IRCLASS
Indian Register of Shipping

GUIDELINES ON
AMMONIA FUELED VESSELS

REVISION 1

SEPTEMBER 2025

Guidelines

Ammonia Fueled Vessels

Revision 1, September 2025

TABLE 1 – AMENDMENTS INCORPORATED IN THIS EDITION

These amendments are effective from 1 January 2026

Subject/ Amendments
The Guidelines are completely revised to elaborate and provide better clarity regarding requirements for Ammonia Fueled Vessels based on MSC.1/Circ.1687.

Guidelines

Ammonia Fueled Vessels

Revision 1, September 2025

Contents

Sections

Section 1

Introduction

With a view to promote the use of alternative fuels in shipping in order to reduce greenhouse gases emissions, use of ammonia as fuel is being encouraged by Governments.

These guidelines are intended to provide requirements for ships using ammonia as fuel.

The basic philosophy of these guidelines is to provide provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems in ships using ammonia as fuel to minimize the risk to the ship, its crew and the environment, having regard to the nature of the fuels involved.

Throughout the development of these guidelines, it was recognized that it must be based upon sound naval architectural and engineering principles and the best understanding available of current operational experience, field data and research and development.

These guidelines address all areas that need special consideration for the usage of the ammonia as fuel. These guidelines consider the goal based approach (MSC.1/Circ.1394/Rev.2). Therefore, goals and functional requirements were specified for each section forming the basis for the design, construction and operation.

The current version of these guidelines includes requirements to meet the functional requirements for ammonia as fuel.

These guidelines have been developed in order to assist the ship owners, ship designers and shipyards in designing, building and operating ammonia fueled vessels.

Section 2

General

2.1 Application

2.1 Unless expressly provided otherwise these guidelines apply to ships of 500 GT and above using ammonia as fuel. In the case of ships of less than 500 GT, requirements will be specially considered based on individual designs and risk assessments. These guidelines do not address ships using ammonia cargo as fuel.

2.2 Notations

2.2.1 Ship using Ammonia as fuel, complying with the requirements of these guidelines or complying with the alternative design requirements in Cl. 2.3.3 of Part 5, Chapter 35 of *Rules and Regulations for the Construction and Classification of Steel Ships* (hereinafter referred to, as the Main Rules) will be assigned with notation **LFPF(AM)**. In the above mentioned notation **(AM)** is an additional qualifier notation indicating the usage of Ammonia as fuel.

2.2.2 Following additional notation will be assigned as applicable:

(SFE) – Ships with single fuel engines using ammonia or other low flash point fuel.

(DFE) – Ship using dual fuel engines

2.3 Definitions

Unless otherwise stated below, definitions of various terms are as defined in Part 6 (SOLAS Chapter II-2) and Section 2.2 of Part 5, Chapter 35 of the Main Rules.

2.3.1 *Ammonia* means an inorganic compound represented by the chemical formula NH_3. In these Guidelines, ammonia either in its liquefied or gaseous state is referred to as ammonia.

IR2.3.1 Where the term ‘anhydrous ammonia’ is used, it denotes ammonia in a pure form containing no water.

2.3.2 *Fuel* means ammonia, either in its liquefied or gaseous state.

2.3.3 *Fuel consumer* means any unit within the ship using ammonia as a fuel.

2.3.4 *Fuel tank* is any integral, independent or portable tank used for storage of fuel. The spaces around the fuel tank are defined as follows:

.1 *Fuel storage hold space* is the space enclosed by the ship´s structure in which a fuel tank is situated. If tank connections are located in the fuel storage hold space, it will also be a tank connection space. Integral fuel tanks do not have a fuel storage hold space;

.2 *Cofferdam* for fuel tanks is a structural space surrounding a fuel tank which provides an added layer of vapour tight protection against toxic and flammable vapours between the fuel tank and other areas of the ship;

.

.3 *Tank connection space* is a space surrounding all tank connections and tank valves that is required for tanks with such connections in enclosed spaces.

2.3.5 *Fuel preparation room* means any space containing equipment for fuel preparation purposes, such as fuel pumps, fuel valve train, heat exchangers and filters.

2.3.6 *Gas dispersion analysis* is the analysis of the dispersion behavior of gases using appropriate modeling techniques such as computational fluid dynamics (CFD) analysis.

2.3.7 *Gas freeing* is the process carried out to achieve a safe tank atmosphere. It includes two distinct operations:

.1 Purging the hazardous tank atmosphere with an inert gas or other suitable medium (e.g. water) to dilute the hazardous vapour to a level where air can be safely introduced;

.2 Replacing the diluted inert atmosphere with air.

2.3.8 *Gross Tonnage* means the measure of the overall size of a ship determined in accordance with the provisions of the *International Convention on Tonnage Measurement of Ships, 1969*.

2.3.9 *Independent tanks* are self-supporting, do not form part of the ship's hull and are not essential to the hull strength.

2.3.10 *Integral tank* means a tank which forms part of the ship's hull and which may be stressed in the same manner and by the same loads which stress the contiguous hull structure and which is normally essential to the structural completeness of the ship's hull.

2.3.11 *Portable tank* means an independent tank being able to be:

– easily connected and disconnected from ship systems; and

– easily removed from ship and installed on board ship.

2.3.12 *Purging* means the introduction of inert gas into a tank to reduce the oxygen level so that combustion is not supported; continued purging can reduce the quantity of hydrocarbon vapours to below the LEL such that combustion will not be supported if air is subsequently introduced to the tank.

2.3.13 *Single failure* is where loss of intended function occurs through one fault or action.

2.3.14 *Single fuel engine* means an engine capable of operating on ammonia on one fuel only.

2.3.15 *Fuel Containment System*: is the arrangement for the storage of fuel including tank connections.

2.3.16 *Unacceptable loss of power:* means that it is not possible to sustain or restore normal operation of the propulsion machinery in the event of one of the essential auxiliaries becoming inoperative, in accordance with SOLAS regulation II-1/26.3.

2.3.17 *Toxic Areas* means an area in which ammonia is or may be expected to be present.

2.3.18 *Toxic Space* means an enclosed or semi-enclosed space in which ammonia is or may be expected to be present. A gas-safe machinery space is not considered to be a toxic space.

2.3.19 *Enclosed Space* means any space within which, in the absence of artificial ventilation, the ventilation will be limited, and any explosive and/or toxic atmosphere will not be dispersed naturally

2.3.20 *Bunkering:* means the transfer of ammonia fuel from land-based or floating facilities into ship’s permanent tanks or connection of portable tanks to the fuel supply system.

2.4 Alternative Design

2.4.1 These guidelines contain functional requirements for all appliances and arrangements related to the usage of ammonia as fuel.

2.4.2 Appliances and arrangements of fuel systems may deviate from those set out in these guidelines, provided such appliances and arrangements meet the intent of the goal and functional requirements concerned and provide an equivalent level of safety of the relevant sections.

2.4.3 The equivalence of the alternative design is to be demonstrated as specified in SOLAS regulation II-1/55 and approved by the Administration. However, operational methods or procedures to be applied as an alternative to a particular fitting, material, appliance, apparatus, item of equipment, or type thereof which is prescribed by these guidelines would not be acceptable.

2.5 Documentation Requirements

2.5.1 For a ship with ammonia engine installations, plans and documents are to be submitted for approval as listed in the following:

.1 Documentation related to the design, testing and operation as applicable:

a) Design statement that provides information about the intended service of the ship, including a description of the arrangements, essential services and the intended operating capability and functionality of the main propulsion and auxiliary systems that use ammonia as fuel.

b) Operating manuals that indicate the installation particulars, including operating and maintenance instructions. Equipment manufacturers' instructions are to include the drawings and diagrams necessary for putting into service, maintenance, inspection, checking of correct operation, repair of the machinery, the use of correct spares and tools, and useful instructions with regard to safety.

c) Quality plans for sourcing, design, installation and testing of all components and equipment used in the fuel system.

d) Evidence of type testing of the engine with electronic controls or a proposed test plan at the builders with the electronic controls operational, to verify suitability of the electronic control system and correct functioning during normal operation and identified failure modes.

e) Schedule of testing at engine builders and commissioning prior to sea trials, to demonstrate that various consumers are capable of operating as described in the design statement, including any testing required to verify the safeguards determined in the risk-assessment. The test schedules are to identify all modes of operation and the sea trials are to include typical manoeuvres under all intended engine operating modes.

f) Documentation for Control and Monitoring of the fuel system including safety system, interfaces to other safety and control systems.

g) Bunkering operational procedures and maintenance instruction manuals.

h) Fire Safety operational documentation including ammonia safety / emergency procedures.

i) Testing and trial procedure (including sea trials). The testing procedures should include testing of safety shutdowns in accordance with the cause-and-effect diagram. The cause-and-effect diagram is to indicate the results of activation of each shutdown, shut-off and cut-out associated with the fuel system including engine operation and bunkering.

.2 Arrangement plan of the ship indicating the following, as applicable:

a) machinery and boiler spaces, accommodation spaces, service spaces and control station spaces.

b) fuel tanks and containment systems

c) fuel preparation spaces

d) fuel bunkering pipes with shore connections

e) tank hatches, ventilating pipes and any other openings to fuel tanks

f) ventilating pipes, door and openings to fuel preparation room, double walled piping and other hazardous areas

g) entrances, air inlets and openings to accommodation spaces, service spaces and control station spaces

h) Air lock arrangements

.3 Plans and documents of the fuel tanks covering the following details, as applicable:

a) tank hatches, pipes and any openings to tanks
b) supports and stays
c) insulation
d) Independent Tanks: specification of design loads and structural analysis of fuel tanks
e) Integral Tanks: hull structural analyses
f) tank connection space arrangement
g) tank hatches, pipes and any openings to the gas tanks
h) purging and gas freeing system, including safety relief valves and associated piping
i) fabrication details of independent tanks including building tolerances, NDT plan and welding procedures (WPS)

.4 Plans and documentation showing arrangement and details of piping systems covering the following, as applicable:

a) vent lines for pressure/ vacuum relief valves or similar piping and ducts for fuel pipes
b) electrical bonding for piping
c) fuel heating and cooling system
d) exhaust gas system, including arrangement of explosion relief
e) drip tray and coaming arrangement
f) functional testing procedure of all piping systems including valves, fittings and associated equipment for handling fuel.
g) Control and monitoring system documentation for ventilation systems.

.5 Hazardous area Classification plan

.6 Toxic Area Classification Plan

.7 Electrical schematic drawing, including single line diagrams for all intrinsically safe circuits including explosion protection details of components.

.8 Plans and Documentation for Fire safety as listed in the following:

a) Gas detection and alarm system
b) Fire detection and alarm system
c) Fire extinguishing equipment
d) Structural fire protection plan
e) Control and monitoring system documentation for:

- Gas detection and alarm system
- Fire detection and alarm system

f) Fixed fire extinguishing system documentation, containing details on:

- External surface protection water spraying system
- Bunkering station fire extinguishing system

2.6 Properties of Ammonia

2.6.1 Table 2.6.1 indicates important properties of ammonia, vis-à-vis current and other future fuels. The Table may be used for guidance purposes only and is not to be considered as fuel standard. Further, Table 2.6.2 provides information on the health implications caused by exposure to ammonia.

Table 2.6.1 - Properties of Ammonia and some of the other existing fuels and future fuels
(*Source: Maritime Cleantech*)

	Boiling point (^{0}C at 1 bar)	**Density (kg/m$_3$)**	**Specific energy LHV (MJ/kg)**	**Specific energy LHV (kWh/kg)**	**Energy density (MJ/m$_3$)**	**Storage temperature / pressure**	**Chemical composition**
MGO	175-650	890	42.7	11.97	38,000	Ambient / atmospheric	Hydrocarbon
LNG	-162	440	50	12.5	22,000	Cryogenic /Atmospheric/ Low pressure	CH_4
LPG (Propane)	-42	490	46.4	12.9	22,740	Amb. Or Cryogenic / Atm.	C_3H_8
Ammonia (liquid)	-33.3	653.1	18.6	5.17	14,100	Refrigerated / atmospheric pressure	NH_3
Methanol	65	780	20	5.56	36,700	Ambient Atm.	CH_3OH

Table 2.6.2 Health implications according to ammonia concentration and exposure time
(*Source: US Environmental Protection Agency, Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 6*)

	Exposure Time				
AEGL Level	**10min**	**30min**	**60min**	**240min**	**480min**
AEGL1	30 ppm	30 ppm	30 ppm	30 ppm	30 ppm
AEGL2	220 ppm	220 ppm	160 ppm	110 ppm	110 ppm
AEGL3	2700 ppm	1600 ppm	1100 ppm	550 ppm	390 ppm

Notes:-
AEGL : Acute Exposure Guideline Level
AEGL 1: Causes irritation but is recoverable immediately when the exposure is stopped
AEGL 2: Cause irreversible or long-lasting health hazards
AEGL 3: Fatal

Section 3

Goal and Functional Requirements

3.1 Goal

3.1.1 The goal of these guidelines is to provide for safe and environmentally-friendly design, construction and operation of ships and in particular their installations of systems for propulsion machinery, auxiliary power generation machinery and/ or other purpose machinery using ammonia as fuel.

3.2 Functional Requirements

3.2.1 The safety, reliability and dependability of the systems are to be equivalent to that achieved with new and comparable conventional oil-fueled main and auxiliary machinery.

3.2.2 The probability and consequences of ammonia-related hazards in general and that of toxicity in particular are to be limited to a minimum through arrangement and system design, such as ventilation, detection and safety actions. In the event of fuel leakage or failure of the risk reducing measures, necessary safety actions are to be initiated.

3.2.3 The design philosophy is to ensure that risk reducing measures and safety actions for the fuel installation do not lead to an unacceptable loss of power.

3.2.4 Hazardous areas, toxic areas and toxic spaces are to be restricted, as far as practicable, to minimize the potential risks that might affect the safety of the ship, persons on board and equipment.

3.2.5 Equipment installed in hazardous areas is to be minimized to that required for operational purposes and are to be suitably and appropriately certified.

3.2.6 Unintended accumulation of explosive, flammable or toxic gas concentrations is to be prevented.

3.2.7 System components are to be protected against external damage.

3.2.8 Sources of ignition in hazardous areas are to be minimized to reduce the probability of fire and explosions.

3.2.9 Sources of ammonia release are to be minimized to reduce the probability of ammonia exposure to humans and the environment.

3.2.10 Measures to minimize the health hazards associated with exposure to ammonia are to be provided.

3.2.11 Direct release of ammonia into the atmosphere during normal operation and during any foreseeable and controllable abnormal scenario is to be avoided.

3.2.12 Safe and suitable, fuel supply, storage and bunkering arrangements are to be provided, capable of receiving and containing the fuel in the required state without leakage. Other than when necessary for safety reasons, fuel supply, storage and bunkering arrangements are to be designed to prevent venting under all normal operating conditions including idle periods.

3.2.13 Piping systems, containment and over-pressure relief arrangements that are of suitable design, material, construction and installation for their intended application are to be provided.

3.2.14 Machinery, systems and components are to be designed, constructed, installed, operated, maintained and protected to ensure safe and reliable operation.

3.2.15 Suitable control, alarm, monitoring and shutdown systems are to be provided to ensure safe and reliable operation.

3.2.16 Fixed fuel vapour and/or leakage detection suitable for all spaces and areas concerned are to be arranged.

3.2.17 Fire detection, protection and extinction measures appropriate to the hazards concerned are to be provided.

3.2.18 Commissioning, trials and maintenance of fuel systems and fuel utilization machinery are to be satisfy the goal in terms of safety, availability and reliability.

3.2.19 The technical documentation is to permit an assessment of the compliance of the system and its components with the applicable rules, guidelines, design standards used and the principles related to safety, availability, maintainability and reliability.

3.2.20 A single failure in a technical system or component is not to lead to an unsafe or unreliable situation.

Section 4

General Requirements

4.1 Goal

4.1.1 The goal of this Section is to ensure that the necessary assessments of the risks involved are carried out in order to eliminate or mitigate any adverse effect on the persons on board, the environment or the ship.

4.2 Risk Assessment

4.2.1 A risk assessment is to be conducted to ensure that risks arising from the use of ammonia as fuel affecting persons on board, the environment and the structural strength or the integrity of the ship are addressed. Consideration is to be given to the hazards associated with physical layout, operation and maintenance and following any reasonably foreseeable failure..

4.2.2 The risk assessment should specifically consider the ammonia system integrity with focus on its ability to prevent and isolate leakages and also evaluate potential toxicity hazards, ignition mechanisms and consequences of ignition. Special consideration should be given, but not limited to, the following specific ammonia-related hazards and topics: :

- Loss of function
- Component damage
- Fire
- Explosion
- toxicity; and
- electric shock

4.2.3 Risks, which cannot be eliminated, should be mitigated as necessary. Details of risks, and the means by which they are mitigated, should be documented.

4.3 Limitation of Explosion Consequences

4.3.1 To limit the consequences of an explosion in any space containing any potential of release of flammable vapor/liquid and potential ignition sources, Part 5, Chapter 35, 4.3 of the Main Rules is applicable. (Note: Double wall fuel pipes are not considered as potential sources of release)

4.3.2 Also an explosion in any space containing any potential sources of release and potential ignition sources is not to harm ship personnel normally present in work or accommodation spaces under normal operating conditions.

Section 5

Ship Design and Arrangement

5.1 Goal

5.1.1 The goal of this Section is to provide for safe location, space arrangements and mechanical protection of power generation equipment, fuel storage system, fuel supply equipment and refueling systems.

5.2 Functional Requirements

5.2.1 This section is related to functional requirements in Section 3, 3.2.1 to 3.2.3, 3.2.5 to 3.2.9, 3.2.13 to 3.2.16, 3.2.18 and 3.2.20. In particular, the following apply:

.1 the fuel tank(s) is/ are to be located in such a way that the probability for the tank(s) to be damaged following a collision or grounding is reduced to a minimum, taking into account the safe operation of the ship and other hazards that may be relevant to the ship;

.2 fuel containment systems, fuel piping and other fuel sources of release are to be so located and arranged that released ammonia is led to a recovery system, treatment system or a safe location in the open air;

.3 the access or other openings to spaces containing fuel sources of release are to be so arranged that flammable, asphyxiating or toxic gas cannot escape to spaces that are not designed for the presence of such gases taking into account the specific gravity and dispersion characteristics of ammonia gas;

.4 fuel piping and fuel supply system are to be protected against mechanical damage;

.5 the propulsion and fuel supply system are to be so designed that safety actions after any ammonia leakage do not lead to an unacceptable loss of power;

.6 the probability of an explosion in a machinery space with ammonia-fueled machinery is to be minimized; and

.7 the space where machinery and fuel-handling equipment are installed is to be designed to minimize the risk of exposure of persons on board to leaked ammonia.

5.3 General

5.3.1 Fuel tanks should be protected against mechanical damage.

5.3.2 Fuel tanks and/or equipment located on an open deck should be located to ensure sufficient natural ventilation to prevent accumulation of ammonia.

5.3.3 Mustering stations and life-saving equipment, and access to such stations and equipment, are not to be located in toxic areas as specified in 13.4.

5.3.4 Air intakes, outlets and other openings into the accommodation, service and machinery spaces, control stations and other non-toxic spaces in the ship are not to be located in toxic areas as specified in 13.4.

5.4 Protection of Fuel Tanks from Collision and Grounding

5.4.1 For protection of fuel tanks from collision and grounding, the requirements of Part 5, Chapter 35 5.3.3, 5.3.4 and 5.3.5 of Main Rules are to apply to ships using ammonia as fuel.

5.5 Machinery Space Arrangements

5.5.1 Machinery spaces containing ammonia fuel systems and/or ammonia-fueled machinery are to be arranged such that the spaces may be considered gas safe under all conditions, normal as well as abnormal conditions, i.e. inherently gas safe.

5.5.2 In a gas-safe machinery space, a single failure is not to lead to the release of fuel gas into the machinery space.

5.5.3 A gas-safe machinery space may be arranged as a conventional machinery space.

5.5.4 A single failure within the fuel system is not to lead to a release of fuel into the machinery space. Therefore, the gas safe machinery concept of Part 5, Chapter 35, Cl. 5.4.1.1 of Main Rules is to be applied to all machinery spaces containing ammonia consumers. 'ESD machinery space' concept mentioned in IGF Code and Part 5, Chapter 35 of Main Rules is not to be applied for ammonia as fuel installations. Accordingly, all references to Part 5, Chapter 35 of Main Rules from this Guidelines, that may include the 'ESD machinery space' concept requirements, are not applicable.

5.5.5 All fuel piping within machinery space boundaries is to be enclosed in vapour/ gas tight and liquid tight enclosures in accordance with Part 5, Chapter 35, Cl. 9.6 of Main Rules.

5.5.6 Access to machinery spaces is not to be arranged from toxic areas or toxic spaces.

IR5.5.7 Machinery spaces containing ammonia fuel consumers are to be arranged for remote monitoring in accordance with the requirements for **SYJ** notation of the Main Rules.

5.6 Requirements for Location and Protection of Fuel Piping

5.6.1 Fuel pipes are not to be located less than 800 [mm] from the ship's side.

5.6.2 Fuel piping is not to be led directly through accommodation spaces, service spaces, electrical equipment rooms or control stations as defined in the SOLAS Convention, even though the piping is protected by secondary enclosures.

5.6.3 Fuel pipes led through ro-ro spaces, special category spaces and on open decks are to be protected against mechanical damage.

5.7 Requirements for Fuel Preparation Room Design

5.7.1 Requirements for fuel preparation room

5.7.1.1 Fuel process equipment is to be arranged in a fuel preparation room in accordance with provisions in this Guideline. As an exemption to this provision, vaporizers, heat exchangers and motors for pumps submerged in tanks may be located in tank connection spaces.

5.7.1.2 When fuel preparation rooms cannot be located on open deck, or accessed from open deck, access is to be provided through an airlock in compliance with 5.11.

5.7.1.3 Fuel preparation rooms are to be designed to safely contain fuel leakages. The fuel preparation room boundaries are to be gastight towards other spaces in the ship.

5.7.1.4 The probable maximum leakage into the fuel preparation room is to be determined based on detail design, detection and shutdown systems.

5.7.1.5 The material of the boundaries of the fuel preparation room is to have a design temperature corresponding with the lowest temperature it can be subjected to in a probable maximum leakage scenario, unless the boundaries of the space, i.e. bulkheads and decks, are provided with suitable thermal protection.

5.7.1.6 The fuel preparation room is to be fitted with ventilation arrangements ensuring that the space can withstand any pressure build-up caused by vaporization of the liquefied fuel.

5.7.1.7 The fuel preparation room entrance is to be arranged with a sill height exceeding the liquid level resulting from a calculated maximum leakage, but in no case to be lower than 300 [mm].

5.7.1.8 Fuel preparation room entrances are to be arranged with water screens having constantly available water supply. The water screen is to be possible to activate from a safe location outside the fuel preparation room toxic zone if an ammonia leak occurs. The water screens are to be arranged on the outside of the fuel preparation room. The arrangement is to include the means to safely manage any ammonia effluent produced in their operation.

5.7.1.9 A leakage in the fuel preparation room is not to render necessary safety functions out of order due to low temperatures caused by the evaporation of leaking fuel.

5.7.1.10 Fuel preparation rooms are to be designed to manage any ammonia release for personnel to enter safely.

IR5.7.1.11 When located on deck, fuel preparation rooms are to be protected against mechanical damage where vessel cargo handling operations increase the risk of mechanical impact damage.

IR5.7.1.12 Fuel preparation rooms are to contain only the equipment essential for fuel conditioning, preparation and supply, together with necessary safety equipment such as fire and gas detection, low oxygen level detection system, fi-fi equipment, bilge equipment, etc.

IR5.7.1.13 Where ammonia is heated or cooled, the heating or cooling medium is to be utilized in an independent, closed system.

IR5.7.1.14 Unless permitted by SOLAS Chapter II-2 Regulation 13.2, a minimum of two widely separated means of escape are to be provided for these spaces. Water screens are to be provided above access doors and operable manually from outside the compartment and automatically in accordance with Section 15. One of the means of escape may be a vertical ladder through a hatch to the weather deck. In that case, a water deluge system that covers the area of the hatch and entrance to any ladder trunk is to be provided in lieu of the water screen.

IR5.7.1.15 Duct, pipe and cable penetrations of bulkheads and decks of the fuel preparation room are to be made gastight.

IR5.7.1.16 Fuel preparation rooms/ spaces which may contain potential sources of release, such as seals on rotating equipment, instrument connections and valves, etc., are considered hazardous spaces and are normally unmanned.

5.7.2 Requirements for tank connection spaces

5.7.2.1 Fuel tank connections, flanges and tank valves are to be located in a tank connection space arranged in accordance with the requirements in this Guidelines. Apart from fuel process equipment allowed in tank connection spaces as defined in 5.7.1.1, tank connection spaces and fuel preparation rooms are not to be combined.

5.7.2.2 Tank connection spaces are to be designed to safely contain fuel leakages. The tank connection space boundaries are to be gastight towards other spaces in the ship.

5.7.2.3 The material of the bulkheads of the tank connection space is to have a design temperature corresponding with the lowest temperature it can be subject to in a probable maximum leakage scenario.

5.7.2.4 The probable maximum leakage into the tank connection space is to be determined based on detail design, detection and shutdown systems.

5.7.2.5 Tank connection spaces are to be fitted with ventilation arrangements ensuring that the spaces can withstand any pressure build-up caused by vaporization of the liquefied fuel.

5.7.2.6 Tank connection space entrances are to be arranged with a sill height exceeding the liquid level resulting from a calculated maximum leakage but, in no case, to be lower than 300 [mm].

5.7.2.7 Tank connection space entrances are to be arranged with water screens having constantly available water supply. The water screen is to be possible to activate from a safe location outside the tank connection space toxic zone if an ammonia leak occurs. The water screens are to be arranged on the outside of the tank connection spaces. The arrangement is to include the means to safely manage any ammonia effluent produced in their operation.

5.7.2.8 Unless the access to the tank connection space is independent and direct from the open deck, it is to be provided through a bolted hatch. The bolted hatch is to be located in a protective entry space of gastight construction with a self-closing gastight door. The access is to be arranged to facilitate the evacuation of an injured person from the tank connection space by personnel wearing breathing apparatus and PPE.

5.7.2.9 A leakage in the tank connection space is not to render necessary safety functions out of order due to low temperatures caused by the evaporation of leaking fuel.

5.7.3 Provision for fuel bunkering stations

5.7.3.1 The location and arrangement of the bunkering station, including whether open, enclosed, or semi-enclosed, is to be subject to special consideration within the risk assessment. Depending on the arrangement, this may include, but is not limited to:

.1 segregation from other areas of the ship;

.2 hazardous and toxic area plans for the ship;

.3 requirements for forced ventilation;

.4 requirements for leakage detection;

.5 safety actions related to leakage detection;

.6 access to bunkering station from non-hazardous areas through airlocks; and

.7 monitoring of bunkering station by direct line of sight or closed-circuit television (CCTV).

5.7.3.2 Mechanical spray shielding is to be arranged around potential leakage sources from the ammonia system in the bunkering station.

5.7.3.3 The bunker station is to be located in an area where sufficient space for efficient work and access is ensured for the personnel involved in bunkering and their equipment while wearing SCBA and PPE, and to ensure that, in an emergency, they have a clear escape route.

5.8 Requirements for Bilge Systems

5.8.1 Bilge system design and arrangements are to be in accordance with Part 5, Chapter 35, 5.9 of Main Rules.

IR5.8.2 The deck plating is to be arranged to facilitate easy cleaning and drying. No other plating above the deck is to be provided.

IR5.8.3 In spaces where a water mist system is installed, the number and diameter of the scupper pipes or bilge suctions are to be sufficient to avoid any risk of water accumulation.

IR5.8.4 Bilge water holding tanks and drain tanks likely to contain dissolved ammonia are to be

a) located outside the machinery spaces and provided with a vent pipe led to the vent mast with means of ammonia vapor detection and;
b) are to be surrounded by cofferdam, except on those surfaces bound by ammonia preparation room.

5.9 Requirements for Drip Trays

5.9.1 Drip tray design and arrangements, as applicable to ammonia, are to be in accordance with Part 5, Chapter 35, Cl.5.10 of Main Rules.

5.9.2 Drip trays are to be provided with means to safely drain or transfer spills that contain ammonia to be contained or treated.

5.10 Requirements for Arrangement of Entrances and other Openings in Enclosed Spaces

5.10.1 Arrangements of entrances and other opening in enclosed spaces are to be in accordance with Part 5, Chapter 35, Cl.5.11.1 and Cl.5.11.5 of the Main Rules

5.10.2 Direct access is not to be permitted from a non-toxic space to a toxic area or space. Where such openings are necessary for operational reasons, an airlock which complies with 5.11 is to be provided.

5.10.3 Arrangements for fuel storage hold spaces, void space, fuel tanks and other spaces classified as hazardous/toxic areas or spaces are to be such as to allow entry and inspection of any such space by ship personnel wearing PPE and breathing apparatus, as well as to allow for the evacuation of injured or unconscious ship personnel. Such arrangements are to comply with the following:

.1 access is to be provided as follows:

a) access to all fuel tanks. Access is to be directly from open decks as far as practicable;

b) access through horizontal openings, hatches or manholes. The size is to be sufficient to allow a person wearing a breathing apparatus to ascend or descend any ladder without obstruction, and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening is to be not less than 600 [mm] X 600 [mm];

c) access through vertical openings or manholes providing passage through the length and breadth of the space. The minimum clear opening is to be not less than 600 [mm] × 800 [mm] at a height of not more than 600 [mm] from the bottom plating, unless gratings or other footholds are provided; and

d) circular access openings to type C tanks are to have a diameter of not less than 600 [mm].

.2 the sizes referred to in 5.10.3.1 b) and 5.10.3.1 c) may be decreased, if 5.10.3 can be met to the satisfaction of IRS /Administration.

.3 where fuel is carried in containment systems requiring secondary barriers, 5.10.3.1 b) and c) do not apply to spaces separated from hold spaces by a single gastight steel boundary. Such spaces are to be provided only with direct or indirect access from open decks, excluding any enclosed non-hazardous areas.

5.11 Requirements for Air Locks

5.11.1 Airlocks are to be in accordance with Part 5, Chapter 35, Cl. 5.12.1 to 5.12.6 of Main Rules.

Section 6

Fuel Containment System

6.1 Goal

6.1.1 The goal of this Section is to provide that ammonia storage is adequate so as to minimize the risk to personnel, the ship and the environment to a level that is at least equivalent to a conventional oil fueled ship.

6.2 Functional Requirements

6.2.1 This Section relates to functional requirements in 3.2.1, 3.2.2, 3.2.5, 3.2.7 and 3.2.8 to 3.2.18. In particular, the following apply:

.1 the fuel containment system is to be so designed that a leak from the tank or its connections does not endanger the ship, persons on board or the environment. Potential dangers to be avoided include:

.1 exposure of ship materials to temperatures below acceptable limits;

.2 flammable fuels spreading to locations with ignition sources;

.3 toxicity potential and risk of oxygen deficiency due to fuels and inert gases;

.4 restriction of access to muster stations, escape routes and life-saving appliances (LSA); and

.5 reduction in availability of LSA;

.2 the pressure and temperature in the fuel tank are to be kept within the design limits of the containment system and possible carriage requirements of the fuel; and

.3 the fuel containment arrangement is to be so designed that safety actions after any ammonia leakage do not lead to an unacceptable loss of power.

6.3 General

6.3.1 The ammonia fuel is to be stored in a refrigerated state at atmospheric pressure.

6.3.2 Tank connection spaces and fuel storage hold spaces other than for tank type C are to be gastight towards adjacent spaces. These spaces are not to be adjacent to accommodation spaces, service spaces, electrical equipment rooms and control stations by a single bulkhead or deck. "Adjacent" means linear contact and point contact.

6.3.3 The general fuel containment requirements of Part 5, Chapter 35, Cl. 6.3.5, 6.3.6, 6.3.9, 6.3.11 and 6.3.12 of Main Rules are also applicable to the storage of ammonia.

6.4 Requirements for Liquefied Ammonia Fuel Containment

6.4.1 Unless expressly provided otherwise, the requirements of Part 5, Chapter 35, Section 6.4 of the Main Rules, are to apply to ships using ammonia as fuel.

6.4.2 The provision of Part 5, Chapter 35, Cl. 6.4.1.3 of Main Rules related to portable tanks is not to apply to ships using ammonia as fuel.

6.5 Portable Tanks

6.5.1 The requirements of Pt.5, Ch.35, Cl.6.5 of Main Rules are not to be applied.

6.6 Compressed Fuel containment

6.6.1 The requirements of Pt.5, Ch.35, Cl.6.6 of Main Rules are not to be applied.

6.7 Pressure relief system

6.7.1 Pressure relief valves and systems in accordance with Part 5, Chapter 35, 6.7.1 to 6.7.3 of Main Rules are to be provided, as applicable. Part 5, Chapter 35, 6.7.2.1 and 6.7.2.8 of the Main Rules are not applicable. For the application of 6.7.3.1.2 of Part 5, Chapter 35 of the Main Rules, the chapeau of 6.7.3.1.2 is to be read as: '*For tanks in fuel storage hold spaces separated from potential fire loads by cofferdams or surrounded by ship spaces with no fire load, the following applies:…*'.

6.7.2 The outlet from the pressure relief valves is normally to be located at least B (greatest moulded breadth) or 25 [m], whichever is less, from the nearest:

.1 air intake, air outlet or opening to accommodation, service and control spaces, or other non-hazardous area; and

.2 exhaust outlet from machinery installations.

IR6.7.3 Other than when necessary for safety reasons, the pressure control and relief system is to be designed to prevent venting under all operating conditions including idle periods.

IR6.7.4 Pressure relief discharges are to be through the vent mast. Vent masts are to be equipped with fixed ammonia gas detection and monitored in accordance with Section 16.

IR6.7.5 Fuel storage hold spaces, inter-barrier spaces, tank connection spaces and tank cofferdams, which may be subject to pressures beyond their design capabilities, are to be provided with a suitable pressure relief system that vents to the hazardous area vent mast or riser location. These pressure relief systems are to be independent of the fuel control systems specified in Cl.6.8.1.

6.8 Loading limits for ammonia fuel tanks

6.8.1 Loading limits for ammonia fuel tanks are to be in accordance with Part 5, Chapter 35, Cl.6.8.1 of the Main Rules.

6.8.2 Also, in cases where the tank insulation and tank location make the probability very small for the tank contents to be heated up due to an external fire, special considerations may be made to allow a higher loading limit than calculated using the reference temperature, but never above 95%.

6.9 Maintenance of fuel storage condition

6.9.1 Control of fuel temperature and tank pressure

6.9.1.1 The temperature of the liquefied ammonia in the fuel tanks is to be maintained at a temperature of no more than -30°C at all times by means acceptable to IRS/ the Administration. Systems and arrangements to be used for this purpose may include one, or a combination of, the following methods:

.1 reliquefaction of vapours;

.2 thermal oxidation of vapours; or

.3 liquefied ammonia fuel cooling.

The method chosen is to be capable of maintaining the fuel temperature assuming no consumption for propulsion or power generation.

6.9.1.2 Venting of fuel vapour for control of the tank pressure is not acceptable, except in emergency situations.

6.9.2 Design of systems

6.9.2.1 Design of systems is to be in accordance with Part 5, Chapter 35, Section 6, 6.9.2.

6.9.3 Reliquefaction systems

6.9.3.1 The reliquefaction system is to be designed and calculated according to Part 5, Chapter 35, Section 6, Cl.6.9.3.2.

6.9.4 Thermal oxidation systems

6.9.4.1 Thermal oxidation can be done by either consumption of the vapours according to the provisions for fuel consumers described in these Guidelines or in a dedicated gas combustion unit. It is to be demonstrated that the capacity of the oxidation system is sufficient to consume the required quantity of vapours.

6.9.5 Compatibility

6.9.5.1 Refrigerants or auxiliary agents used for refrigeration or cooling of fuel are to be compatible with the fuel they may come in contact with (not causing any hazardous reaction or excessively corrosive products). In addition, when several refrigerants or agents are used, these are to be compatible with each other.

6.9.6 Availability of systems

6.9.6.1 The availability of the system is to be in accordance with Part 5, Chapter 35, Section 6, 6.9.6.

6.10 Other Requirements

6.10.1 Other fuel containment system requirements in Part 5, Chapter 35, Section 6 of Main Rules are to be taken into account, where applicable, in order to fulfil the functional requirements.

Section 7

Material and General Pipe Design

7.1 Goal

7.1.1 The goal of this Section is to ensure the safe handling of fuel, under all operating conditions, to minimize the risk to the ship, personnel and to the environment, having regard to the nature of the products involved.

7.2 Functional Requirements

7.2.1 This Section relates to functional requirements in 3.2.1, 3.2.5 to 3.2.10 and 3.2.13. In particular the following apply:

.1 Fuel piping is to be capable of absorbing thermal expansion or contraction caused by temperatures of the fuel without developing substantial stresses.

.2 Provision is to be made to protect the piping, piping system and components and fuel tanks from excessive stresses due to thermal movement and from movements of the fuel tank and hull structure.

.3 If the fuel gas contains heavier constituents that may condense in the system, means for safely removing the liquid is to be fitted.

.4 Low-temperature piping is to be thermally isolated from the adjacent hull structure, where necessary, to prevent the temperature of the hull from falling below the design temperature of the hull material.

.5 Materials are to be selected considering the relevant properties of ammonia. Consideration is to be given to the corrosiveness of the fuel according to the relevant environment conditions, including stress corrosion cracking. System components other than piping that are likely to come into contact with and be degraded by ammonia in a leakage scenario are to be compatible with ammonia.

.6 Fuel piping is to be designed to prevent fuel from unintended accumulation in piping in consideration of the characteristics of ammonia. In addition, fuel piping is to be arranged for emptying, inerting and gas freeing.

7.3 General Pipe Design

7.3.1 Fuel piping systems for liquid ammonia are to, as a minimum, have a design pressure of 18 bar, corresponding to the vapour pressure of ammonia at 45°C, in order to prevent venting of ammonia in idle conditions. Fuel piping systems for gaseous ammonia are to, as a minimum, have a design pressure of 10 bar. For fuel piping systems for liquid ammonia fitted with closed-loop pressure relief arrangements routed back to the fuel storage tank, the minimum design pressure is to as a minimum have a design pressure of 10 bar.

7.3.2 Expansion joints and bellows are not to be used in ammonia fuel piping systems. Engine-mounted expansion bellows could be accepted based on evaluation, as reflected in the safety concept of the engine.

7.3.3 Anhydrous ammonia may cause stress corrosion cracking in containment and process systems made of carbon-manganese steel or nickel steel. To minimize the risk of this occurring, measures detailed in Part 5, Chapter 4, Section 17, Cl. 17.12.2 to 17.12.7 of the Main Rules are to be taken, as appropriate.

IR7.4 Requirements for Materials

IR7.4.1 In general, requirements for materials are to be in accordance with Part 2 of the Main Rules.

IR7.4.2 Materials for fuel containment, fuel piping and process pressure vessels are to be in accordance with Part 5, Chapter 35, Cl. 7.4 of Main Rules.

IR7.4.3 Materials that may be directly exposed to ammonia during normal operations are to be resistant to the corrosive actions and environmentally assisted cracking associated with ammonia service.

IR7.4.4 Anhydrous ammonia may, under certain conditions, cause stress corrosion cracking in containment and process systems constructed from susceptible materials. To minimize the risk of this occurring in carbon manganese and nickel steels, specific measures detailed in Part 5, Chapter 4, Cl.17.12.2 to 17.12.8 of Main Rules are to be taken, as appropriate.

IR7.4.5 Materials of construction such as aluminum and austenitic stainless steel may be applied in ammonia service as permitted by Pt.5, Ch.35, Section 7 of the Main Rules. Subject to review and agreement of IRS, other materials may be considered for ammonia service provided they meet design criteria, are suitable at the service temperatures, and sufficient corrosion data and environmental cracking susceptibility data exists.

IR7.4.6 In addition, mercury, cadmium, copper, zinc or alloys of these materials are not to be used as materials of construction for fuel tanks and associated pipelines, valves, fittings and other items of equipment normally in direct contact with the ammonia liquid or vapor.

IR7.4.7 Components of rubber or plastic materials that are likely to deteriorate if exposed to ammonia are not to be used. Subject to review and agreement of IRS, certain rubbers and plastics may be considered for ammonia service provided they meet design criteria, are suitable at the service temperatures, aging properties are established as appropriate for the design life, and sufficient corrosion data and environmental cracking/damage susceptibility data exists.

7.5 Other Requirements

7.5.1 Other Material and General Pipe Design requirements in Part 5, Chapter 35, Section 7 of Main Rules are to be taken into account, where applicable, in order to fulfil the functional requirements.

Section 8

Bunkering

8.1 Goal

8.1.1 The goal of this Section is to provide for suitable systems on board the ship to ensure that bunkering can be conducted without causing danger to persons, the environment or the ship.

8.2 Functional Requirements

8.2.1 This Section relates to functional requirements in 3.2.1 to 3.2.12 and 3.2.14 to 3.2.18. In particular, the following is to apply:

.1 The piping system for transfer of fuel to the storage tanks are to be designed such that any leakage from the piping system cannot cause danger to persons, the environment or the ship.

8.3 Requirements for Bunkering Station

8.3.1 General

8.3.1.1 Enclosed or semi-enclosed bunkering stations are to be gastight towards adjacent spaces. The term "adjacent" includes linear contact and point contact.

8.3.1.2 Air intakes and openings in accommodation spaces, service spaces, engine rooms and control stations are not to be located in hazardous and toxic areas associated with bunkering stations.

8.3.1.3 Connections and piping are to be so positioned and arranged that any damage to the bunkering piping does not cause damage to the ship's fuel containment system resulting in an uncontrolled fuel discharge.

8.3.1.4 Bunkering piping is not to be led through accommodation spaces, service spaces, electrical equipment rooms or control stations. Where bunkering piping is arranged in other enclosed spaces, bunkering piping is to pass through a secondary enclosure meeting the requirements of 9.5.1.

8.3.1.5 Arrangements are to be made for safe management of any spilled fuel.

8.3.1.6 Suitable means are to be provided to relieve the pressure and remove ammonia contents from pump suctions and bunker lines. Ammonia is to be discharged to the fuel tanks or other suitable location.

8.3.1.7 The surrounding hull or deck structures are not to be exposed to unacceptable cooling, in case of leakage of fuel.

8.3.2 Ship's fuel hoses

8.3.2.1 Liquid and vapour hoses used for fuel transfer are to be compatible with the fuel and suitable for the fuel temperature.

8.3.2.2 Hoses subject to tank pressure, or the discharge pressure of pumps or vapour compressors, are to be designed for a bursting pressure not less than five times the maximum pressure the hose can be subjected to during bunkering. Hoses are to be regularly visually inspected, and hydrostatic pressure tested periodically at not more than a five-year interval.

8.3.2.3 Where fuel hoses are stored on the open deck or in a storage room, arrangements are to be made for safe storage of the hoses.

IR8.3.2.4 When the fuel hoses are stored in an enclosed space, the space is to be adequately mechanically ventilated.

8.4 Requirements for Manifold

8.4.1 The bunkering manifold is to be designed to withstand the external loads during bunkering. The connections at the bunkering station are to be arranged in order to achieve a dry-disconnect operation in one of the followings ways:

.1 a dry-disconnect/connect coupling;

.2 a manual connect coupler or hydraulic connect coupler, used to connect the bunker system to the receiving vessel bunkering manifold presentation flange; or

.3 a bolted flange to flange assembly.

8.4.2 When intended to use either of the connections specified in 8.4.1.2 and 8.4.1.3, these are to be combined with operating procedures that ensure a dry-disconnect is achieved. The arrangement is to be subject to special consideration informed by a bunkering arrangement risk assessment conducted at the design stage and considering dynamic loads at the bunkering manifold connection, the safe operation of the ship and other hazards that may be relevant to the ship during bunkering operation. The fuel handling manual required by 19.2.1.3 is to include documentation that the bunkering arrangement risk assessment was conducted, and that special consideration was granted under this requirement.

8.4.3 An emergency release coupler (ERC)/emergency release system (ERS) or equivalent means are to be provided, unless installed on the bunkering supply side of the bunkering line. It is to enable a quick physical disconnection "dry break-away" of the bunker system in an emergency event.

8.5 Requirements for Bunkering System

8.5.1 Bunkering system arrangements are to be in accordance with Part 5, Chapter 35, Cl.8.5.1 to 8.5.6 and 8.5.8 of Main Rules.

8.5.2 Vapour return line, where fitted, is to be sized adequately taking into consideration the expansion ratio of the fuel during bunkering operations.

8.5.3 A bunkering-safety link (BSL), or an equivalent means for automatic and manual ESD communication to the bunkering source is to be fitted.

8.5.4 Sampling valves, if fitted, is to be arranged at suitable locations in the bunkering line to allow verification procedures to confirm that the bunkering line is safe before opening any flanges. A double shut-off, blank flange or plug is to be installed on sampling valves in the bunkering line.

8.6 Gas Detection

8.6.1 All bunker stations and ventilated ducts, or double wall piping systems, around fuel bunker pipes are to be fitted with permanently installed gas detectors for leak detection, suitable for flammability and toxicity, in accordance with Cl.16.8.

8.6.2 Monitoring and safety system functions are to be provided in accordance with Section 16.

Section 9

Fuel Supply to Consumers

9.1 Goal

9.1.1 The goal of this Section is to ensure safe and reliable distribution of fuel to the fuel consumers.

9.2 Functional Requirements

9.2.1 This section is related to functional requirements in 3.2.1 to 3.2.6, 3.2.8 to 3.2.12 and 3.2.14 to 3.2.18. In particular, the following apply:

.1 the fuel supply system is to be designed so as to avoid direct release of ammonia to the atmosphere during normal operation and during any foreseeable and controllable abnormal scenario, while providing safe access for operation and inspection. The causes and consequences of ammonia gas release are to be given special consideration when carrying out the risk assessment required by 4.2;

.2 the piping system for fuel transfer to the fuel consumers is to be designed in a way that a failure of one barrier cannot lead to a leak from the piping system into the surrounding area causing danger to the persons on board, the environment or the ship;

.3 fuel lines outside the machinery spaces are to be installed and protected so as to minimize the risk of injury to personnel and damage to the ship in case of leakage;

.4 the fuel supply system is to be designed and arranged not to cause unintentional phase changes within the fuel supply system; and

.5 operational gas releases are to be collected and handled by a suitable ammonia release mitigation system.

9.3 Redundancy of Fuel Supply

9.3.1 Redundancy of fuel supply systems is to be in accordance with Part 5, Chapter 35, 9.3 of Main Rules.

9.4 Safety Functions of the Fuel Supply System

9.4.1 Fuel storage tank inlets and outlets are to be provided with valves located as close to the tank as possible. Valves required to be operated during normal operation* which are not accessible are to be remotely operated. Tank valves whether accessible or not are to be automatically operated when the safety system required in Section 16.2.2 is activated..

Note: *Normal operation in this context is when fuel is supplied to fuel consumers and during bunkering operations.

9.4.2 The main fuel supply line and return lines to each consumer or set of consumers are to be equipped with a manually operated stop valve and an automatically operated "master fuel valve" coupled in series or a combined manually and automatically operated valve. The valves are to be situated in the part of the piping that is outside the machinery space containing fuel consumers and placed as near as possible to the installation for heating the fuel, if fitted. The master fuel valve is to automatically shut off the fuel supply when activated by the safety system required in Section 16.2.2.
If the master fuel valve is located in an enclosed space such as a fuel preparation room, that space is to be protected against fuel leakage by another automatic shutdown valve arranged for closure in the event that gas or leakage is detected within the enclosed space, or loss of ventilation for the duct or

casing of the double wall fuel piping occurs. That additional automatic shutdown valve may be the fuel tank outlet valve required by Cl.9.4.1.

9.4.3 The automatic master gas fuel valve is to be operable from safe locations on escape routes inside a machinery space containing a gas consumer, the engine control room, if applicable; outside the machinery space, and from the navigation bridge.

9.4.4 The fuel supply lines to fuel preparation rooms are to be equipped with automatically operated shut-off valves situated at the bulkhead inside the fuel preparation room.

9.4.5 Each fuel consumer is to be provided with a "double block and bleed" valves arrangement. These valves are to be arranged as indicated in i) or ii) below, so that when the safety system required in Section 16.2.2 is activated this will cause the shutoff valves that are in series to close automatically and the bleed valve to open automatically, and:

i) the two shut-off valves are to be in series in the fuel pipe to the consuming equipment. The bleed valve is to be in a pipe that vents to a suitable ammonia release mitigation system that portion of the fuel piping that is between the two valves in series; or

ii) the function of one of the shutoff valves in series and the bleed valve can be incorporated into one valve body, so arranged that the flow to the fuel utilization unit will be blocked and the ventilation opened.

9.4.6 The two valves are to be the fail-to-close type, while the ventilation valve is to be fail-to-open.

9.4.7 The fuel supply system is to include an ammonia release mitigation system capable of collecting and handling ammonia releases, including but not limited to:

i) bleed from double block and bleed arrangements on the fuel piping systems;

ii) releases from the opening of pressure relief valves in the fuel piping system; and

iii) releases from purging and draining operations of fuel pipes.

9.4.8 The release mitigation system is to be capable of reducing the ammonia concentration to below 110 ppm. Discharges from the release mitigation system should be arranged in accordance with 6.7.2.

9.4.9 Where fuel supply systems supply ammonia in the liquid state, relevant bleed lines and vent lines are to be led to the fuel tank or gas-liquid separator or similar device to prevent ammonia liquid from being released to the atmosphere.

9.4.10 The double block and bleed valves are also to be used for normal stop of the engine.

9.4.11 In cases where the master fuel valve is automatically shut down when the safety system as required in Section 16.2.2 is activated, the complete fuel supply branch downstream of the double block and bleed valve is to be automatically purged through the ammonia release mitigation system.

9.4.12 There is to be one manually operated shutdown valve in the fuel supply line to each engine upstream of the double block and bleed valves to provide isolation during maintenance of the engine. Where fuel is recirculated from each engine to the fuel supply piping, one manually operated shutoff valve should also be provided downstream of the double block bleed valve in the fuel return piping for each engine.

9.4.13 For single-engine installations and multi-engine installations, where a separate master fuel valve is provided for each consumer, the master fuel valve and the double block and bleed valve functions can be combined.

9.4.14 Where gaseous ammonia fuel is supplied to a consumer, provisions are to be made to prevent ammonia condensate from entering the consumer.

IR9.4.15 Where the fuel treatment or vent control systems utilize water scrubbing or treatment systems, these are to be arranged to be independent of other water treatment or bilge systems and arranged to collect residues or contaminated water in holding tanks for further processing or disposal ashore.

IR9.4.16 The transient response characteristics of the fuel supply and control systems are to be such that transient variations in fuel demand would not cause unintended shutdown of the fuel supply system.

9.5 Fuel Distribution Outside of Machinery Spaces

9.5.1 Fuel pipes are to be protected by a secondary enclosure. This enclosure can be a duct or a double wall piping system. The duct or double wall piping system is to be fitted with gas detection as required in 16.8. Other solutions providing an equivalent safety level may also be accepted by the IRS/Administration.

9.5.2 The provision in 9.5.1 need not be applied for fuel pipes located in a fuel preparation room or tank connection space.

9.5.3 Where gas detection as required in 16.8.2.2 is not fit for purpose, the secondary enclosures around liquefied fuel pipes are to be provided with leakage detection by means of pressure or temperature monitoring systems, or any combination thereof.

9.5.4 The provision in 9.5.1 also applies for fuel vent pipes, except for open-ended fully welded fuel vent pipes in open air.

9.6 Other Requirements

9.6.1 Other fuel supply system requirements in Part 5, Chapter 35, Section 9 of Main Rules are to be taken into account, where applicable, in order to fulfil the functional requirements.

Section 10

Power Generation including Propulsion and other Energy Consumers

10.1 Goal

10.1.1 The goal of this Section is to provide requirements for the safe and reliable delivery of mechanical, electrical or thermal energy.

10.2 Functional Requirements

10.2.1 This section is related to functional requirements in 3.2.1, 3.2.12, 3.2.14, 3.2.17 and 3.2.18. In particular, the following apply:

.1 the exhaust systems are to be configured to prevent any accumulation of unburnt fuel;

.2 unless designed with the strength to withstand the worst-case overpressure due to ignited fuel leaks, engine components or systems containing or likely to contain an ignitable ammonia gas and air mixture are to be fitted with suitable pressure relief systems. Dependent on the particular engine design this may include the air inlet manifolds and scavenge spaces;

.3 the explosion venting is to be led away from where persons may normally be present;

.4 all fuel consumers are to have a separate exhaust system; and

.5 the possibility of ammonia leakage from fuel consumers into the auxiliary system, such as cooling water systems and its consequences, is to be minimized.

10.3 General

10.3.1 Power generation systems requirements in Part 5, Chapter 35, Section 10 of Main Rules are to be taken into account, where applicable, in order to fulfil the functional requirements

IR10.3.2 Internal combustion engines intended to use ammonia as fuel are to be designed, tested and certified in accordance with Pt.4 Ch. 4, Sec.4, Pt. 5, Ch. 4, Sec.16 and Pt. 5, Ch. 35, Sec. 10, as applicable, of Main Rules. The fuel specification required by the engine is to be declared by the manufacturer and detailed in the operation and maintenance manuals.

IR10.3.3 As applicable, where the engine auxiliary systems are likely to contain ammonia in abnormal conditions as a result of a component failure (also refer Cl. IR10.3.4 and IR10.3.2), they are to be arranged with means to detect leakage. Alarm is to be given when the presence of ammonia is detected. Auxiliary circuits are to be arranged in a closed system with pressure protection. Vent pipes are to be independent and to be led to the vent mast or riser location.

IR10.3.4 A Failure Modes and Effects Analysis (FMEA) is to be carried out by the engine manufacturer in order to determine necessary additional safeguards to address the hazards associated with the use of ammonia as a fuel, for example, protection against explosion, cylinder overpressure, etc. This requirement is in addition to, but may be included by revision of, the FMEA required by IRS Classification Note: *Approval of IC Engines*. The analysis is to identify all plausible scenarios of fuel leakage and the resulting hazards. Then the analysis is to identify necessary means to control the identified hazards.

IR10.4 Dual-Fuel Engines

IR10.4.1 Dual fuel internal combustion engines are to be arranged in accordance with Pt.5, Ch.35, Cl. 10.3.2 of Main Rules.

IR10.4.2 Dual fuel internal combustion engine type testing is to include verification of the exhaust and crankcase breather, or under piston space, limits of Cl.10.3.5.

IR10.5 Fuel Cells

IR10.5.1 Fuel cell systems using ammonia are to comply with the relevant requirements given in IRS Guidelines on *Vessels with Fuel Cell Power Installations*.

Section 11

Fire Safety

11.1 Goal

11.1.1 The goal of this Section is to provide fire protection, detection and fighting for all system components related to storage, conditioning, transfer and use of ammonia as ship fuel.

11.2 Functional Requirements

11.2.1 This section is related to functional requirements in 3.2.2, 3.2.4, 3.2.5, 3.2.6, 3.2.7, 3.2.13, 3.2.15, 3.2.16 and 3.2.18.

11.3 General

11.3.1 Fire safety requirements in Part 5, Chapter 35, Section 11 of Main Rules are to be taken into account, where applicable, in order to fulfil the functional requirements.

Section 12

Explosion Prevention

12.1 Goal

12.1.1 The goal of this Section is to provide for the prevention of explosions and for the limitation of effects from explosion.

12.2 Functional Requirements

12.2.1 This section is related to functional requirements in 3.2.2 to 3.2.5, 3.2.7, 3.2.8, 3.2.13, 3.2.15 and 3.2.18. In particular the following apply:

12.2.2 The probability of explosions is to be reduced to a minimum by:

a) reducing the number of sources of ignition;

b) reducing the probability of the formation of ignitable mixtures

12.3 General

12.3.1 Explosion prevention requirements in Part 5, Chapter 35, Section 12 of Main Rules are to be taken into account, where applicable, in order to fulfil the functional requirements.

Section 13

Prevention of Exposure to Toxicity

13.1 Goal

13.1.1 The goal of this chapter is to provide for the prevention of exposure to toxic gases.

13.2 Functional Requirements

13.2.1 This section is related to functional requirements in 3.2.2 to 3.2.5, 3.2.7, 3.2.9, 3.2.14 and 3.2.17. In particular, the following apply:

13.2.2 The probability of exposure to toxic gases is to be reduced to a minimum by considering arrangement and location of:

.1 potential sources of ammonia release, such as valves flanges and fittings;

.2 outlet from pressure relief valves;

.3 openings from spaces where ammonia leakages may occur;

.4 bunker stations;

.5 active or passive systems to prevent ammonia propagation to adjacent spaces or areas;

.6 openings to the vessel interior needing to be protected from intake of toxic gas; and

.7 safe havens, life-saving appliances and emergency escapes.

13.3 General Provisions for Toxic Exposure Protection

13.3.1 Toxic area and space classification is a method of analyzing and classifying the areas where ammonia vapour is or may be expected to be present. The objective of the classification is to limit the risk of direct exposure to ammonia for persons on board.

13.3.2 Toxic areas and spaces are defined to allow for a safe arrangement preventing cross-contamination from ammonia releases, and to facilitate safe arrangement of life-saving appliances, emergency escapes, air intakes, outlets and other openings into the accommodation, service and machinery spaces, control stations and other non-toxic spaces.

13.4 Provisions for Toxic Area and Space Classification

13.4.1 Toxic areas include, but are not limited to:

.1 areas on open deck within 10 [m] of any flanges, valves, and other potential leakage sources in ammonia fuel systems;

.2 areas on open deck within B (breadth) or 25 [m], whichever is less, from outlets from the pressure relief valves installed on a liquefied fuel gas tank and all other fuel gas vent outlets;

.3. areas on open deck within B or 25 [m], whichever is less, from outlets from interbarrier spaces for type A tanks;

.4 areas on open deck within 10 [m] from outlets from interbarrier spaces for type B tanks;

.5 areas on open deck within 10 [m] from outlets from secondary enclosures around ammonia piping, ventilation outlets from tank connection spaces and fuel preparation rooms and other spaces containing ammonia leakage sources;

.6 areas on open deck within 5 [m] from inlets to secondary enclosures around ammonia piping, ventilation inlets to tank connection spaces and fuel preparation rooms and other spaces containing ammonia leakage sources; and

.7 areas on open deck within 5 [m] from entrance openings to spaces containing ammonia leakage sources.

13.4.2 Toxic spaces include, but are not limited to:

.1the interiors of fuel tanks, any pipework for pressure-relief or other venting systems for fuel tanks, pipes and equipment containing fuel;

.2 tank connection spaces, interbarrier spaces and fuel storage hold spaces for tank containment systems requiring secondary barriers;

.3 fuel preparation rooms;

.4 annular space of secondary enclosures around fuel pipes; and

.5 enclosed and semi-enclosed spaces in which potential sources of release, such as single-walled piping containing fuel, are located.

13.4.3 In addition to the toxic area requirements in this section, a dispersion analysis is to be carried out in order to determine the extent of a toxic area. The gas dispersion analysis is to demonstrate that ammonia concentrations exceeding 220 ppm do not reach:

.1 air intakes, outlets and other openings into the accommodation;

.2 service and machinery spaces;

.3 control stations;

.4 other non-toxic spaces in the ship; and

.5 other areas, as specified by IRS.

13.4.4 The toxic area determined by the dispersion analysis is to extend the minimum area as defined in 13.4.1, or lead to additional mitigation measures.

13.4.5 The dispersion analysis boundary conditions is to be approved by IRS. The analysis is to include discharges from the pressure relief valves protecting the tank containment system, discharges from secondary barriers around fuel tanks and discharges from secondary enclosures around ammonia leakage sources.

13.5 Provisions for Safe Havens

13.5.1 A safe haven providing refuge in case of a release of ammonia is to be arranged in one or more enclosed spaces with a cumulative total capacity to accommodate all persons on board. Safe havens are to be arranged, as necessary, at essential locations for the ship's operation. The space is to be designed to minimize the risk of exposure to ammonia during release of ammonia. This may be achieved by measures including, but not limited to, arrangement of ventilation systems or by arranging self-sustaining air supply for the space.

Section 14

Ventilation

14.1 Goal

14.1.1 The goal of this Section is to provide for the ventilation required for safe operation of ammonia-fueled machinery and equipment where ammonia is used as fuel.

14.2 Functional Requirements

14.2.1 This section is related to functional requirements in 3.2.2, 3.2.5, 3.2.8, 3.2.9, 3.2.11, 3.2.13, 3.2.14 and 3.2.17.

14.3 General

14.3.1 Ventilation requirements in Part 5, Chapter 35, Section 13 of Main Rules are to be taken into account, where applicable, in order to fulfil the functional requirements.

IR14.3.2 The ventilation arrangements are to take into account the density of any potential releases of ammonia. While gaseous anhydrous ammonia is lighter than air, it is hygroscopic and therefore readily absorbs moisture. Releases in the air may form vapours that are heavier than air. Therefore, ventilation outlets are to be provided both in the lowest and highest parts of the space and suitably protected.

IR14.3.3 The windows and side scuttles of accommodation spaces, service spaces and control stations, which are normally manned, and facing ammonia fuel tanks located on deck and/or the vent mast or riser location are to be of the fixed (non-opening) type.

Section 15

Electrical Installations

15.1 Goal

15.1.1 The goal of this Section is to provide for electrical installations that minimizes the risk of ignition in the presence of a flammable atmosphere.

15.2 Functional Requirements

15.2.1 This section is related to functional requirements in 3.2.1, 3.2.2, 3.2.4, 3.2.7, 3.2.8, 3.2.12, 3.2.13 and 3.2.16 to 3.2.18. In particular, the following apply:

15.2.2 Electrical generation and distribution systems, and associated control systems, are to be designed such that a single fault will not result in the loss of ability to maintain fuel tank pressure and temperature within normal operating limits.

15.3 General

15.3.1 Electrical installation requirements in Part 5, Chapter 35, Section 14 of Main Rules are to be taken into account, where applicable, in order to fulfil the functional requirements.

IR15.3.2 For the purposes of application of IEC standards and selection of electrical equipment, ammonia is treated as anhydrous ammonia with IEC LEL and UEL limits of 15% and 28% respectively. Electrical equipment is to meet ISO/IEC 80079-20-1 group IIA class T1. Gas detectors are to be in accordance with Cl.16.8.

Section 16

Control Monitoring and Safety Systems

16.1 Goal

16.1.1 The goal of this Section is to provide for the arrangement of control, monitoring and safety systems that support an efficient and safe operation of the ammonia-fueled installations as covered in the other chapters of these guidelines.

16.2 Functional Requirements

16.2.1 This section is related to functional requirements in 3.2.1, 3.2.2, 3.2.12, 3.2.13 to 3.2.15, 3.2.17 and 3.2.18 of these Guidelines. In particular, the following apply:

.1 the control, monitoring and safety systems of the ammonia-fueled installation are to be so arranged that the remaining power for propulsion and power generation is in accordance with Part 5, Chapter 35, Cl. 9.3.1 of the Main Rules, in the event of single failure;

.2 an ammonia safety system is to be arranged to close down the fuel supply system automatically, upon failure in systems as described in Table 1 and upon other fault conditions which may develop too fast for manual intervention;

.3 the safety functions are to be arranged in a dedicated gas safety system that is independent of the gas control system in order to avoid possible common cause failures. This includes power supplies and input and output signal;

.4 the safety systems including the field instrumentation are to be arranged to avoid spurious shutdown, e.g. as a result of a faulty gas detector or a wire break in a sensor loop; and

.5 where two or more fuel supply systems are required to meet the provisions, each system is to be fitted with its own set of independent fuel control and fuel safety systems.

16.3 General Requirements

16.3.1 Suitable instrumentation devices are to be fitted to allow a local and a remote reading of essential parameters to ensure a safe management of the whole fuel gas equipment including bunkering.

16.4 Requirements for Bunkering and Fuel Tank Monitoring

16.4.1 Each fuel tank is to be provided with means for indicating fuel level, pressure and temperature.

16.4.2 The fuel tank level and overflow control monitoring arrangements are to be in accordance with Part 5, Chapter 35, Cl.15.4 of Main Rules. Part 5, Chapter 35 15.4.7, 15.4.9 and 15.4.11 of the Main Rules are not applicable. “Liquefied gas fuel tank” in Part 5, Chapter 35, 15.4 is to be read as “fuel tank” while application under this clause.

16.4.3 The local pressure indicators should be provided to indicate the pressure between ship's bunker manifold valves and hose connections to the bunkering facility.

16.4.4 Each fuel tank should be provided with devices to measure and indicate the temperature of the fuel.

16.5 Requirements for Bunkering Control

16.5.1 Control of the bunkering is to be possible from a safe location remote from the bunkering station. At this location the tank pressure, tank temperature, and tank level is to be monitored. Remotely controlled valves required by Part 5, Chapter 35, Section 8, Cl. 8.5.3 are to be capable of being operated from this location. Overfill alarm and automatic shutdown are also to be indicated at this location.

16.5.2 If ammonia leakage is detected in the secondary enclosure around the bunkering lines, an audible and visual alarm are to be provided at the bunkering control location. The bunker valve and other valves required to isolate the leakage are to be automatically closed by the safety system in accordance with Table 1.

16.6 Requirement for Gas Compressor Monitoring

16.6.1 Gas compressors are to be fitted with audible and visual alarms both on the navigation bridge and in the engine control room. As a minimum, the alarms are to include low gas input pressure, low gas output pressure, high gas output pressure and compressor operation.

16.6.2 Where bulkhead penetrations are used to separate the drive from a hazardous space, temperature monitoring for the bulkhead shaft glands and bearings are to be provided, which automatically give a continuous audible and visual alarm on the navigation bridge or in a continuously manned central control station.

16.7 Requirements for Gas Engine Monitoring

16.7.1 Engine monitoring arrangements are to be in accordance with Part 5, Chapter 35, 15.7 of Main Rules.

16.8 Requirements for Leakage Detection

16.8.1 Where gas detection is to cause shutdown in accordance with Table 1, detector voting is to be applied where two units are to detect gas to activate shutdown. A failed detector is to be considered as an active detection.

16.8.2 Permanently installed gas detectors are to be fitted in:

.1 tank connection spaces;

.2 all secondary enclosures around fuel pipes;

.3 machinery spaces containing gas piping, gas equipment or gas consumers;

.4 fuel preparation rooms;

.5 bunkering stations and other enclosed spaces containing fuel piping or other fuel equipment not protected by a secondary enclosure;

.6 other enclosed or semi-enclosed spaces where fuel vapours may accumulate including interbarrier spaces and fuel storage hold spaces of independent tanks other than type C;

.7 airlocks and entry spaces to tank connection spaces;

.8 gas heating circuit expansion tanks;

.9 motor rooms for compressors as specified in 16.6.2 (if fitted);

.10 at ventilation inlets to accommodation and machinery spaces where required based on the risk assessment in 4.2;

.11 at ventilation inlets for safe haven;

.12 at outlet from tank pressure relief valves; and

.13 fuel hose storage space

16.8.3 The number of detectors in each space is to be considered taking into account the size, layout and ventilation of the space, and each space is to be covered by a sufficient number of detectors to allow for voting in accordance with Table 1.

16.8.4 The detection equipment is to be located where gas may accumulate and in the ventilation outlets. Gas dispersal analysis is to be used to find the best location of gas detectors.

16.8.5 Gas detection equipment is to be designed, installed and tested in accordance with a recognized standard.

16.8.6 Fuel piping is also to be arranged with the detection of liquid leakages in the secondary enclosure at the lowest point.

16.8.7 Each tank connection space, fuel preparation room and bunker station are to be provided with liquid leakage detection. Alarm should be given at high liquid level and low temperature indication should activate the safety system.

16.8.8 An audible and visible alarm is to be activated at an ammonia vapour concentration of 110 ppm as specified in Table 1. The safety system is to be activated at an ammonia vapour concentration of 220 ppm with actions as specified in Table 1. In addition, at an ammonia vapour concentration, a visual local indication is to be given at all entrances to enclosed spaces affected.

16.8.9 Audible and visible alarms from the leakage detection equipment is to be located on the navigation bridge, in the continuously manned central control station and inside and outside the space where the leakage is detected.

16.8.10 Gas detection required by this section is to be continuous without delay.

IR16.8.11 Where the ammonia gas detector range of operation cannot cover the ppm levels required for toxicity detection and the percentage (%) level required for fire and explosion detection, separate gas detectors covering each range of operation are required at each detector location. Monitoring is to be in accordance with Section 15.

IR16.8.12 Fuel preparation rooms are to be fitted with low oxygen level detection and alarm system.

16.9 Provisions for Prevention of Condensation in Fuel Supply Line

16.9.1 Where gaseous ammonia fuel is supplied to a consumer, the following are to be monitored:

.1 fuel pipe wall temperature; and

.2 fuel pressure.

16.9.2 The control system is to be capable of calculating the dynamic dew point based on measurements of fuel pressure and fuel pipe wall temperature. If fuel pipe wall temperature falls within 10°C of the calculated dew point of the fuel, the fuel system is to shut down and fuel system is to be purged of ammonia fuel.

16.10 Requirements for Ventilation

16.10.1 Any reduction of the required ventilating capacity in tank connection spaces, fuel preparation rooms or other enclosed spaces containing fuel piping or other fuel equipment not protected by a secondary enclosure is to give an audible and visual alarm on the navigation bridge and in a continuously manned central control station or safety centre. Loss of ventilation is to result in automatic closing of valves as specified in Table 1.

16.11 Requirements on Safety Functions of Fuel Supply Systems

16.11.1 If the fuel supply is shut off due to activation of an automatic valve, the fuel supply is not be opened until the reason for the disconnection is ascertained and the necessary precautions taken. A readily visible notice giving instruction to this effect is to be placed at the operating station for the shutoff valves in the fuel supply lines.

16.11.2 A caution placard or signboard is to be permanently fitted in the machinery space containing gas-fuelled engines, stating that heavy lifting, implying danger of damage to the fuel pipes, is not to be done unless the fuel supply lines are free from ammonia.

16.11.3 Compressors, pumps and fuel supply are to be arranged for manual remote emergency stop from the following locations as applicable:

.1 navigation bridge;
.2 cargo control room;
.3 onboard safety centre;
.4 engine control room;
.5 fire-control station; and
.6 adjacent to the exit of fuel preparation rooms.

16.11.4 The ammonia compressor is also to be arranged for manual local emergency stop.

Table 1: Monitoring of ammonia fuel installation						
Parameter	**Alarm**	**Automatic shutdown of bunker valve**	**Automatic shutdown of tank valve(s)**	**Automatic shutdown of fuel preparation room valve(s)**	**Automatic shutdown of master valve(s)**	**Comments**
Ammonia detection in enclosed spaces at 25 ppm	X (see comment)					Local indication at all entrances to the space, no alarm at the alarm system
High-level fuel tank	X					
High-high level fuel tank	X	X	X			
Submerged fuel pumps, low level in tank	X					Stop fuel pumps at low-low liquid level
Ammonia detection in bunker station at 110 ppm	X					
Ammonia detection in bunker station at 220 ppm		X				
Liquid leakage detection in bunker station	X	X				Close valve at low temperature
Ammonia detection in secondary enclosure around bunkering lines at 110 ppm	X					

Table 1: Monitoring of ammonia fuel installation (contd.)						
Parameter	**Alarm**	**Automatic shutdown of bunker valve**	**Automatic shutdown of tank valve(s)**	**Automatic shutdown of fuel preparation room valve(s)**	**Automatic shutdown of master valve(s)**	**Comments**
Ammonia detection in secondary enclosure around bunkering lines at 220 ppm		X	X			
Liquid leakage detection in secondary enclosure around bunkering lines	X	X	X			
Ammonia detection in tank connection space at 110 ppm	X					
Ammonia detection on two detectors in tank connection space at 220 ppm	X		X			
Liquid leakage detection in tank connection space	X		X			Close valve at low temperature
Ammonia detection in fuel preparation room at 110 ppm	X					

Table 1: Monitoring of ammonia fuel installation (contd.)						
Parameter	**Alarm**	**Automatic shutdown of bunker valve**	**Automatic shutdown of tank valve(s)**	**Automatic shutdown of fuel preparation room valve(s)**	**Automatic shutdown of master valve(s)**	**Comments**
Ammonia detection on two detectors in fuel preparation room at 220 ppm	X			X		
Liquid leakage detection in fuel preparation room	X			X		Close valve at low temperature
Ammonia detection in secondary enclosure of fuel supply piping at 110 ppm	X					
Ammonia detection on two detectors in secondary enclosure of fuel supply piping at 220 ppm	X		X	X	X	All valves required to isolate the leakage are to close. Transient releases which are expected in normal operation of the consumers are not to cause shutdown of the consumers.

Table 1: Monitoring of ammonia fuel installation (contd.)						
Parameter	**Alarm**	**Automatic shutdown of bunker valve**	**Automatic shutdown of tank valve(s)**	**Automatic shutdown of fuel preparation room valve(s)**	**Automatic shutdown of master valve(s)**	**Comments**
Liquid leakage detection in secondary enclosure of fuel supply pipes	X		X	X	X	All valves required to isolate the leakage are to close
Reduced ventilation in tank connection space	X					
Loss of ventilation in tank connection space			X			
Reduced ventilation in fuel preparation room	X					
Loss of ventilation in fuel preparation room				X		
Manually activated emergency shutdown of master fuel valve(s) engine	X				X	
Ammonia concentration from discharge of ARMS (Ammonia Release Mitigation System) at 110 ppm	X					

An alarm as indicated in Table 1 is to include an audible and visual alarm at a manned location in accordance with the 2009 Code on Alerts and Indicators.

Section 17

Manufacture, Workmanship and Testing

17.1 General

17.1.1 For manufacture, workmanship and testing, the requirements of Part 5, Chapter 35, Section 16, are to apply to ships using ammonia as fuel, where appropriate.

Section 18

Drills and Emergency Exercises

18.1 Drills and emergency exercises on board are to be conducted at regular intervals.

18.2 Such ammonia-related exercises could include, for example:

.1 tabletop exercise;

.2 review of fueling procedures based on the fuel handling manual;

.3 responses to potential contingencies;

.4 tests of equipment intended for contingency response; and

.5 reviews that assigned seafarers are trained to perform assigned duties during fueling and contingency response.

18.3 Ammonia-related exercises may be incorporated into periodical drills required by SOLAS.

18.4 The response and safety system for hazards and accident control are to be reviewed and tested.

Section 19

Operation

19.1 Goal

19.1.1 The goal of this chapter is to ensure that operational procedures for the loading, storage, operation, maintenance and inspection of systems for ammonia minimize the risk to persons, the ship, and the environment, and that they are consistent with practices for a conventional oil-fueled ship whilst taking into account the nature of ammonia.

19.2 Functional Requirements

19.2.1 This section relates to the functional requirements in 3.2.1 to 3.2.3, 3.2.10, 3.2.12, 3.2.15, 3.2.16 and 3.2.17 of these Guidelines. In particular, the following apply:

.1 a copy of these Guidelines, or national regulations incorporating the provisions of the same, is to be on board every ship covered by these Guidelines;

.2 maintenance procedures and information for all ammonia-related installations are to be available on board;

.3 the ship is to be provided with operational procedures including a suitably detailed fuel handling manual, such that trained personnel can safely operate the fuel bunkering, storage and transfer systems; and

.4 the ship is to be provided with suitable emergency procedures.

Section 20

Training

20.1 Goal

20.1.1 The goal of this chapter is to ensure that seafarers on board ships to which these Guidelines apply are adequately qualified, trained and experienced.

20.2 Functional Requirements

20.2.1 The company is to ensure that seafarers on board ships using ammonia fuel are to have completed training to attain the abilities that are appropriate to the capacity to be filled, and duties and responsibilities to be taken up.

20.2.2 The master, officers, ratings and other personnel on ships using ammonia fuel are to have received training and be qualified in the use of gaseous fuel in accordance with the STCW Convention and the STCW Code, taking into account the specific hazards of ammonia.

Section 21

Personnel Protection

21.1 Goal

21.1.1 The goal of this chapter is to ensure that protective equipment is provided for persons on board, considering both routine operations and emergency situations and possible short- or long-term effects of ammonia exposure.

21.2 Functional Requirements

21.2.1 This section relates to functional requirements in 3.2.1, 3.2.12 and 3.2.16. In particular the following apply:

.1 For the protection of crew members who are engaged in operations, maintenance of ammonia fuel systems, and emergency response, the ship is to have on board protective equipment suitable for ammonia exposure, taking the exposure risk of different operations into account;

.2 For the protection and treatment of crew members affected by ammonia leakages, the ship is to have on board suitable emergency equipment; and

.3 Suitable respiratory and eye protection for emergency escape purposes are to be provided for every person on board.

21.3 Protective equipment

21.3.1 Suitable protective equipment, including eye protection, to a recognized national or international standard, are to be provided for the protection of crew members engaged in normal operations related to the ammonia fuel system.

21.3.2 Personal protective and safety equipment required in this chapter are to be kept in suitable, clearly marked lockers located in readily accessible places.

21.4 Emergency equipment

21.4.1 Suitably marked decontamination showers and eyewashes are to be available in convenient locations:

.1 close to bunkering stations;

.2 close to exit from tank connection spaces;

.3 close to exit from fuel preparation rooms;

.4 in machinery spaces for ammonia-fuelled consumers; and

.5 close to lifeboat embarkation stations.

21.4.2 The showers and eyewashes are to be operable in all ambient conditions. A heating system with temperature control is required if pipe routeing of the water supply exposes the piping to freezing conditions. Water supply capacity is to be sufficient for simultaneous use of at least two units. Thermal insulation is not considered as an alternative to a system with temperature control.

21.4.3 A stretcher that is suitable for hoisting an injured person from spaces, such as tank hold spaces, should be kept in a readily accessible location.

21.4.4 The ship should have onboard medical first aid equipment, including oxygen resuscitation equipment, based on the requirements of the Medical First Aid Guide (MFAG) for ammonia.

21.4.5 Suitable respiratory and eye protection for emergency escape purposes are to be provided for every person on board, subject to the following:

.1 filter-type respiratory protection is unacceptable;

.2 self-contained breathing apparatus should have at least 15 minutes of service time; and

.3 emergency escape respiratory protection is not to be used for fire-fighting or cargo handling purposes and is to be marked to that effect.

21.5 Safety equipment

21.5.1 Sufficient, but not less than three complete sets of safety equipment, is to be provided in addition to fire-fighter's outfits required by SOLAS regulation II-2/10.10. These additional sets are to provide adequate personal protection to permit entry and work in a gas-filled space, and be equipped with two-way portable radiotelephone apparatus comprising of earpiece with microphone and push-to-talk units. This equipment is to consider the nature of ammonia.

21.5.2 Each complete set of safety equipment is to consist of:

.1 one self-contained positive pressure air breathing apparatus incorporating full face mask not using stored oxygen and having a capacity of at least 1,200 litres of free air. Each set is to be compatible with that required by SOLAS regulation II-2/10.10;

.2 gastight protective clothing, boots and gloves to a recognized standard;

.3 steel-cored rescue line with belt; and

.4 explosion-proof lamp.

21.5.3 An adequate supply of compressed air should be provided and should consist of:

.1 at least one fully charged spare air bottle for each breathing apparatus required by 21.5.1;

.2 an air compressor of adequate capacity capable of continuous operation, suitable for the supply of high-pressure air of breathable quality; and

.3 a charging manifold capable of dealing with sufficient spare breathing apparatus air bottles for the breathing apparatus required by 21.5.1.

21.5.4 The compressed air equipment is to be inspected at least once a month by a responsible officer and the inspection should be logged in the ship's records. This equipment should also be inspected and tested by a competent person at least once a year.

Section 22

Surveys

22.1 Annual Surveys

The surveys are to include applicable sections of Pt.1, Ch.2, (including Sec.20) of Main Rules. Additionally, annual surveys are to include:

a) Functional testing of water screens above access doors for fuel preparation room.

b) Functional testing of gas evacuation system for fuel preparation room.

c) Functional testing of alarms for monitoring and safety functions.

d) Functional testing of eyewash and decontamination showers.

e) Operational testing of fuel treatment or vent control systems utilizing water scrubbing or water treatment systems.

f) Operational testing of associated exhaust after treatment systems.

g) Testing of portable gas detectors for ammonia.

h) Testing of fixed gas detection for ammonia.

i) Testing of gas detection:

j) Examination of toxic areas and ventilation intakes including gas detection system for ammonia.

k) Examination of all other personnel safety and PPE specific to ammonia.

End of Guidelines