptical head so,
Volume of elliptical head $= 0.13(1)^3$

$= 0.13\ m^3$

Total volume of pressure vessel
$1.571\ m^3 + 0.13\ m^3 + 0.13\ m^3$ = **$1.831\ m^3$**

Volume of the pipe

Then we need to calculate volume of the pipe,

Volume of the pipe = $\frac{\pi D^2}{4}$ x pipe length

If we assume the diameter of the pipe is 2inch and the total pipe length is 40m

Therefore, we can assume the total volume of the pipe is

Total volume of the pipe $= \frac{\pi(0.058)^2}{4} \times 40m$

$= 0.105\ m^3$

So, the total maximum quantity of ammonia refrigerant can be calculated as below

Total Volume Ammonia refrigerant system =

Total volume pressure vessel **$1.831\ m^3$** + **Total volume of pipe** **$0.105\ m^3$** = **$1.936\ m^3$**

Note: **$1m^3$** refrigerant ammonia weight **682.6 kg**

Therefore, total weight of refrigerant ammonia in pressure vessel and the pipe is;

$= 1.936\ m^3$ x **682.6 kg**

= 1321.51 kg

Most ammonia refrigerant system has at least 4 types of pressure vessels. Therefore, the total volume of the system must consider all the volume of the pressure vessels. The volume of the pressure vessels could be referred to the pressure vessel design drawings.

Appendix 5

EXAMPLE OF ANHYDROUS AMMONIA CLASSIFICATION FROM INTERNATIONAL LABOUR ORGANIZATION (ILO) AND WORLD HEALTH ORGANIZATION (WHO)

AMMONIA (ANHYDROUS) R717 Refrigerant gas 717	**ICSC: 0414** **October 2013**
CAS #: 7664-41-7 **UN #: 1005** **EC Number: 231-635-3**	

	ACUTE HAZARDS	PREVENTION	FIRE FIGHTING
FIRE & EXPLOSION	Flammable. Cylinder may explode in heat of fire. Gas/air mixtures are explosive.	NO open flames, NO sparks and NO smoking. Closed system, ventilation, explosion-proof electrical equipment and lighting.	In case of fire in the surroundings, use appropriate extinguishing media. In case of fire: keep cylinder cool by spraying with water.

AVOID ALL CONTACT! IN ALL CASES CONSULT A DOCTOR!			
	SYMPTOMS	**PREVENTION**	**FIRST AID**
Inhalation	Burning sensation. Cough. Laboured breathing. Shortness of breath. Sore throat.	Use ventilation, local exhaust or breathing protection.	Fresh air, rest. Half-upright position. Administration of oxygen may be needed. Refer immediately for medical attention.
Skin	Redness. Pain. Blisters. Skin burns. ON CONTACT WITH LIQUID: FROSTBITE.	Cold-insulating gloves. Protective clothing.	Rinse skin with plenty of water or shower for at least 15 minutes. ON FROSTBITE: rinse with plenty of water, do NOT remove clothes. Refer immediately for medical attention .
Eyes	Redness. Pain. Severe burns. ON CONTACT WITH LIQUID: FROSTBITE.	Wear face shield or eye protection in combination with breathing protection.	Rinse with plenty of water for several minutes (remove contact lenses if easily possible). Refer immediately for medical attention.
Ingestion			

SPILLAGE DISPOSAL	**CLASSIFICATION & LABELLING**
Evacuate danger area! Consult an expert! Personal protection: gas-tight chemical protection suit including self-contained breathing apparatus. Ventilation. Shut off cylinder if possible. Isolate the area until the gas has dispersed. Remove gas with fine water spray. NEVER direct water jet on liquid.	**According to UN GHS Criteria**  **DANGER** Flammable gas Contains gas under pressure; may explode if heated Toxic if inhaled Causes severe skin burns and eye damage Very toxic to aquatic life **Transportation** **UN Classification** UN Hazard Class: 2.3; UN Subsidiary Risks: 8
STORAGE	
Fireproof. Separated from oxidants, acids and halogens. Cool. Keep in a well-ventilated room.	
PACKAGING	

Prepared by an international group of experts on behalf of ILO and WHO, with the financial assistance of the European Commission.

AMMONIA (ANHYDROUS) **ICSC: 0414**

PHYSICAL & CHEMICAL INFORMATION

Physical State; Appearance
COLOURLESS GAS OR COMPRESSED LIQUEFIED GAS WITH PUNGENT ODOUR.

Physical dangers
The gas is lighter than air.

Chemical dangers
Mixtures with mercury, silver and gold oxides are shock-sensitive. The substance is a strong base. It reacts violently with acid and is corrosive. Reacts violently with strong oxidants, halogens and many other substances. Attacks copper, aluminium, zinc and their alloys. Dissolves in water evolving heat. The substance reacts with most organic and inorganic compounds, causing fire and explosion hazard.

Formula: NH_3
Molecular mass: 17.0
Boiling point: -33°C
Melting point: -78°C
Relative density (water = 1): 0.7 (-33°C)
Solubility in water, g/100ml at 20°C: 54
Vapour pressure, kPa at 26°C: 1013
Relative vapour density (air = 1): 0.60
Auto-ignition temperature: 630°C
Explosive limits, vol% in air: 15-33.6

EXPOSURE & HEALTH EFFECTS

Routes of exposure
The substance can be absorbed into the body by inhalation.

Effects of short-term exposure
Rapid evaporation of the liquid may cause frostbite. The substance is corrosive to the eyes, skin and respiratory tract. Exposure could cause asphyxiation due to swelling in the throat. Inhalation may cause lung oedema, but only after initial corrosive effects on eyes and/or airways have become manifest.

Inhalation risk
A harmful concentration of this gas in the air will be reached very quickly on loss of containment.

Effects of long-term or repeated exposure
Repeated or chronic inhalation of the vapour may cause chronic inflammation of the upper respiratory tract. Lungs may be affected by repeated or prolongated exposure. This may result in chronic obstructive pulmonary disorders (COPD).

OCCUPATIONAL EXPOSURE LIMITS

TLV: 25 ppm as TWA; 35 ppm as STEL.
EU-OEL: 14 mg/m^3, 20 ppm as TWA; 36 mg/m^3, 50 ppm as STEL.
MAK: 14 mg/m^3, 20 ppm; peak limitation category: I(2); pregnancy risk group: C

ENVIRONMENT

The substance is very toxic to aquatic organisms. It is strongly advised not to let the chemical enter into the environment.

NOTES

Ammonia is normally supplied in compressed liquified form in cylinders.
See ICSC 0215.
Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.

ADDITIONAL INFORMATION

EC Classification
Symbol: T, N; R: 10-23-34-50; S: (1/2)-9-16-26-36/37/39-45-61; Note: U

Appendix 6

WORKED EXAMPLE OF PRESSURE DESIGN OF PIPE UNDER INTERNAL PRESSURE

Using ASME B31.5
Given, **P** = 2St/D
(Refer ASME B31.5, section 504.1.2)

- **P =** Internal design pressure, psi (kPa)
- **D =** outside diameter of pipe, in. (mm)
- **S =** applicable allowable hoop stress, psi (kPa)
- **t =** pressure design wall thickness in. (mm)

Example 1:
What is the maximum internal pressure when the pipe is made out of ASTM A106 Grade B, NPS 3, Sch 40 with design condition of 100˚F?

For NPS 3 SCH 40 pipe, the D, outside diameter is 3.5 in. (Refer API 574 Table 1) and t, wall thickness is 0.216 in. (Refer API 574 Table 1)

S is 17100psi (refer ASME B31.5 Table 502.3.1) at 100˚F

Hence, the maximum internal pipe pressure is 2 x 17100 x 0.216 / 3.5 = 2110.6 psi

Example 2:
Is the pipe made out of API 5L grade A, NPS 1 Sch 40 with design conditions of 100psi and 250˚F suitable to be used?

Rearrange the formula,

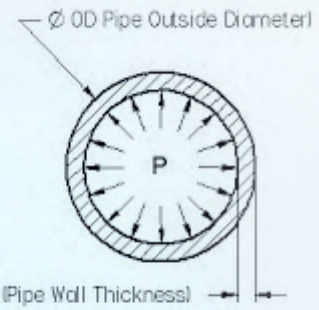
t^{min} = PD/2S

P = 100psi
D = 1.315 (Refer API 574 Table 1)
S = 13700 psi
(Refer ASME B31.5 Table 502.3.1)
The minimum thickness required is 100 x 1.315 /2 x 13700 = 0.0048 in.

Referring to API 574 Table 1, NPS 1 Sch 40 pipe will have a thickness of 0.133 in. > 0.0048in.

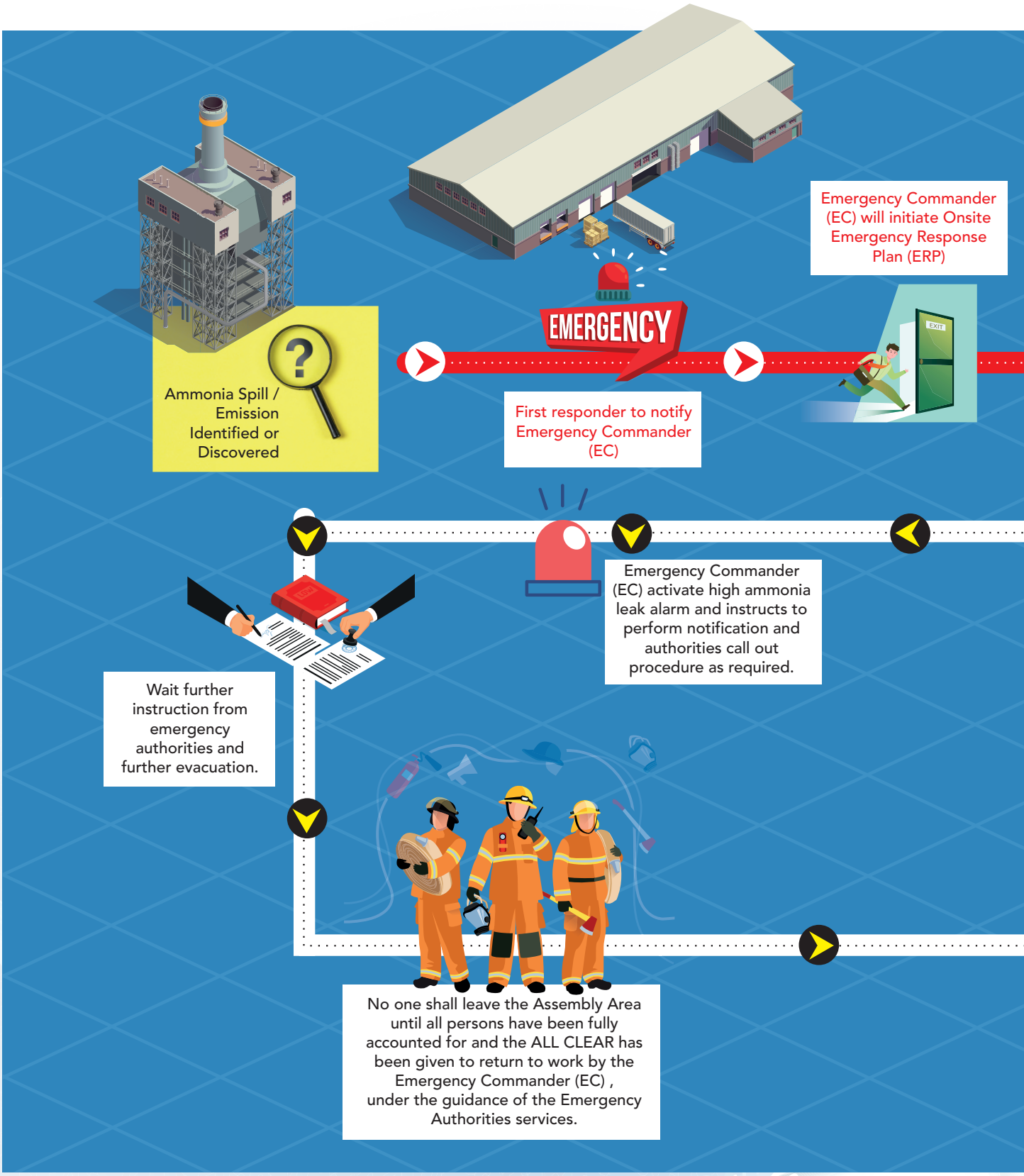
Hence, it is suitable to be used.

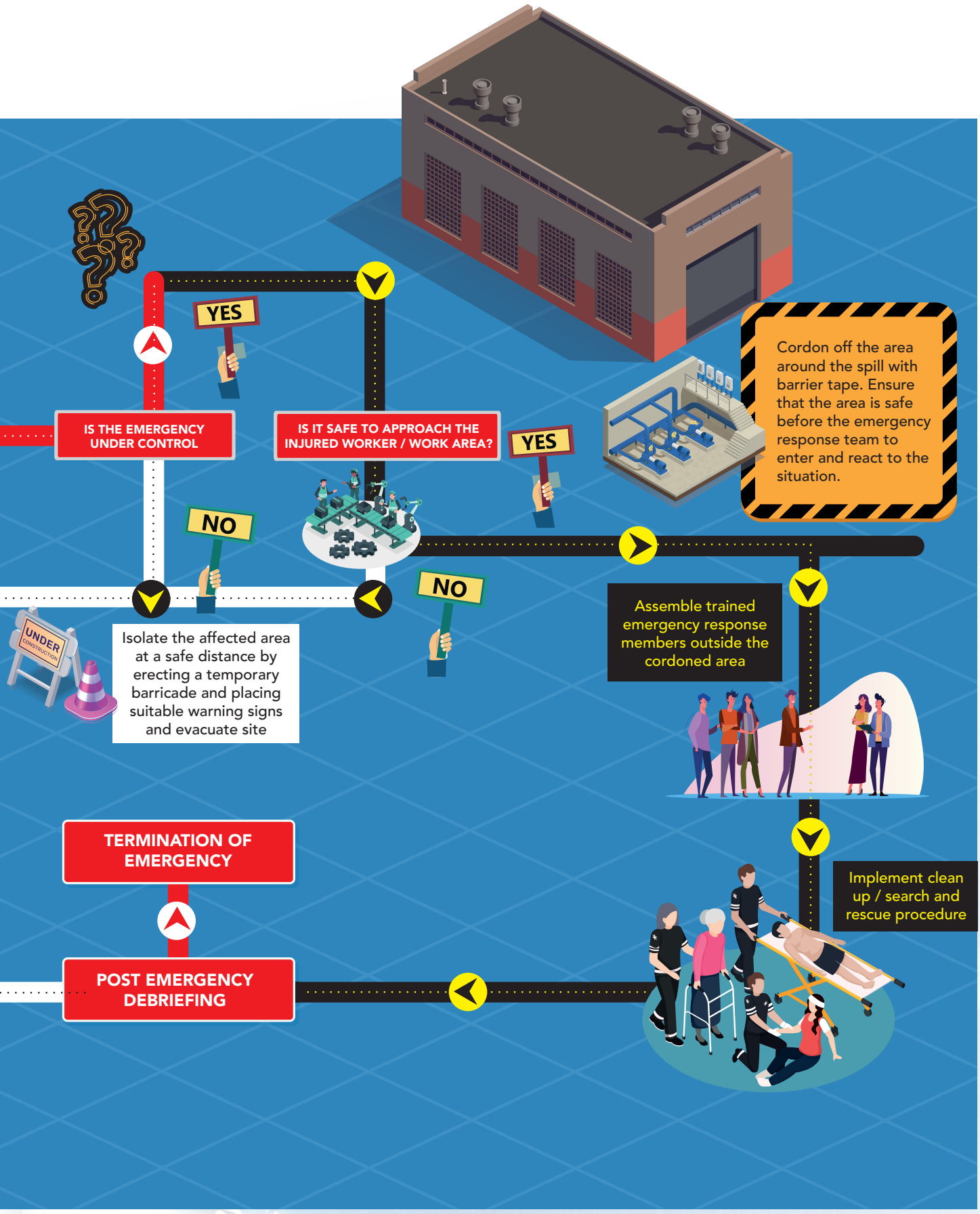
$$P = \frac{2St}{D} \quad \text{or} \quad t = \frac{PD}{2SE}$$



Appendix 7

AMMONIA EMERGENCY RESPONSE PLAN WORK FLOW




IS THE EMERGENCY UNDER CONTROL
YES
NO
IS IT SAFE TO APPROACH THE INJURED WORKER / WORK AREA?
YES
NO
Cordon off the area around the spill with barrier tape. Ensure that the area is safe before the emergency response team to enter and react to the situation.
Isolate the affected area at a safe distance by erecting a temporary barricade and placing suitable warning signs and evacuate site
Assemble trained emergency response members outside the cordoned area
Implement clean up / search and rescue procedure
TERMINATION OF EMERGENCY
POST EMERGENCY DEBRIEFING

Appendix 8

JABATAN KESELAMATAN DAN KESIHATAN PEKERJAAN MALAYSIA

SENARAI SEMAK
PENGURUSAN SELAMAT SISTEM PENYEJUK AMMONIA
CHECKLIST
ON SAFE MANAGEMENT OF AMMONIA REFRIGERATION SYSTEM

1.0 MAKLUMAT TEMPAT KERJA
DETAILS OF WORKPLACE

1.1	Nama Syarikat : *Name of company*
1.2	No. Pendaftaran JKKP : *DOSH Registration Number*
1.3	Alamat Syarikat : *Address of company*
1.4	No. Telefon : *Phone number*
1.5	Nama Pegawai yang Bertanggungjawab : *Name of Person In Charge*
1.6	Emel : *Email*
1.7	Jawatan : *Position*
1.8	Tarikh Tempat Kerja Beroperasi : *Date of Operation*
1.9	Bilangan pekerja : *No. of workers*

Disediakan oleh: ***Prepared by:***	**Jawatan:** ***Position:***	**Tarikh pemeriksaan:** ***Date of inspection:***

2.0 MAKLUMAT SISTEM PENYEJUK AMMONIA
DETAILS OF AMMONIA REFRIGERATION SYSTEM

2.1	Nama Pembekal Sistem Penyejukan : *Name of refrigeration system supplier:*	
2.2	Nama Pembekal Ammonia : *Name of ammonia supplier:*	
2.3	Nama Syarikat Penyelenggaraan : *Name of maintenance company:*	
2.4	Kuantiti Ammonia di Tempat Kerja : *Quantity of ammonia at the workplace :*	tan *tonne*

Tandakan ✓ atau ✗. Sila buat salinan bukti sebagai lampiran dan labelkan mengikut nombor lampiran
Please tick ✓ or ✗. Please provide a copy of compliance evidence and mark with the attachment number.

3.0 TUGAS DAN TANGGUNGJAWAB
DUTIES AND RESPONSIBILITIES
(Rujukan dalam Garis Panduan/ *Reference from Guideline*)

3.1	Pereka Bentuk *Designer*	Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
3.1.1	Sistem penyejuk direkabentuk mengikut perundangan tempatan. *Refrigeration system is designed according to the local legislations.* (**3.1 (a)**)	Kelulusan Rekabentuk UPV dari JKKP *DOSH Design Approval for UPV.*		11.10	
		Sijil Perakuan Kelayakan dari JKKP *DOSH Certificate of Fitness*		11.9	
3.1.2	Sistem penyejuk direkabentuk supaya selamat dan tanpa risiko kepada kesihatan apabila digunakan dengan betul. *Refrigeration system is designed to be safe and without risk to health when properly used.* (**3.1 (b)**)	Gambar rajah Perpaipan dan Perkakasan *Piping and Instrumentation Diagram*		11.26	
3.1.3	Program penyelenggaraan bagi keseluruhan sistem penyejuk disediakan. *Maintenance program for the whole refrigeration system is provided.* (**3.1 (d)**)	Jadual Program Penyelenggaraan *Maintenance Program Schedule*		11.18	

3.1	Pereka Bentuk *Designer*	Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
3.1.4	Mampu menyelesaikan semua isu-isu teknikal dan penyelenggaraan. *Able to resolve all technical and maintenance issues.* **(3.1 (c))**				

3.2	Pembuat *Manufacturer*	Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
3.2.1	Proses pembuatan mengikut amalan baik. *Good manufacturing practices.* **(3.2 (c))**	Laporan Ujian Penerimaan Kilang *Factory Acceptance Test Report*		11.12	
	Prosedur Operasi Standard bagi mengendalikan sistem disediakan. *Standard Operating Procedures (SOP) for the system is provided.* **(3.2 (c))**	Prosedur Operasi Standard *SOP for the system*		11.37	

3.3	Pembekal / Pemasang *Supplier / Installer*	Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
3.3.1	Rekabentuk, ujian, pentauliahan dan penyelenggaraan berdasarkan undang-undang tempatan bagi sistem penyejukan. *Design, testing, commisioning installation and maintenance according to the local legislation for refrigeration system.* **(3.3 (a))**	Laporan Ujian Penerimaan Tapak *Site Acceptance Test Report*		11.35	
		Kelulusan Rekabentuk UPV dari JKKP *DOSH Design approval for UPV.*		11.10	
3.3.2	Mengeluarkan arahan mengenai penggunaan sistem penyejukan dengan betul. *Issuance of instructions on proper use of the refrigeration system.* **(3.3 (c))**	Panduan pengoperasian *Operation Manual*		11.20	
3.3.3	Mengadakan penyelenggaraan bagi sistem penyejukan. *Establish proper maintenance to the refrigeration system.* **(3.3 (d))**	Perjanjian antara pemunya dan pembekal *Agreement between owner and supplier*		11.1	

3.4	Pembekal Ammonia *Supplier of Ammonia*	Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
3.4.1	Menyediakan label yang betul mengikut Peraturan CLASS 2013. *Provide proper label as per CLASS Regulation 2013* (**3.4 (c)**)	Label Bahan Kimia *Chemical Label*		11.4	
3.4.2	Menyediakan Prosedur Operasi Selamat bagi aktiviti pengisian ammonia. *Provide Safe Operating Procedure for ammonia filling activities.* (**3.4 (b)**)	Prosedur Operasi Selamat bagi pengisisan ammnoia *SOP for ammonia filling*		11.36	
3.4.3	Menyediakan Helaian Data Keselamatan mengikut Peraturan CLASS 2013. *Provide Safety Data Sheet as per CLASS Regulation 2013.* (**3.4 (c)**)	Helaian Data Keselamatan *Safety Data Sheet*		11.5	
3.4.4	Menyediakan latihan kepada pengendali ammonia. *Provide training to ammonia handlers* (**3.4 (e)**)	Rekod modul dan latihan *Training module and record*		11.41	
3.4.5	Mendapatkan kebenaran daripada pemunya sebelum mengecas ammonia ke dalam sistem. *Obtain permission from the owner before ammonia charging into the system.* (**3.4 (d)**)	Permit Kerja *Permit to Work*		11.21	

3.5	Pemunya *Owner*	Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
3.5.1	Menjalankan penaksiran risiko bagi keseluruhan operasi sistem penyejukan. *Conduct risk assessment for overall operation of the refrigeration system.* **(3.5 (a))**	Laporan Penilaian Risiko *Risk Assessment report.*		11.34	
3.5.2	Melantik orang yang terlatih bagi pemeriksaan dan penyelenggaraan sistem penyejukan. *Appoint trained person for examination and maintenance of the refrigeration system.* **(3.5 (b))**	Perjanjian antara pemunya dan orang yang terlatih *Agreement between owner and trained person.*		11.20	
3.5.3	Memastikan orang yang terlatih menjalankan penyelenggaraan dan pemeriksaan secara berkala. *Ensure that the trained person carries out periodic maintenance and inspection.* **(3.5 (c))**	Laporan pemeriksaan *Inspection report*		11.13	
3.5.4	Setiap jentera berperakuan mempunyai Sijil Perakuan Kelayakan yang sah. *Every certificated machinery possesses a valid Certificate of Fitness.* **(3.5 (d))**	Sijil Perakuan Kelayakan dari JKKP *DOSH Certificate of Fitness*		11.9	
3.5.5	Memastikan kerja pembaikan dan pengubahsuaian dijalankan oleh Firma Kompeten yang berdaftar. *Ensure the UPV repair and modification work is conducted by registered Competent Firm.* **(3.5 (e))**	Surat kelulusan pembaikan dari JKKP *Repair approval letter from DOSH*		11.32	
		Laporan Pembaikan/ Pengubahsuaian Repair/ *Modification report.*		11.33	
3.5.6	Menyimpan rekod penyelenggaraan dan operasi. *Record keeping of maintenance and operational work.* **(3.5 (f))**				

3.5	Pemunya *Owner*	Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
3.5.7	Menjalankan Penilaian Risiko Kimia kepada Kesihatan (CHRA). *Conduct Chemical Health Risk Assessment (CHRA)* **(3.5 (g))**	Laporan CHRA *CHRA report*		11.6	
3.5.8	Melaporkan sebarang kejadian berbahaya kepada JKKP (jika ada)-JKKP 6 mengikut Peraturan NODOPOD 2014. *Report any incident to DOSH (if any) – JKKP 6 as per NODOPOD Regulations 2014* **(3.5 (h))**	Borang JKKP 6, JKKP 7 and JKKP 8 *JKKP 6, JKKP 7 and JKKP 8 form*		11.15	
3.5.9	Menyediakan maklumat, arahan, latihan dan pengawasan kepada pekerja. *Provide information, instruction, training and supervision to employees.* **(3.5 (i))**	Rekod modul dan latihan *Training module and record.*		11.41	
		Gambar papan tanda di tempat kerja *Pictures of signage at workplace*		11.24	
3.5.10	Mengenalpasti, menghapuskan atau mengurangkan sebarang risiko yang boleh menggagalkan rekabentuk sistem. *Identify and eliminate or minimize any risks related to failure of the design.* **(3.5 (j))**	Senarai semak tinjauan *Walkabout checklist*		11.42	
3.5.11	Mengadakan Prosedur Kerja Selamat (SWP) bagi aktiviti yang berkaitan. *Develop Safe Work Procedure (SWP) for the relevant work activities.* **(3.5 (k))**	Susun atur proses *Process layout*		11.28	
		Susun atur aliran proses pengeluaran *Production flow layout*		11.29	
		Prosedur Kerja Selamat bagi kerja yang berkaitan *SWP for the relevant work activities*		11.40	

3.5	Pemunya *Owner*	Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
3.5.12	Menyediakan pelan tindakan kecemasan dan persediaan/kesiapsiagaan. *Provide emergency response plans and preparedness.* **(3.5 (l))**	Rekod dan prosedur ERP *ERP procedure and record*		11.11	
		Susun atur loji/kilang *Plant layout*		11.27	
3.5.13	Menentukan jumlah kuantiti bahan berbahaya (seperti ammonia) selaras dengan peruntukan Peraturan-Peraturan Keselamatan dan Kesihatan Pekerjaan (Kawalan Terhadap Bahaya Kemalangan Besar dalam Perindustrian CIMAH) 1996. *Determine the total quantity of the hazardous substances (such as ammonia) in accordance with the provisions of the Occupational Safety and Health (Control of Industrial major Accident Hazard CIMAH) Regulations 1996.)* **(3.5 (m))**	Rekod Kuantiti Ammonia / JKKP 5 *Record of Ammonia Quantity / JKKP 5*		11.30	

4.0 KRITERIA REKABENTUK BAGI RUANGAN JENTERA
DESIGN CRITERIA FOR MACHINE ROOM
(Rujukan dalam Garis Panduan/ *Reference from Guideline*)

		Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
4.1	Pengudaraan untuk melepaskan haba dan gas ammonia (sekiranya berlaku kebocoran) daripada ruang jentera. *Ventilation to vent the heat and ammonia (in case of leakage) from the machine room* **(5.3 (g)(i&ii))**	Gambar peranti pengudaraan *Photos of ventilation device*		11.25	
		Susun atur ruang jentera *Machine room layout*		11.16	
4.2	Pengesan gas ammonia dan sistem penggera di bilik motor (disyorkan) *Ammonia gas detector and alarm system installed in the motor room (recommended)* **(5.3 (g)(iii))**	Gambar sistem penggera *Photos of alarm system*		11.22	
		Gambar rajah sistem penggera *Alarm system diagram*		11.3	

5.0 PEMASANGAN
INSTALLATION
(Rujukan dalam Garis Panduan/ *Reference from Guideline*)

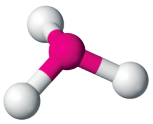
		Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
5.1	Pemasang adalah terlatih dan berpengalaman *Installer with training and experience* **(6.0 (a))**	Sijil Latihan Pemasang dari pembuat atau pembekal *Installer Training certificate from manufacturer or supplier*		11.14	
5.2	Sistem penyejukan dengan lakaran yang perlu- litar penyejukan, rajah aliran, litar elektrik *Refrigeration System with necessary drawings – refrigeration circuit, flow diagram, electric circuit* **(6.0 (b))**	Gambar rajah Perpaipan dan Perkakasan *Piping and Instrumentation Diagram*		11.26	

6.0 PENGISIAN AMMONIA
AMMONIA FILLING
(Rujukan dalam Garis Panduan/ *Reference from Guideline*)

		Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
6.1	Mengadakan Prosedur Kerja Selamat bagi pengisian ammonia *Develop SWP for ammonia filling*	Prosedur Kerja Selamat bagi pengisian ammonia *SWP for ammonia filling*		11.39	
6.2	Peralatan Pelindung Diri yang mencukupi *Sufficient PPE* **(8.0 (b)(i))**	Rekod Pemberian PPE *Record of PPE Issuance*		11.31	
6.3	Notis dan papan tanda keselamatan *Notices and safety signages* **(8.0 (c))**	Gambar papan tanda keselamatan semasa pengecasan ammonia *Photos of safety signages during ammonia charging*		11.23	

7.0 PENYELENGGARAAN
MAINTENANCE
(Rujukan dalam Garis Panduan/ *Reference from Guideline*)

		Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
7.1	Penyelenggaraan secara berkala mengikut cadangan pengilang/pengeluar. *Periodical maintenance complies with manufacturer recommendation* **(9.0 (a))**	Rekod Penyelenggaraan *Maintenance record*		11.19	
7.2	Penggantian komponen dengan pengeluar peralatan asal (OEM) atau spesifikasi yang setara. *Component replacement with original equipment manufacturer (OEM) or equivalent specification.* **(9.0 (b))**	Helaian spesifikasi *Specification sheet*		11.38	



		Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
7.3	Orang yang terlatih - Prosedur Pelan Pencegahan Penyelenggaraan (PPM) selaras dengan cadangan pengeluar. *Trained person - Planned Preventive Maintenance (PPM) procedures in line with the manufacturer's recommendations.* **(9.0 (f)(i))**	Senarai semak penyelenggaraan *Maintenance Checklist*		11.17	
7.4	Orang yang terlatih- Semua Pelan Pencegahan Penyelenggaraan (PPM) mesti disesuaikan dengan kemajuan teknikal dan disemak semula jika perlu. *Trained person - All PPM activities must be line with the latest technical development and be revised if necessary.* **(9.0 (f)(ii))**	Senarai semak penyelenggaraan *Maintenance Checklist*		11.17	
7.5	Orang yang terlatih - Semua peralatan keselamatan dipasang dengan betul dan berfungsi dengan baik. *Trained person - All safety equipment is correctly installed and function accordingly* **(9.0 (f)(iii))**	Senarai semak penyelenggaraan *Maintenance Checklist*		11.17	
7.6	Orang yang terlatih- Ujian fungsi dijalankan secara berkala bagi memastikan peralatan keselamatan beroperasi dengan betul. *Trained person - Functional test are regularly carried out to confirm the correct operation of safety equipment.* **(9.0 (f)(iv))**	Senarai semak penyelenggaraan *Maintenance Checklist*		11.17	
7.7	Orang yang terlatih - Rekod penyelenggaraan dan operasi disimpan dengan baik dan tersedia apabila diminta pihak berkuasa. *Trained person - Maintenance and operational records are properly kept and readily available upon request from the authority.* **(9.0 (f)(v))**	Rekod penyelenggaraan *Maintenance record*		11.19	

8.0 PENGUBAHSUAIAN DAN PEMBAIKAN
MODIFICATION AND REPAIR
(Rujukan dalam Garis Panduan/ *Reference from Guideline*)

		Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
8.1	Memberitahu dan mendapatkan kelulusan untuk pengubahsuaian bagi bejana tekanan tak berapi (UPV) daripada JKKP. *To notify and obtain the approval for modification of unfired pressure vessel (UPV) from DOSH.* **(10.0 (c)(i))**	Surat Kelulusan Pembaikan dari JKKP *DOSH Approval Letter for repair*		11.8	
8.2	Kerja pengubahsuaian dan pembaikan mengikut kod dan standard yang bersesuaian. *Modification and repair works are according to appropriate codes and standard* **(10.0 (c)(ii))**	Laporan penutup selepas kerja pengubahsuaian atau pembaikan *Close up report after modification or repair work*		11.7	

9.0 LATIHAN
TRAINING
(Rujukan dalam Garis Panduan/ *Reference from Guideline*)

		Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
9.1	Menjalankan satu siri latihan yang berkesan. *A series of relevant training.* **(11.0)**	Rekod dan modul latihan *Training module and record*		11.41	
9.2	Latihan perlu melibatkan semua pekerja dan kontraktor. *The training should involve all workers and contractors.* **(11.0)**	Rekod dan modul latihan *Training module and record*		11.41	

10.0 PELAN TINDAKAN KECEMASAN AMMONIA
AMMONIA EMERGENCY RESPONSE PLAN
(Rujukan dalam Garis Panduan/ *Reference from Guideline*)

		Bukti Pematuhan *Compliance Evidence*	✓/✗	No. Lampiran *Attach. No.*	Nota *Notes*
10.1	Pelan Tindakan Kecemasan perlu merangkumi cadangan yang khusus dalam menangani kecemasan kebocoran ammonia. *Emergency Response Plan should incorporate specific recommendations in handling ammonia leakage emergency.* **(12.0)**	Rekod dan Prosedur Pelan Tindakan Kecemasan *ERP Procedure and Record*		11.11	

11.0 LAMPIRAN ATTACHMENT

Lampiran *Attachment*		✓/×	Nota *Notes*
11.1	Perjanjian antara pemunya dan pembekal *Agreement between owner and supplier*		
11.2	Perjanjian antara pemunya dan orang yang terlatih *Agreement between owner and trained person.*		
11.3	Gambar rajah sistem penggera *Alarm system diagram*		
11.4	Label bahan kimia *Chemical Label*		
11.5	Helaian Data Keselamatan *Safety Data Sheet*		
11.6	Laporan CHRA *CHRA report*		
11.7	Laporan penutup selepas kerja pengubahsuaian atau pembaikan *Close up report after modification or repair work*		
11.8	Surat Kelulusan pembaikan oleh JKKP *DOSH Approval Letter for repair*		
11.9	*Sijil Perakuan Kelayakan dari JKKP* *DOSH Certificate of Fitness*		
11.10	*Kelulusan rekabentuk bejana tekanan tak berapi (UPV) dari JKKP* *DOSH Design approval for UPV.*		
11.11	*Prosedur dan rekod Pelan Tindakan Kecemasan (ERP)* *ERP Procedure and Record*		
11.12	*Laporan Ujian Penerimaan Kilang* *Factory Acceptance Test Report*		
11.13	*Laporan pemeriksaan* *Inspection report*		
11.14	*Sijil latihan pemasang dari pengeluar atau pembekal* *Installer Training certificate from manufacturer or supplier*		
11.15	*Borang JKKP 6, JKKP 7 dan JKKP 8* *JKKP 6, JKKP 7 and JKKP 8 form*		
11.16	*Susun atur ruang jentera* *Machine room layout*		
11.17	Senarai semak penyelenggaraan *Maintenance Checklist*		

Lampiran *Attachment*		✓/✗	Nota *Notes*
11.18	Jadual Program Penyelenggaraan *Maintenance Program Schedule*		
11.19	Rekod penyelenggaraan *Maintenance record*		
11.20	Panduan operasi *Operation Manual*		
11.21	Permit bekerja *Permit to Work*		
11.22	Gambar sistem penggera *Photos of alarm system*		
11.23	Gambar papan tanda keselamatan semasa pengecasan ammonia *Photos of safety signages during ammonia charging*		
11.24	Gambar papan tanda keselamatan di tempat kerja *Photos of signage at workplace*		
11.25	Gambar peranti pengudaraan *Photos of ventilation device*		
11.26	Gambar rajah perpaipan dan perkakasan		
11.27	*Susun atur loji/kilang* *Plant layout*		
11.28	*Susun atur proses* *Process layout*		
11.29	Susun atur aliran pengeluaran *Production flow layout*		
11.30	Rekod kuantiti ammonia/ JKKP 5 *Record of Ammonia Quantity / JKKP 5*		
11.31	Rekod pemberian Peralatan Pelindung Diri (PPE) *Record of PPE Issuance*		
11.32	Surat Kelulusan Pembaikan dari JKKP *Repair approval letter from DOSH*		
11.33	Laporan Pembaikan/ Pengubahsuaian *Repair/Modification report*		
11.34	Laporan Penilaian Risiko *Risk Assessment report.*		
11.35	Laporan Ujian Penerimaan Tapak *Site Acceptance Test Report*		
11.36	Prosedur Operasi Standard (SOP) untuk pengisian ammonia *SOP for ammonia flling*		
11.37	Prosedur Operasi Standard untuk sistem *SOP for the system*		

Lampiran *Attachment*		✓/✗	Nota *Notes*
11.38	Helaian Spesifikasi *Specification sheet*		
11.39	Prosedur Kerja Selamat (SWP) bagi pengisian ammonia *SWP for ammonia filling*		
11.40	Prosedur Kerja Selamat (SWP) bagi aktiviti kerja yang berkaitan. *SWP for relevant work activities*		
11.41	Modul latihan dan rekod *Training module and record*		
11.42	Senarai semak tinjauan *Walkabout checklist*		

JABATAN KESELAMATAN DAN KESIHATAN PEKERJAAN
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