GUIDANCE NOTES
GD15-2022

CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR SHIPS USING AMMONIA FUEL

2022

Effective from 1, July 2022

Beijing

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CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.1 Application

1.1.1.1 The Guidelines For Ships Using Ammonia Fuel (hereinafter referred to as the Guidelines) apply to ships of 20 m in length and above, constructed by steel or equivalent metallic material and using ammonia fuel or ready for an ammonia power system (hereinafter referred to as ammonia fueled ships), except liquefied gas carriers. Where ammonia fuel is used on ships of less than 20 m in length and constructed by steel or equivalent metallic material, a risk assessment is to be conducted, and the Guidelines may be referred to at the discretion of China Classification Society (CCS).

1.1.1.2 In addition to the Guidelines, ammonia fueled ships are to comply with the relevant requirements of CCS Rules for Classification of Sea-going Steel Ships, Rules for the Construction of Inland Waterways Steel Ships or Regulations for Classification of Inland Waterways Ships (hereinafter referred to as CCS Rules). These ships are also to comply with the related provisions (if any) of the Administration of the flag State. In addition to the above requirements, ships using ammonia fuel cells are to comply with CCS Guidelines for Ships Using Fuel Cell Power Installations.

1.1.1.3 A ship applying for assignment of the class notation of ammonia power system ready is to comply with Chapter 13 of the Guidelines.

1.1.2 Definitions

Unless expressly provided in this Section, the relevant definitions in CCS Rules for Ships Using Natural Gas Fuel apply for the Guidelines.

1.1.2.1 **Fuel** means the ammonia fuel (anhydrous) (UN 1005) which is appropriate for safe application on board and can satisfy the requirements for the operation of engines, fuel cells and so on.

1.1.2.2 **Breadth of ship, *B***, is the breadth of ship defined in CCS Rules.

1.1.2.3 **Bunkering** means the transfer of fuel from land based or floating facilities into a ship's permanent tank.

1.1.2.4 **Bunkering station** means a location or a space where a fuel bunkering system is installed, including bunkering connections, gas return connections (if any), related valves and control systems.

1.1.2.5 **Certified safe type** means electrical equipment that is certified safe by the relevant authorities recognized by CCS for operation in a flammable atmosphere according to a standard accepted① by CCS.

1.1.2.6 **Fuel containment system** is the arrangement for the storage of fuel including tank connections. It includes where fitted, a primary and secondary barrier, associated insulation and any intervening spaces (if fitted), and adjacent structure if necessary for the support of these elements. If the secondary barrier is part of the hull structure it may be a boundary of the fuel storage hold space.

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 containment system is situated. If tank connections are located in the fuel storage hold space, it will also be a tank connection space;

(2) Interbarrier space is the space between a primary and a secondary barrier, whether or not completely or partially occupied by insulation or other material;

(3) Tank connection space is a space surrounding all tank connections and tank valves.

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① E.g. IEC 60079 series, Explosive atmospheres and IEC 60092-502:1999 Electrical Installations in Ships – Tankers – Special Features, or GB 3836 Explosive atmospheres.

Equipment, such as vaporizers or heat exchangers may be located in the tank connection space. Such equipment is considered to contain only potential sources of release, but not sources of ignition.

The aforementioned terms refer to Figure 1.1.2.6, taking a type C independent tank.

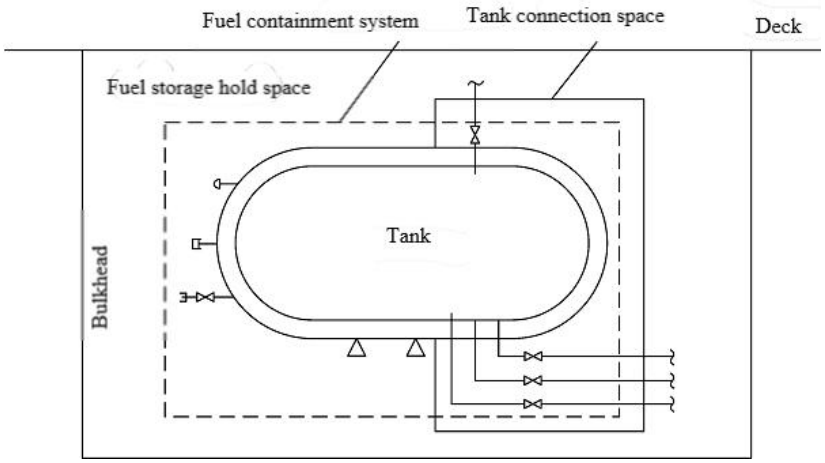

Figure 1.1.2.6 Example of Fuel Containment System in Enclosed Space

1.1.2.7 **Fuel preparation room** means any space containing pumps, heat exchangers, filters and so on for fuel preparation purposes.

1.1.2.8 **Fuel valve unit space** means a gastight space or a valve box inside which valves are fitted for controlling or adjusting the fuel supply to the engine.

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

1.1.2.10 **Membrane tanks** are non-self-supporting tanks that consist of a thin liquid and gas tight layer (membrane) supported through insulation by the adjacent hull structure.

1.1.2.11 **Filling limit (FL)** means the maximum liquid volume in a fuel tank relative to the total tank volume when the liquid fuel has reached the reference temperature.

1.1.2.12 **Loading limit (LL)** means the maximum allowable liquid volume relative to the tank volume to which the tank may be loaded.

1.1.2.13 **Reference temperature** means the temperature corresponding to the vapour pressure of the fuel in a fuel tank at the set pressure of the pressure relief valves (PRVs).

1.1.2.14 **Dual fuel engine** means engines that employ fuel defined in 1.1.2.1 and oil fuel (with pilot oil or an ignition plug), which may operate on oil fuel only.

1.1.2.15 **Single fuel engine** means an engine capable of operating on a fuel defined as in 1.1.2.1 only.

1.1.2.16 **Ammonia engine** means a dual fuel engine or a single fuel engine mentioned above.

1.1.2.17 **High pressure fuel piping system** means a fuel piping system having a maximum operating pressure of above 1 MPa.

1.1.2.18 **Double block and bleed valve** means a set of two valves in series in a pipe and a third valve enabling the pressure release from the pipe between those two valves. The arrangement may also consist of a two-way valve and a closing valve instead of three separate valves.

1.1.2.19 **Tank master valve** means a remote stop valve located in the gas supply line to each tank and as close to the tank outlet as possible. The tank master valve is to be of the fail-closed type (closed on loss of power).

1.1.2.20 **Hazardous area** means an area in which an explosive gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment.

Hazardous areas are divided into:

(1) Hazardous area zone 0 is an area in which an explosive gas atmosphere is present continuously or is present for long periods.

(2) Hazardous area zone 1 is an area in which an explosive gas atmosphere is likely to occur in normal operation.

(3) Hazardous area zone 2 is an area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only.

1.1.2.21 **Non-hazardous area** means an area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of equipment.

1.1.2.22 **Open deck** means a deck having no significant fire risk that at least is open on both ends/sides, or is open on one end and is provided with adequate natural ventilation that is effective over the entire length of the deck through permanent openings distributed in the side plating or deckhead.

1.1.2.23 **Emergency shutdown (ESD)** means the shutdown of power plant, fuel supply and power supply of non-explosion-proof electrical equipment etc, without delay, in order to prevent the damage to the surrounding environment and personnel.

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

1.1.2.25 Source of release means a portion or location which a gas or vapour may be released into the atmosphere, such as valves on pipeline, detachable pipe joints , pipe gaskets or pump seals.

1.1.2.26 **Lower explosive limit (LEL)** means the lowest concentration of a mixture with air of flammable substances in the form of gas, vapour or mist, below which the air of flammable gas or vapour will not form an explosion.

1.1.2.27 **Permissible exposure limit** means, for the purpose of the Guidelines, for the purpose of personnel safety, a maximum concentration of ammonia vapour in air not greater than 30 ppm.

1.1.2.28 **Ammonia treatment system** means a system in which ammonia is consumed, recovered or dispersed by thermal oxidation, catalytic oxidation, water solution or air dilution.

1.1.2.29 **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.

For sea-going ships engaged on domestic voyages and inland waterways ships, the unacceptable loss of power means a loss of power exceeding 60% of the total power essential to the propulsion and normal power supply.

1.1.3 Goals and functional requirements

1.1.3.1 The goal of the Guidelines is to provide a standard for arrangement, installation, control and monitoring of the machinery, equipment and systems of ammonia fueled Ships and to minimize the risk to the ship, persons and the environment.

1.1.3.2 The design and construction of an ammonia fuelled ship are to comply with the following functional requirements for the above goal:

(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;

(2) The probability and consequences of fuel-related hazards 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) The design philosophy is to ensure that risk reducing measures and safety actions for the ammonia fuel installations do not lead to an unacceptable loss of power;

(4) Hazardous areas 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;

(5) The hazardous area is to be fitted only with equipment necessary for operational purposes, and their performance is to be compatible with the working environment and approved by CCS;

(6) Unintended accumulation of explosive, flammable or toxic gas concentrations is to be prevented;

(7) Compartments and parts are to be suitably protected to prevent external damage;

(8) Sources of ignition in hazardous areas are to be minimized to reduce the probability of explosions;

(9) It is to be arranged with safe and suitable fuel supply, storage and bunkering arrangements capable of receiving and containing the fuel in the required state without leakage.

(10) Piping systems, containment and over-pressure relief arrangements that are of suitable design, construction and installation for their intended application are to be provided;

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

(12) Fuel containment systems and machinery spaces containing a liquid fuel or vapour source are to be arranged and located such that a fire or explosion in either will not lead to an unacceptable loss of power or render equipment in other compartments inoperable.

(13) Suitable control, alarm, monitoring and shutdown systems are to be provided to ensure safe and reliable operation of the fuel system;

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

(15) Fire detection, protection and extinction measures appropriate to the hazards concerned are to be provided;

(16) Suitable personnel protective equipment is to be provided for protection of crew members engaged in fuel operations;

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

(18) The technical documentation is to permit an assessment of the compliance of the system and its components with the followings:

① the applicable rules, guidelines, design standards used; and
② the principles related to safety, availability, maintainability and reliability.

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

1.1.4 Risk assessment

1.1.4.1 A risk assessment is to be conducted to ensure that risks involved affecting persons on board, the environment, the structural strength or the integrity of the ship are addressed.

1.1.4.2 Consideration is to be given to the hazards associated with physical layout, operation and maintenance, following any reasonably foreseeable failure, not limited to those expressly specified in the Guidelines.

1.1.4.3 The risks are to be analyzed using acceptable and recognized risk analysis techniques. The analysis is to ensure that risks are eliminated wherever possible. Risks which cannot be eliminated are to be mitigated as necessary. Details of risks, and the means by which they are mitigated, is to be documented and submitted to CCS.

1.1.4.4 Risk assessment may refer to IACS Rec.146 Risk Assessment as Required by the IGF Code, taking account of the following risks:

(1) collision;

(2) grounding;

(3) fire/explosion;

(4) impact;

(5) corrosion;

(6) fatigue;

(7) poisoning;

(8) low temperature;

(9) wear and tear;

(10) stress and strain;

(11) loss of function;

(12) damage of component.

1.1.5 Class Notations

1.1.5.1 An ammonia fuelled ship, upon Owner's or shipyard's/designer's request, may be assigned the class notation Ammonia Fuel after completion of being verified in compliance with Chapter 1 to Chapter 12 of the Guidelines by plan approval and survey of CCS. Meanings of the class notations are as follows:

(1) Ammonia Fuel: A ship having a main propulsion system using ammonia fuel.

1.1.5.2 A ship ready for an ammonia power system, upon Owner's or shipyard's/designer's request, may be assigned the class notation AFD① Ready 1, AFD Ready 2 or AFD Ready 2 (X) after completion of being verified in compliance with Chapter 13 of the Guidelines by plan approval and survey of CCS. Meanings of the class notations are as follows:

(1) AFD Ready 1: Principled drawings are designed and approved for an ammonia-ready ship to ensure it will comply with the basic requirements for a ship using an ammonia power system in the future. No equipment and system related to an ammonia power system has been actually installed on the ship;

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① AFD is the abbreviation of Ammonia Fuel Design.

(2) AFD Ready 2: Detailed drawings are designed and approved for an ammonia-ready ship to ensure that the ammonia power system intended to install at a future date will comply with Chapter 13 of the Guidelines. No equipment and system related to an ammonia power system has been actually installed on the ship;

(3) AFD Ready 2 (X): A ship has been fitted with any equipment or system related to an ammonia power system in addition to the requirements for AFD Ready 2. X is one or more suffixes to a class notation, with meanings as follows:

① S: Hull structure concerned and ammonia tank support structure strengthened;
② T: An ammonia tank and its containment system fitted;
③ M: A main propulsion engine using ammonia fuel fitted;
④ P: An ammonia piping system fitted;
⑤ D: Electrical installations within the hazardous area related to an ammonia power system complying with the corresponding explosion prevention requirements.

1.1.5.3 A ship, upon assignment of the class notation for ammonia ready, if converted before it is retrofitted for an ammonia power system, is to submit the revised drawings to CCS for review.

1.1.5.4 The class notation Ammonia Fuel may be assigned to a ship which has been retrofitted for an ammonia power system and satisfactorily inspected by CCS according to the Guidelines, and the class notation for ammonia ready is to be withdrawn.

1.1.6 Alternative design

1.1.6.1 Where the Guidelines require that a particular fitting, material, appliance, apparatus, item of equipment or type thereof is to fitted or carried in a ship, or that any particular provision is to be made, or any procedure or arrangement is to be complied with, CCS may allow any alternative equipment or measure, if it is confirmed by trial or other methodologies to be at least as effective as that required by the Guidelines.

1.1.6.2 The equivalence of alternative designs is to be demonstrated in accordance with CCS Guidelines for Application of Alternative Designs and Arrangements of Ships and approved by CCS.

1.1.6.3 However CCS does not allow operational methods or procedures to be made an alternative to particular fitting, material, appliance, apparatus, item of equipment, or type thereof which is prescribed by the Guidelines.

Section 2 PLANS AND DOCUMENTS

1.2.1 Plans and documents for approval

1.2.1.1 In addition to those specified in CCS Rules, the following plans and documents are to be submitted to CCS for approval:

(1) Ship arrangements

① machinery spaces and boiler rooms, accommodation spaces, service spaces and control stations;
② fuel tanks/fuel storage hold spaces;
③ fuel bunkering system, including bunkering connections;
④ accesses, vent pipes and other openings of fuel storage hold spaces and tank connection spaces;
⑤ ventilation pipes, doors and openings in hazardous areas;
⑥ entrances and air inlets into accommodation and service spaces and control stations;
⑦ locations and structures of air locks, if fitted;

⑧ penetrations in gastight bulkheads, if any;
⑨ hazardous area zones classification;
⑩ toxic area zones classification.

(2) The plans of fuel containment system are to be submitted according to the requirements for cargo containment system in CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

(3) Piping systems

① fuel piping systems, including fuel supply, fuel bunkering, pressure relief valves and vent piping;
② plans and instruction of the flanges, valves and other devices;
③ technical documents of the materials, welding, post-weld heat treatment and non-destructive testing of fuel piping;
④ technical documents of pressure testing (strength and tightness test) of fuel piping;
⑤ functional test guidelines for all piping, including valves, fittings and equipment relating to fuel (liquid or vapour) operation;
⑥ technical documents of the measures for removing fuel from fuel bunkering pipes before the bunkering joint is cut off;
⑦ cooling water systems or heat exchange systems relating to fuel systems, if any;
⑧ arrangement and instruction of gas freeing and inert gas purging systems;
⑨ arrangement of bilge and drainage systems for the fuel preparation room and tank connection space, if any;
⑩ displacement calculations of pipe pressure relief valves.

(4) Ventilation systems

① arrangement and instruction of mechanical ventilation systems in hazardous areas, including the capacity and arrangement of fans and their motors;
② arrangement of double wall pipes (air ducts);

(5) Fire-fighting appliances and systems

① arrangement and instruction (e.g. capacity calculation) of water spray systems, including pipes, valves, nozzles and fittings;
② arrangement of fire detection systems;
③ structural fire protection arrangement of fuel tanks/fuel storage hold spaces and their vent pipes, bunkering stations (if applicable);
④ arrangement of dry powder and other fire-extinguishing devices, if any.

(6) Electrical systems

① arrangement of all electrical installations within hazardous areas;
② check data of intrinsically safe circuits, including voltage, current, inductance and capacitance;
③ list of certified explosion-proof equipment.

(7) Control, monitoring and safety systems

① arrangement and specifications of fuel vapour detection and alarm systems,including probes, alarm devices and alarm set points;

② arrangement and specifications of tank monitoring and control systems, including sensors and alarm set points;
③ arrangement and specifications of fuel pump control and monitoring systems, if any;
④ arrangement and specifications of ammonia engine control and monitoring systems;
⑤ electrical schematic diagram and monitoring lists of fuel supply system and fuel bunkering system.

(8) Ammonia engines

① plans and documents required for diesel engines in CCS Rules;
② diagram of fuel injection system, instruction of explosion and leakage prevention measures;
③ arrangement and specifications of crankcase explosion prevention;
④ arrangement and calculations of exhaust system explosion prevention;
⑤ diagram of ammonia engine control system, including monitoring, alarm and safety protection devices;
⑥ test procedure and test report for ammonia engines;
⑦ arrangement and calculations (if applicable) of gas-intake system explosion prevention;
⑧ other plans and documents as deemed necessary by CCS.

(9) Documented testing or procedures

① mooring and sea trials procedure relating to fuel, e.g. functional tests for all fuel piping and their valves, fittings and relevant equipment.

1.2.2 Plans and documents for information

1.2.2.1 In addition to the plans and documents specified in CCS Rules, the related risk analysis reports, e.g. risk analysis of ammonia engine (e.g. FMEA report) are to be submitted to CCS for information.

1.2.3 Plans and documents kept on board

1.2.3.1 In addition to those specified in CCS Rules, the following documents are to be kept on board:

(1) arrangement of fuel preparation room, if any;

(2) instruction of coamings, drip trays or other protection means;

(3) technical documents of the branch pipes, return pipes, bends, expansion joints, bellows or similar devices;

(4) technical documents of electrical bonding of piping;

(5) a safe operation procedure of fuel tank;

(6) an operation manual of fuel supply system;

(7) an operation procedure and a maintenance manual of ammonia engine;

(8) emergency response to operations in toxic areas and safe escape.

Section 3 PRODUCTS SURVEYS

1.3.1 General requirements

1.3.1.1 In addition to the Guidelines, products surveys are to comply with CCS Rules and CCS' products survey guidelines.

1.3.1.2 The equipment (such as fuel tanks, ammonia engines, fuel bumps, ammonia absorbing tanks or ammonia cleaning systems, ammonia combustors, ammonia oxidation catalysis plants and air dilution systems), piping systems and valves associated to ammonia fuel are to be approved and issued a Marine Product Certificate by CCS if intended for a ship.

Section 4 SHIP SURVEYS

1.4.1 General requirements

1.4.1.1 All survey programmes, survey methods, types of survey, intervals between the surveys, survey conditions, preparations before survey, survey and testing requirements and preservation of the drawings and documentation, certificates, records and reports etc., are to be in compliance with CCS Rules for Classification of Sea-going Steel Ships for sea-going ships, or CCS Regulations for Classification of Inland Waterways Ships for inland waterways ships.

1.4.2 Surveys during construction

1.4.2.1 In addition to following the applicable requirements of CCS rules, the following survey items are to be carried out in surveys during construction:

(1) Installation and testing of ammonia engines;

(2) Installation and testing of fuel tanks;

(3) Installation and testing of fuel bunkering systems;

(4) Installation and testing of fuel supply systems;

(5) Installation and testing of the ventilation systems for machinery spaces containing ammonia engine(s), tank connection spaces, double walled pipes and fuel preparation room (if any);

(6) Installation and testing of remote closing appliances for ammonia engines;

(7) Locations and quantity of gas detectors and test of gas detection and alarm systems;

(8) Verification and safety checking of explosion-proof equipment;

(9) Performance test of ventilation plants of the spaces of which the hazard levels depend on mechanical ventilation; the ventilation is to be enough and the alarm for the fault of ventilation systems is to be correct;

(10) Verification of installation of equipment and cables of intrinsically safe circuits;

(11) Verification and safety checking of protected spaces by positive pressure ventilation;

(12) Installation and test of fire detection and extinction arrangements;

(13) Verification of the compliance of the ship to toxic area zones classification;

(14) Checking of the operation manual of fuel supply systems.

1.4.3 Surveys after construction

1.4.3.1 Annual surveys: in addition to following the applicable requirements of CCS Rules, the following survey items are to be carried out:

(1) Fuel containment system

① verifying that the nameplate of independent tanks of type C is clear, solid and the contents are full, if applicable;
② examining whether the tank level indicators are in working condition and the high level alarms and high level self-closing systems are in normal working condition;
③ external examination of tank pressure relief valves;
④ examining whether the pressure, liquid level and temperature indicators and control and alarm means of fuel tanks are in order;
⑤ external examination of fuel tanks, including secondary barrier (if fitted), and accessibility for inspection and maintenance; Examination of any erosion, corrosion, scratch, indent or deformation of the shell of type C independent tanks;
⑥ visual examination of tank interfaces for weld cracks, as far as practical;
⑦ verifying that the tank safety operation procedure is kept on board, including control of tank master valves, liquid volume tables, emergency disconnecting of pressure relief valves;
⑧ general examination of fuel storage hold spaces;
⑨ testing of remote and local closing of tank master valves.

(2) Checking heat exchangers (if fitted) and confirming their operation and heating capacity in compliance with the technical specifications;

(3) Verifying that sealing devices of tank connection spaces and fuel preparation rooms are in order, and examining internally tank connection spaces;

(4) Checking of the satisfactory condition of doors, side scuttles and windows in end bulkheads of superstructures and deckhouses facing the hazardous area and toxic area;

(5) Examining whether the shutdown devices and other means (if any) of any special enclosed space to protect the crew in case of fuel leakage are in order;

(6) Examining whether the portable ventilation (if any) used in the space which is not generally entered are in order;

(7) Examining whether drip trays (if any) are in order;

(8) Examining the ventilation systems (including fitted portable ventilation) of the spaces containing fuel storage, fuel bunkering and fuel supply arrangements/components or associated systems, including spaces containing air locks, pump rooms, compressor rooms, fuel preparation rooms, fuel valve rooms, control rooms and gas burning equipment. Where an alarm, such as for differential pressure and loss of pressure, is fitted, it is to be operationally tested as far as practicable to verify its functions in order;

(9) Checking the piping, hoses, emergency shut-down valves, remote operating valves, relief valves, machinery and equipment for fuel storage, fuel bunkering, and fuel supply such as venting, compressing, refrigerating, liquefying, heating, cooling or otherwise handling the fuel, as far as practicable. Special attention is to be given to the pipe expansion joints and supports. Checking the satisfactory inerting function. Confirming the satisfactory stopping of pumps and compressors upon emergency shut-down of the system, as far as practicable;

(10) Examining the penetrations of electrical equipment and bulkheads/decks within the hazardous area,

including access openings to hazardous areas, for continued suitability for their intended service and installation area, and checking the maintenance and repair record;

(11) Examining the satisfactory operational condition of gas detection equipment and other leakage detection equipment (including indicators and alarms) in spaces containing fuel storage, fuel bunkering, and fuel supply arrangements/components or associated systems, and checking the satisfactory recalibration of gas detection system according to the manufacturers' recommendations;

(12) Confirming that no substantial change has been made to the fireproof structure and arrangement of the fuel tank, bunkering station and machinery space containing any engine(s) etc.;

(13) Examining the fire detection and extinction systems, and testing one main fire-fighting pump;

(14) Examining whether sprinkler systems and water spray systems are in order;

(15) Examining whether the dry powder fire-extinguishing system is in order;

(16) Checking the logbooks and operating records to confirm the satisfactory operation of gas detection systems, fuel supply/gas systems etc., taking into consideration the evaporative capacity and nitrogen consumption (for membrane containment systems), if applicable;

(17) Confirming that the manufacturer/builder instructions and manuals covering the operations, safety and maintenance requirements and occupational health hazards relating to fuel storage, fuel bunkering, and fuel supply and fuel utilization are kept aboard the ship;

(18) Examining the electrical bonding arrangement in hazardous areas, including bonding straps;

(19) Fuel bunkering systems

① examination of bunkering stations and fuel bunkering systems；
② verification of the satisfactory operation of fuel bunkering control, monitoring and shut-down systems.

(20) Examining fuel supply systems under working conditions as far as practicable：

① checking of the satisfactory operation of fuel supply control, monitoring and shut-down systems;
② testing of the remote and local closing of master fuel valves of engine rooms.

1.4.3.2 Intermediate surveys: in addition to following the applicable requirements of CCS Rules and the requirements of 1.4.3.1, the following survey items are to be carried out:

(1) Confirming the provision of spares for the fans used for the mechanical ventilation of hazardous spaces;

(2) Examining visually the pressure, temperature and liquid level instruments of fuel systems and carrying out comparative test by changing the pressure, temperature and liquid level; A simulation test may be accepted to the inaccessible sensors. including alarm test and safety functional test.

(3) Electrical equipment: ground protection (checking of earthing contact), integrity of flame-proof enclosures, damage of cable jackets, functional tests of pressurized apparatuses and the related alarm devices for the electrical equipment within hazardous areas as far as possible, testing of shutoff the power supply for non-certificated explosion-proof electrical equipment in the spaces protected by air locks (if any), and measurement of insulation resistance.

(4) Safety systems: Gas detectors, temperature sensors, pressure sensors, level indicators, and other equipment providing input to the fuel safety system are to be randomly tested to confirm their satisfactory operating condition. Verifying the satisfactory response of fuel safety systems under failure conditions.

1.4.3.3 Special surveys: in addition to following the applicable requirements of CCS Rules and the requirements of 1.4.3.2, the following survey items are to be carried out:

(1) Fuel containment systems

① visual examination for gas tanks with manholes as follows:

(a) connection of swashplates (if fitted) to tank bodies, cracks in way of connecting welds, loosening of fixed bolts, crack, break or breakaway of swashplates;

(b) crack, break or loosening in way of the connection of the brackets of tank vapour pipes, liquid meters to the tank body.

② gas-tightness test for tanks together with their pipes (including fuel piping and vent piping), and the test medium is to be dry and clean nitrogen or air. Air is not permitted to use as test medium unless gas composition in the tank is qualified before the gas-tightness test;

③ hydraulic test for tanks together with their pipes, including fuel piping and vent piping;

④ all valves and cocks directly connecting to the tank are to be opened upon for examination, and where practicable the internal examination is to be carried out for connecting pipes;

⑤ the tank's pressure relief valves are to be opened out for examination, calibration and functional testing. If non-metallic membranes are provided in their main or pilot valves, such non-metallic membranes are to be replaceable;

⑥ Special caution to the insulation of tanks and gaskets, supports and locking arrangements. The insulation may be removed, as necessary, to verify the conditions of tanks or insulations;

⑦ checking of tanks in accordance with an approved survey plan. In addition to those stated below, the surveys of fuel containment systems are to comply with A2.3.2.4, Chapter A2, Part 2 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk or A1.3.3.4, Chapter A1, Part 2 of CCS Rules and Regulations for the Construction and Equipment of Inland Waterways Ships Carrying Liquefied Gases in Bulk when developing the inspection/survey plan according to 4.2.1.8 of CCS Rules for Ships Using Natural Gas Fuel:

(a) visual examination of the tank's insulation and supports. Non-destructive testing may be required if raise doubt to the structural integrity.

(b) vacuum insulated independent fuel storage tanks of type C need not be examined internally. Where fitted, the vacuum monitoring system is to be examined and records are to be reviewed.

(2) Piping systems

① All piping for fuel storage, fuel bunkering, and fuel supply such as venting, compressing,refrigerating, liquefying, heating storing, burning or otherwise handling the fuel and liquid nitrogen installations are to be examined. Removal of insulation from the piping and opening for examination may be required. Where deemed suspect, a hydrostatic test to 1.25 times the Maximum Allowable Relief Valve Setting (MARVS) for the pipeline is to be carried out. After reassembly, the whole piping is to be tested for leaks. Where water cannot be tolerated and the

piping cannot be dried prior to putting the system into service, the Surveyor may accept alternative testing fluids or alternative means of testing.

② Pressure relief valves for the fuel supply and bunkering piping are to be opened for examination, adjusted, and function tested. Where a proper record of continuous overhaul and retesting of individually identifiable relief valves is maintained, consideration will be given to acceptance on the basis of opening, internal examination, and testing of a representative sampling of valves, including each size and type of liquefied gas or vapor relief valve in use, provided there is logbook evidence that the remaining valves have been overhauled and tested since crediting of the previous Special Survey.

③ All emergency shut-down valves, check valves, block and bleed valves, master fuel valves, remote operating valves, isolating valves for pressure relief valves in the fuel storage, fuel bunkering, and fuel supply piping systems are to be examined and proven operable. A random selection of valves is to be opened for examination.

(3) Examining fuel pumps, compressors, process pressure vessels, heat exchangers, inert gas generators and other components used in connection with fuel handling as required in CCS Rules for periodical surveys of machinery.

(4) Heat exchangers are to be opened up for examination and tested for performance;

(5) Examining the inert gas generator to confirm that the generated inert gas is compliance with the technical specifications and the generator is in order;

(6) A general examination of inert gas distributing valves and pipes, an internal and external examination of pressure vessels for storage of inert gas and a special survey to its securing device are to be carried out, and the satisfactory condition of pressure relief valves confirmed;

(7) Each compressor (if fitted) is to be opened up for examining the moving parts, fixed parts, valves, valve seat rings, gland covers, relief devices, filters and lubricating equipment, etc. Where the Surveyor is satisfied to the alignment and abrasion, the lower bearing and crankcase seal glands may not be opened up for examination;

(8) Electrical equipment

① examination of electrical equipment, including the physical conditions of electrical cables and supports, intrinsically safe, explosion proof, or increased safety features of electrical equipment;

② functional testing of pressurized equipment and associated alarms;

③ testing of the system for cutoff of electrical equipment which is not certified for use in hazardous areas;

④ electrical insulation resistance testing of the circuits terminating in, or passing through, the hazardous zones and spaces is to be carried out.

(9) Safety systems

① testing to confirm that gas detectors, temperature sensors, pressure sensors, level indicators, and other equipment providing input to the fuel safety system are in order;

② verification of the satisfactory response of fuel safety systems under failure conditions;

③ calibration of pressure, temperature and level indicating equipment in accordance with the manufacturer's requirements.

(10) Removing the shaft seals on gastight bulkheads and examining the sealing device;

(11) In addition to the special survey items specified in CCS Rules, the following items are to be carried out: general inspection of ducts or cover enclosure of gas pipes, inspection of pipe discharge or inerting equipment, and operating testing of ammonia engines under working conditions.

CHAPTER 2 SHIP ARRANGEMENTS

Section 1 GENERAL PROVISIONS

2.1.1 Goal

2.1.1.1 The goal of this Chapter is to provide the technical requirements for safe location, space arrangements and mechanical protection of power generation equipment, fuel storage systems, fuel supply equipment and bunkering systems.

2.1.2 Functional requirements

2.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (1) to (3), (5), (6), (8), (12) to (15) and (18).

2.1.2.2 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.

2.1.2.3 Ammonia is not permitted to be discharged directly to the air under normal conditions.

2.1.2.4 It is not unacceptable to directly discharge ammonia in order to reduce the tank's pressure, but permitted under failure conditions.

2.1.2.5 Fuel tanks, pipes and other fuel release sources are to be so arranged that the released vapour is led to a safe location in the open air, via the ammonia processing system (if necessary).

2.1.2.6 The accesses or openings to spaces containing fuel sources of release are to be so arranged that flammable vapour, asphyxiating or toxic vapour will not escape to other spaces which are not designed for the presence of such gases.

Section 2 ARRANGEMENT OF FUEL TANKS

2.2.1 General requirements

2.2.1.1 Tanks are not to be located within accommodation spaces or machinery spaces of category A (for sea-going ships) / essential machinery spaces (for inland waterways ships).

2.2.1.2 Tanks and their cofferdams are to be abaft of the collision bulkhead.

2.2.1.3 Tanks are to be protected against mechanical damage.

2.2.1.4 Tanks located on the open deck are to be provided with coamings, sprinkler systems and independent ammonia drain systems. The solution containing liquid or dissolved ammonia is not to be discharged directly overboard. If this is inevitable, this discharge may be accepted provided that it is conducted according to the standards and operational procedures required in MARPOL 73/78 ANNEX Ⅱ and other appropriate regulations.

2.2.1.5 Fuel tanks and/or equipment located on open deck are to be located to ensure sufficient natural ventilation, so as to prevent accumulation of escaped gas.

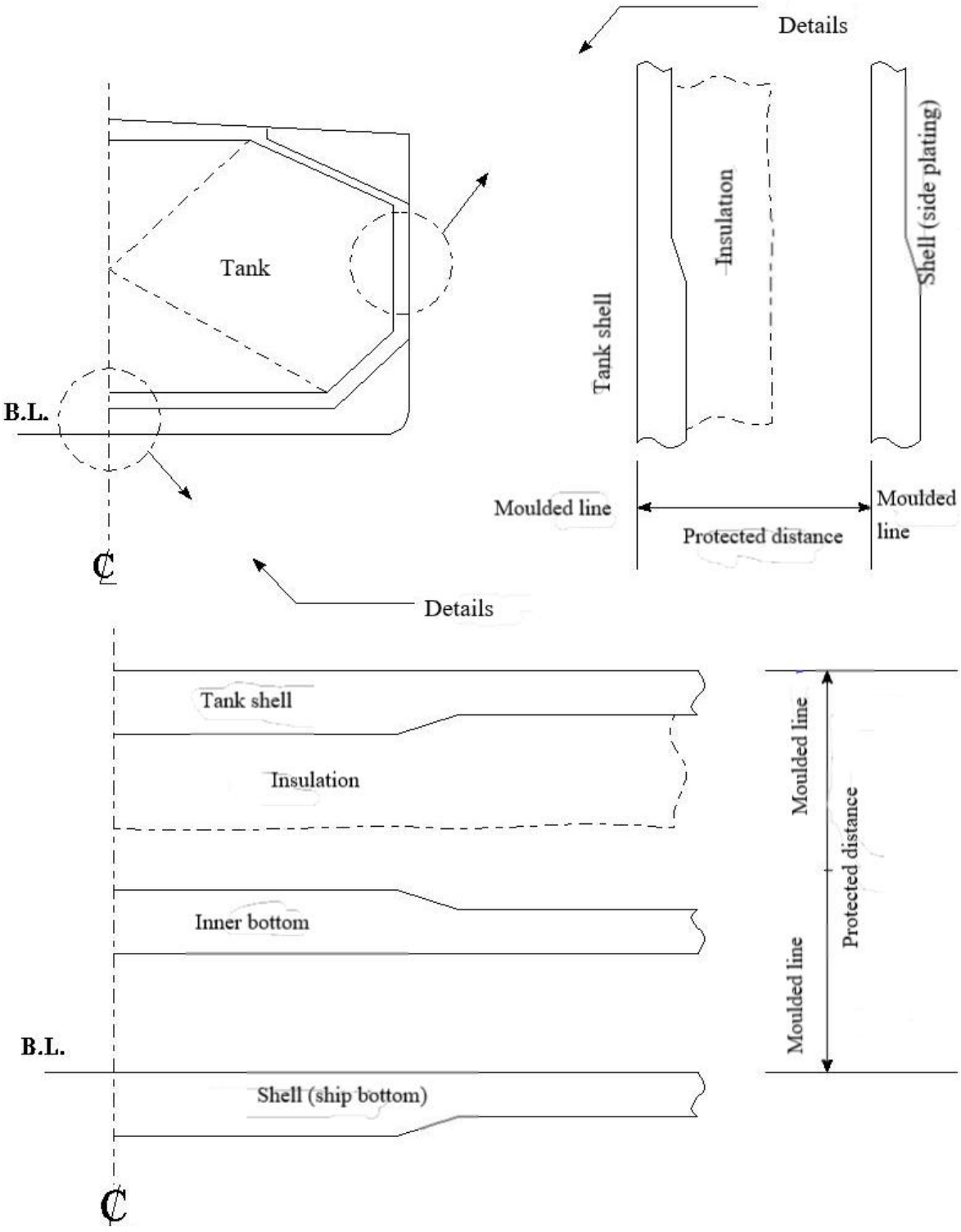
2.2.1.6 Independent fuel tanks are to be secured to the ship's structure. The arrangement for supporting and fixing the tanks is to be designed for the maximum expected static, dynamic inclinations and acceleration, taking into account the ship characteristics and the position of the tanks.

2.2.1.7 The fuel tank(s) is(are) to be protected from external damage caused by collision or grounding in the following way:

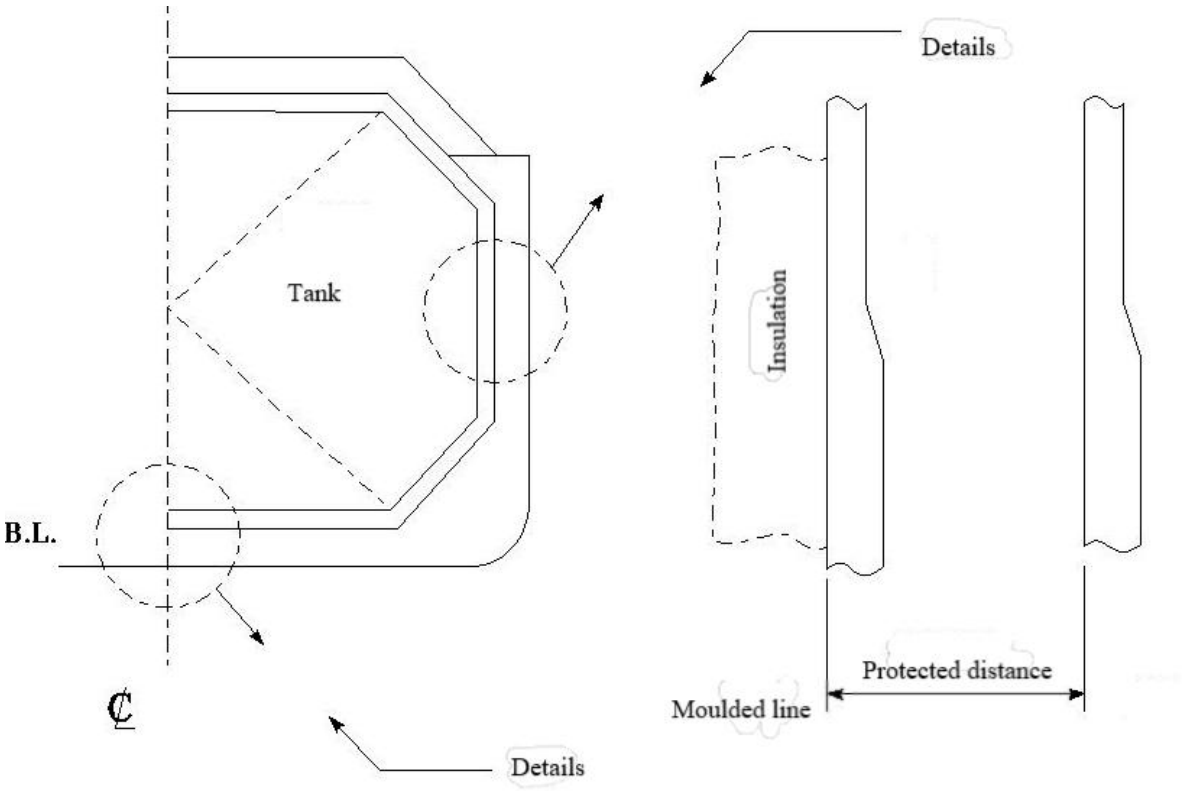
(1) The boundaries of each fuel tank are to be taken as the extreme outer longitudinal, transverse and

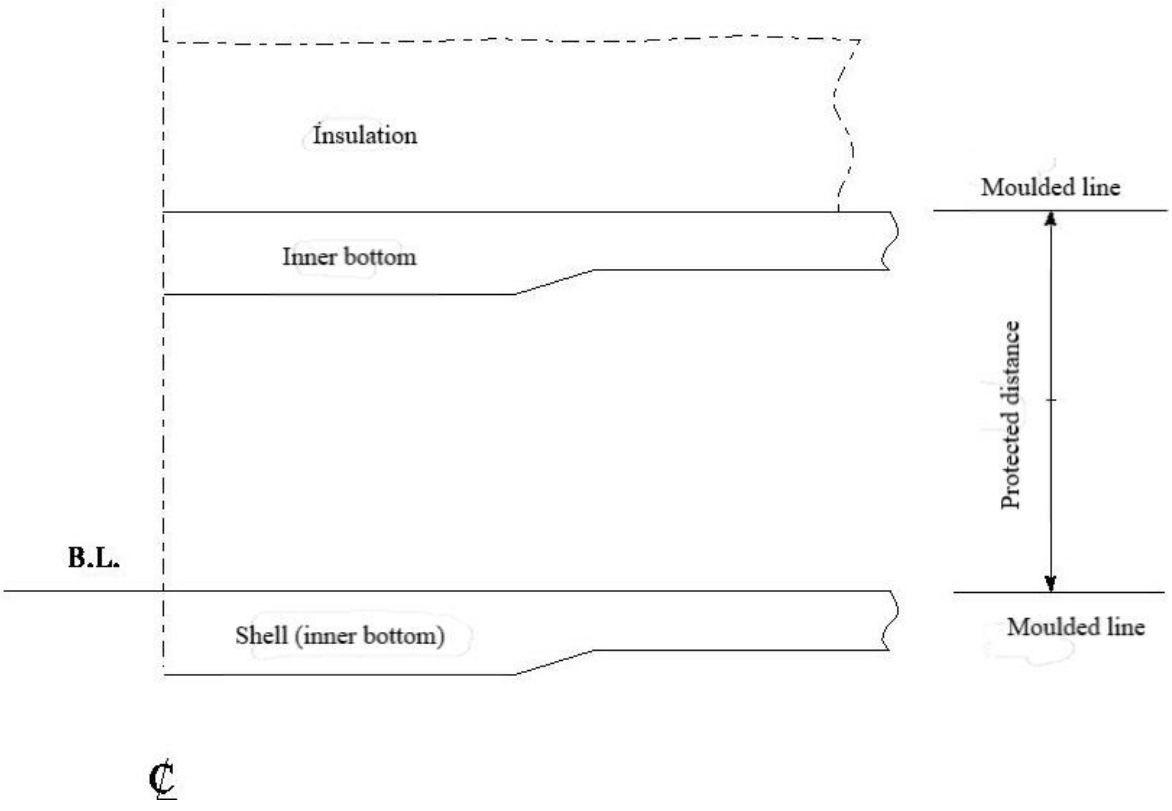
vertical limits of the tank structure including its tank valves.

(2) For independent tanks the protective distance is to be measured to the tank shell (the primary barrier of the tank containment system). For membrane tanks the distance is to be measured to the bulkheads surrounding the tank insulation. The protective distances of different types of tanks see Figure 2.2.1.7(2).

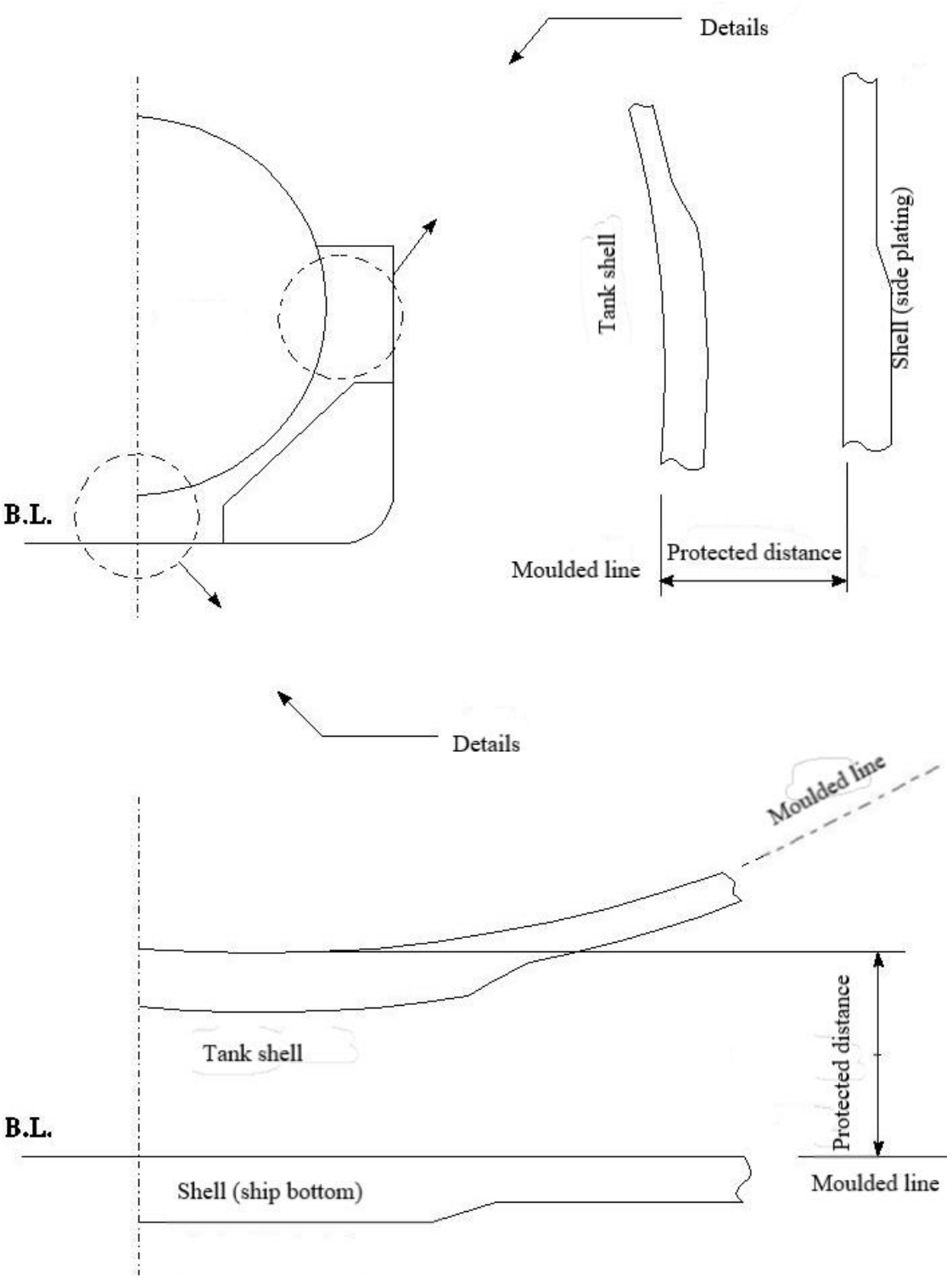


(a) Independent Prismatic Tank





(b) Membrane Tank



(c) Type C Independent Tank

Figure 2.2.1.7 (2) The Protective Distances of Different Types of Tanks

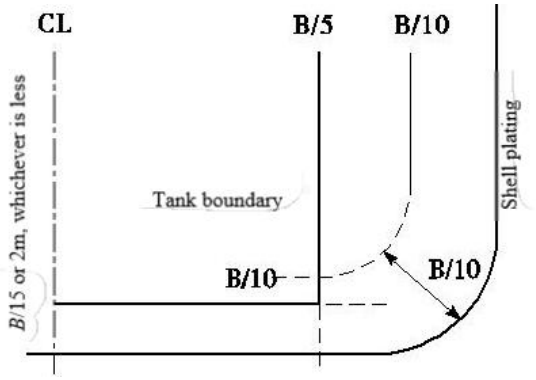
(3) For sea-going ships:

① The fuel tanks are to be located at a minimum distance of B/5 or 11.5 m, whichever is less, measured inboard from the ship side at right angles to the centreline at the level of the summer

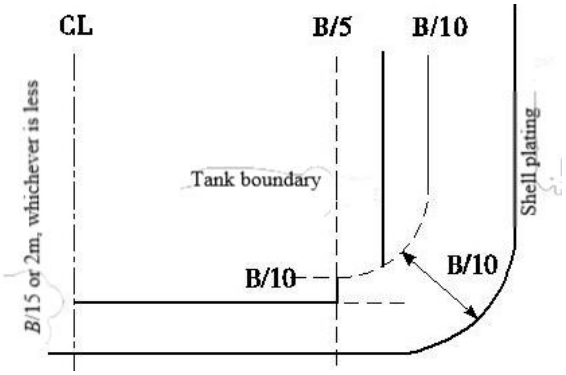
load line draught; where, B is the greatest moulded breadth of the ship at or below the deepest draught (summer load line draught).

② In no case, the boundary of the fuel tank is to be located closer to the shell plating or aft terminal of the ship than as follows:

(a) For passenger ships: *B*/10 but in no case less than 0.8 m. However, the distance need not be greater than *B*/15 or 2 m whichever is the less for the area located between the middle line of the ship and the distance of *B*/5 or 11.5 m (whichever is the less) required in①, referring to Figure 2.2.1.7(3).



(a) The protection distance obtained by Deterministic Approach



(b) The protection distance served by Probabilistic Approach

Figure 2.2.1.7 (3) Arrangement of Fuel Tank of Passenger Ship

(b) For cargo ships:

for $Vc \leq 1{,}000\ m^3$, 0.8 m;

for $1{,}000\ m^3 < V_c < 5{,}000\ m^3$, $0.75 + V_c \times 0.2/4{,}000$ m;

for $5{,}000\ m^3 \leq V_c < 30{,}000\ m^3$, $0.8 + V_c/25{,}000$ m;

for $Vc \geq 30000 m^3$, 2m;

where, Vc corresponds to 100% of the gross design volume of the individual fuel tank at 20°C, including domes and appendages.

③ The lowermost boundary of the fuel tank(s) is to be located above the minimum distance of B/15 or 2.0 m, whichever is less, measured from the moulded line of the bottom shell plating at the centreline.

(4) For inland waterways ships:

① The fuel tanks are to be located at a minimum distance of B/10 or 1.0 m, whichever is less, measured inboard from the ship side at right angles to the centreline at the level of the full load line draught;

② In no case, the boundary of the fuel tank is to be located closer to the shell plating or aft terminal of the ship than 0.8 m.

(5) For multi-hull ships, B is the breadth of the side hull.

(6) The fuel tank(s) is(are) to be abaft a transverse plane at 0.08L measured from the forward perpendicular for passenger ships, and to be abaft the collision bulkhead for cargo ships.

(7) For ships with a hull structure providing higher collision and/or grounding resistance, fuel tank location regulations may be specially considered in accordance with 1.1.6.

2.2.1.8 As an alternative to 2.2.1.7 (3) ①, the following calculation methods may be used for sea-going ships:

(1) The value f_{CN} calculated as described in the following is to be less than 0.02 for passenger ships and 0.04 for cargo ships.

(2) The f_{CN} is calculated by the following formulation:

$$f_{CN}=f_l \times f_t \times f_v$$

where:

f_{CN} is calculated by use of the formulations for factor p contained in SOLAS regulation II-1/7-1.1.1.1. The value of x1 is to correspond to the distance from the aft terminal to the aftmost boundary of the fuel tank and the value of x2 is to correspond to the distance from the aft terminal to the foremost boundary of the fuel tank.

f_l is calculated by use of the formulations for factor r contained in SOLAS regulation II-1/7-1.1.2, and reflects the probability that the damage penetrates beyond the outer boundary of the fuel tank. The formulation is:

$$f_t = 1\text{-}r\,(x1, x2, b)$$

When the outermost boundary of the fuel tank is outside the boundary given by the deepest subdivision waterline the value of b is to be taken as 0.

f_v is calculated by use of the formulations for factor v contained in SOLAS regulation II-1/7-2.6.1.1 and reflects the probability that the damage is not extending vertically above the lowermost boundary of the fuel tank. The formulations are:

If $(H\text{-}d) \leq 7.8$m, $f_v = 1.0 - 0.8\dfrac{H-d}{7.8}$ (f_v to be taken not greater than 1)

If $(H\text{-}d) > 7.8$m, $f_v = 0.2 - 0.2\dfrac{(H-d)-7.8}{4.7}$ (f_v to be taken not greater than 0)

where, H --- the distance from baseline to the lowermost boundary of the fuel tank; in m.

d--- the deepest draught (summer load line draught), in m.

(3) In case of arrangements of more than one non-overlapping tanks along the longitudinal direction, f_{CN} is to be calculated in accordance with 2.2.1.8 (2) for each fuel tank separately. The value f_{CN} used for the complete fuel tank arrangement is the sum of all values f_{CN} obtained for each separate tank.

(4) In case of unsymmetrical arrangements of tanks about the ship's centreline, the values of f_{CN} are to be calculated for both starboard and port sides and the average value is to be used for the assessment.

Section 3 LOCATION AND DIVISION OF SPACES

2.3.1 Machinery spaces

2.3.1.1 A machinery space containing any fuel consumer is to be gas safe of which the arrangement is such that it is considered gas safe under all conditions, normal as well as abnormal conditions, i.e. inherently gas safe in order to minimize the probability of a gas leakage and explosion thereof.

2.3.1.2 In a gas safe machinery space a single failure cannot lead to release of fuel gas into the machinery space.

2.3.1.3 Fuel piping within a machinery space is to be arranged in compliance with Section 3, CHAPTER 6 of the Guidelines.

2.3.2 Fuel preparation rooms

2.3.2.1 Fuel preparation spaces are to be located outside machinery spaces of category A (for sea-going ships) / essential machinery spaces (for inland waterways ships).

2.3.2.2 Fuel fuel preparation rooms are to be arranged in compliance with Section 5, CHAPTER 6 of the Guidelines.

2.3.3 Bilge systems and relief arrangements

2.3.3.1 Bilge systems installed in areas where fuel can be present are to be segregated from the bilge system of other spaces.

2.3.3.2 One or more holding tanks dedicated for collecting drainage and any possible fuel leakage from fuel pumps, valves or double walled inner pipes are to be provided. These tanks are to comply with the relevant requirements for fuel tank arrangement. A means is to be provided for safely transferring contaminated liquid fuel to onshore reception facilities.

2.3.3.3 The bilge system serving the fuel preparation space is to be operable from outside the fuel preparation space.

2.3.3.4 The bilge from a space containing a potential ammonia release source is to be kept in the dedicated holding tank on board, so that it will be discharged to a receiving device or into the sea after processing.

2.3.3.5 The number and diameter of drain pipes or bilge suctions located in a space containing a sprinkler system are to be sufficient to prevent the presence of any ponding.

2.3.3.6 Bilge tanks and dedicated holding tanks, if containing dissolved ammonia, are to be located outside the machinery space, and provided with discharge piping to the ammonia vapour processing system or venting mast and liquid indicating, ammonia vapour concentration detecting devices.

2.3.3.7 A cofferdam is to be provided to bilge tanks which may contain dissolved ammonia and dedicated holding tanks, and it may be dispensed with between the tank and the fuel preparation room.

2.3.3.8 The mixture of ammonia may be discharged outboard according to the standards and operational procedures required in MARPOL 73/78 ANNEX Ⅱ and other appropriate regulations. This is not permitted on inland waterways ships.

2.3.4 Drip trays and coamings

2.3.4.1 Drip trays are to be fitted where leakage and spill may occur, in particular:

(1) in way of connection of single wall pipes;

(2) in bunkering stations;

(3) in fuel preparation rooms, potential liquid fuel leakage sources, including detachable pipe connections, bumps, valves and heat exchangers.

2.3.4.2 A risk analysis is to be conducted to determine the potential maximum leakage, including leaked fuel and spray water, in order to design the volume of drip tray or coaming.

2.3.4.3 The drip tray or coaming is to be provided with a pipe for transferring the leaked fuel to the dedicated holding tank on which a non-return valve and a shut-off valve are fitted.

2.3.4.4 If rain water will affect drip trays and coamings, they are to be fitted with a drain valve to enable the rain water to be drained over the ship's side.

2.3.5 Accesses

2.3.5.1 Direct access is not to be permitted from a non-hazardous area to a hazardous area. Where such accesses are necessary for operational reasons, an airlock which complies with the provisions of 2.3.6 is to be provided.

2.3.5.2 Fuel preparation spaces below open deck are to have independent access direct from open deck. Where a separate access from open deck is not practicable, an airlock complying with 2.3.6 is to be provided.

2.3.5.3 Fuel tanks and surrounding cofferdams are to have suitable direct access from the open deck, where practicable, for gas freeing, cleaning, maintenance and inspection.

2.3.5.4 Without direct access to open deck, an entry space to fuel tanks or surrounding cofferdams are be provided and comply with the following:

(1) be fitted with an independent mechanical extraction ventilation system, providing a minimum of six air changes per hour; a low oxygen alarm is to be fitted.

(2) have sufficient open area around the fuel tank hatch for efficient evacuation and rescue operation.

(3) not be directly entered from an accommodation space, service space, control station, ro-ro space, special category space or machinery space of category A (for sea-going ships) / essential machinery spaces (for inland waterways ships).

2.3.5.5 The area around independent fuel tanks is to be sufficient to carry out evacuation and rescue operations.

2.3.5.6 Unless access to the tank connection space is independent and direct from open deck, it is to be arranged as a bolted hatch.

2.3.6 Airlocks

2.3.6.1 An airlock is a space enclosed by gastight bulkheads with two substantially gastight doors spaced at least 1.5 m and not more than 2.5 m apart. Unless subject to the requirements of the International Convention on Load Lines or the requirements of the Administration's relevant regulations, the door sill is not to be less than 300 mm in height. The doors are to be self-closing without any holding back arrangements.

2.3.6.2 Airlocks are to be mechanically ventilated at an overpressure relative to the adjacent hazardous area or space.

2.3.6.3 The airlock is to be designed in a way that no gas can be released to safe spaces in case of the most critical event in the gas dangerous space separated by the airlock. The events are to be evaluated in the risk analysis according to 1.1.4.

2.3.6.4 Airlocks are to have a simple geometrical form. They are to provide for free and easy passage and have a deck area not less than 1.5 m2. Airlocks are not to be used for other purposes, for instance as storerooms.

2.3.6.5 An audible and visual alarm system to give a warning on both sides of the airlock is to be provided to indicate if more than one door is moved from the closed position.

2.3.6.6 For non-hazardous spaces with access from hazardous spaces below deck where the access is protected by an airlock, upon loss of underpressure in the hazardous space access to the space is to be restricted until the ventilation has been reinstated. Audible and visual alarms are to be given at a manned location to indicate both loss of pressure and opening of the airlock doors when pressure is lost.

2.3.6.7 Essential equipment required for safety is not to be de-energized and to be of a certified safe type. This may include lighting, fire detection, public address, general alarms systems.

2.3.6.8 Electrical equipment which is not of the certified safe type for propulsion, power generation, manoeuvring, anchoring and mooring equipment as well as the emergency fire pumps is not to be located in spaces to be protected by airlocks.

Section 4 CONTROLS OF AMMONIA VAPOR EMISSION

2.4.1 General requirements

2.4.1.1 Equipment for control of ammonia vapour emission and its arrangement are to ensure that the ammonia concentration at any manned location is limited to not more than the permissible exposure limit.

2.4.1.2 The control of ammonia vapour emission generally contains an ammonia vapour process system and a sprinkler system.

2.4.1.3 The equipment controlling ammonia vapour emission is to be designed and arranged in one or more ways according to various expected scenarios, and the capacity depends on the ammonia vapour emission amount under normal and failure conditions.

2.4.2 Ammonia vapour processing systems

2.4.2.1 In general, ammonia vapour processing systems include but not limited to the followings, of which one or more may be chose to satisfy 2.4.1.1:

(1) Ammonia vapour absorbing tank or ammonia vapour cleaning system;

(2) Ammonia combustor/oxidation catalysis plant;

(3) Ammonia vapour dilution system with air;

2.4.2.2 Ammonia vapour absorbing tank or ammonia vapour cleaning system;

(1) The tank capacity of ammonia vapour absorbing tank and ammonia vapour cleaning system depends on the solubility of ammonia at correlated temperature.

(2) Ammnonia vapour absorbing tank and ammonia vapour cleaning system are to be provided with a means to prevent from icing in the tank.

(3) Ammonia vapour absorbing tanks and ammonia vapour cleaning systems are to be provided with temperature gauges, level indicators and low/high level alarms.

(4) The intake pipe of ammonia vapour absorbing tank is to be located below the low level at the tank bottom.

(5) Ammonia vapour absorbing tanks and ammonia vapour cleaning systems are to be provided with a means to discharge to land-based receiving installations. The mixture of ammonia may be discharged outboard according to the standards and operational procedures required in MARPOL 73/78 ANNEX Ⅱ and other appropriate regulations. On inland waterways ships, the mixture is not permitted to discharge overboard.

(6) If neutralization acid is used for reducing ammonia water in the tank of ammonia vapour absorbing tank and ammonia vapour cleaning system, a means is required to prevent its damage to personnel, corrosion of contact materials and production of flammable gas.

(7) The materials of ammonia vapour absorbing tank and ammonia vapour cleaning system are to comply with Section 3, CHAPTER 3 of the Guidelines.

2.4.2.3 Ammonia combustors/oxidation catalysis plants

(1) Ammonia combustors are to be so designed as to operate within the whole range of expected flows and to ensure complete ammonia combustion.

(2) Pilot flame is to be provided for starting and maintaining of the burning of ammonia and if necessary, buffer tanks are to be fitted to ensure immediate running upon opening of relief valves or exhaust valves.

(3) A phase separator (separating pot) is to be provided to separate liquid ammonia (drips) from ammonia vapour.

2.4.2.4 Ammonia dilution systems with air

(1) The system is to dilute ammonia vapour by mixing the emitted ammonia vapour with fresh air or by increasing the ventilation rate.

(2) A means is to be provided to avoid a fire and explosion risk from the ammonia/air mixture in the ammonia dilution system with air.

2.4.3 Sprinkler systems

2.4.3.1 The nozzles of sprinkler system are to be arranged so that the area of protection can cover all equipment and pipe connections with potential ammonia leakage in the space thereof.

2.4.3.2 The sprinkler system is to be independent and supplied with fresh water by a pressurizing system. The pressurizing system consists of two bumps and one group of water tanks with a quantity of water for all nozzles in the protected area spraying for 30 min at the same time, having a discharge rate of 10L/min/m2 (based on the horizontal area of the protected area). The water tank is to be provided with safety relief devices, pressure gauges, level controllers and liquid meters required.

2.4.3.3 The system is to automatically sustain the required pressure and level. Protected spaces and control rooms are to give an audible and visual alarm in case of a low pressure or a low level.

2.4.3.4 When the ammonia vapour concentration detected in the space reaches 300 ppm, a sprinkler system is to automatically start, or to manually start at its control position and outside the protected space.

2.4.3.5 Electrical equipment in the space protected by a sprinkler system is to IP55 standard.

CHAPTER 3 MATERIAL AND PIPE DESIGN

Section 1 GENERAL PROVISIONS

3.1.1 Goal

3.1.1.1 The goal of this Chapter 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 ammonia involved.

3.1.2 Functional requirements

3.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (1) , (5), (6), (8), (9) and (10).

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

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

3.1.2.4 Pipes which may contain low temperature fuel are to be thermally isolated from the adjacent hull structure to prevent the temperature of the hull from falling below the design temperature of the hull material.

Section 2 PIPE DESIGN

3.2.1 General requirements

3.2.1.1 Fuel pipes and all the other piping are to be colour marked in accordance with a standard① accepted by CCS.

3.2.1.2 All fuel piping, independent tanks and membrane tanks are to be electrically bonded to the ship's hull. All gasketed pipe joints and hose connections are to be electrically bonded. Except where bonding straps are used, it is to be demonstrated that the electrical resistance of each joint or connection is not more than 1 MΩ.

3.2.1.3 Piping other than fuel supply piping and cabling may be arranged in the double wall piping or duct provided that they do not create a source of ignition or compromise the integrity of the double pipe or duct or corroded by ammonia. The double wall piping or duct is to only contain piping or cabling necessary for operational purposes.

3.2.1.4 Tank bunkering pipes are to be arranged to minimize the possibility of the generation of static electricity, and filling lines are to be extended into the tank as close as possible to the bottom.

3.2.1.5 Fuel piping is to be so designed as to prevent the generation of vapour lock.

3.2.1.6 Pipes, which may contain low temperature fuel, are to be thermally insulated to an extent which will minimize condensation of moisture or frosting.

3.2.2 Wall thickness

3.2.2.1 The minimum wall thickness is to be calculated as follows:

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① Refer to GB 3033 Ship and marine technology - Identification colours for the content of piping systems and ISO 14726 Ship and marine technology - Identification colours for the content of piping systems

$$t = \frac{t_0 + b + c}{1 - \frac{a}{100}} \quad \text{mm}$$

where:

t_0 = theoretical thickness,

$$t_0 = \frac{PD}{2.0Ke + P} \quad \text{in mm;}$$

with:

P = design pressure, in MPa;

D = outside diameter, in mm;

K = allowable stress, in N/mm^2;

e = efficiency factor. e is efficiency factory equal to 1.0 for seamless pipes and for longitudinally or spirally welded pipes, delivered by approved manufacturers of welded pipes, that are considered equivalent to seamless pipes when non-destructive testing on welds is carried out in accordance with recognized standards. In other cases an efficiency factor of less than 1.0, in accordance with recognized standards, may be required depending on the manufacturing process;

b = allowance for bending, in mm. The value of b is to be chosen so that the calculated stress in the bend, due to internal pressure only, does not exceed the allowable stress.

Where such justification is not given, b is to be:

$$b = D \cdot \frac{t_0}{2.5r} \quad \text{in mm;}$$

with:

r = mean radius of the bend, in mm;

c = corrosion allowance, in mm. If corrosion or erosion is expected the wall thickness of the piping is to be increased over that required by other design regulations. This allowance is to be consistent with the expected life of the piping; and

a= negative manufacturing tolerance for thickness, %.

3.2.3 Design pressure

3.2.3.1 The greater[①②] of the following design conditions is to be used for piping, piping system and

① Lower values of ambient temperature regarding design condition in 3.2.3.1(1) may be accepted by CCS for ships operating in restricted areas. Conversely, higher values of ambient temperature may be required.

② For ships on voyages of restricted duration, P0 may be calculated based on the actual pressure rise during the voyage and account may be taken of any thermal insulation of the tank. Reference is made to the Application of amendments to gas carrier codes concerning type C tank loading limits (SIGTTO/IACS).

components:

（1）for systems or components which may be separated from their relief valves and which contain only vapour at all times, vapour pressure at 45°C(1.8MPa) assuming an initial condition of saturated vapour in the system at the system operating pressure and temperature; or

（2）the MARVS of the fuel tanks and fuel processing systems;

（3）the pressure setting of the associated pump or compressor discharge relief valve;

（4）the maximum total discharge or loading head of the fuel bunkering piping system;

（5）the relief valve setting on a pipeline system.

3.2.3.2 Piping, piping systems and components are to have a minimum design pressure of 1.0 MPa except for open ended lines where it is not to be less than 0.5 MPa. The design pressure P in the formula of 3.2.2 is the maximum gauge pressure that the system might sustain in its operation, taking into account the maximum permissible setting of any relief valve.

3.2.4 Allowable stress

3.2.4.1 For pipes made of steel including stainless steel, the allowable stress to be considered in the formula of the strength thickness in 3.2.2.1 is to be the lower of the following values:

$$\frac{R_m}{2.7} \text{ or } \frac{R_e}{1.8}$$

where:

R_m = specified minimum tensile strength at room temperature, in N/mm^2;

R_e = specified minimum yield strength at room temperature, in N/mm^2. If the stress strain curve does not show a defined yield stress, the 0.2% proof stress applies.

3.2.4.2 Where necessary for mechanical strength to prevent damage, collapse, excessive sag or buckling of pipes due to superimposed loads, the wall thickness is to be increased over that required by 3.2.2. if this is impracticable or would cause excessive local stresses, these loads are to be reduced, protected against or eliminated by other design methods. Such superimposed loads may be due to supports, ship deflections, liquid pressure surge during transfer operations, the weight of suspended valves, reaction to loading arm connections, or otherwise.

3.2.4.3 High pressure fuel piping systems are to have sufficient constructive strength. This is to be confirmed by carrying out stress analysis and taking into account:

（1）stresses due to the weight of the piping system;

（2）acceleration loads when significant; and

（3）internal pressure and loads induced by hog and sag of the ship.

3.2.5 Flexibility of piping

3.2.5.1 The arrangement and installation of fuel piping are to provide the necessary flexibility to maintain the integrity of the piping system in the actual service situations, taking potential for fatigue into account.

3.2.6 Piping fabrication and joining details

3.2.6.1 Fuel piping is to utilize pipes of class Ⅰ on which no cast iron valves are permitted.

3.2.6.2 The piping system is to be joined by welding with a minimum of flange connections, except for

（1）approved connections to shut-off valve and expansion joints, if fitted; and

（2）other exceptional cases specifically approved by CCS.

3.2.6.3 The following direct connections of pipe without flanges may be considered:

（1）butt-welded joints with complete penetrations at the root;

（2）slip-on welded joints with sleeves are only to be used in pipes having an external diameter of 50 mm or less; the possibility for corrosion are to be considered; and

（3）Screwed couplings are only to be used for accessory lines and instrumentation lines with external diameters of 25 mm or less.

3.2.6.4 Flanged connections are to satisfy the following requirements:

(1) Flanges in flange connections are to be of the welded neck, slip-on or socket welded type; and

(2) For all piping except open ended, the following restrictions apply:

① For design temperatures colder than minus 55°C, only welded neck flanges are to be used;
② For design temperatures colder than minus 10°C, slip-on flanges are not to be used in nominal sizes above 100 mm and socket welded flanges are not to be used in nominal sizes above 50 mm.

3.2.6.5 Expansion joints or bending pipes may be provided on fuel piping to allow expansion of the pipes, but slip joints are not to be used.

3.2.6.6 Piping connections are to be jointed in accordance with 3.2.6.2 to 3.2.6.4 but for other exceptional cases CCS may consider alternative arrangements upon assessment of the safety, reliability and durability.

Section 3 MATERIALS

3.3.1 General requirements

3.3.1.1 Materials for fuel tanks and piping systems are to consider their corrosion and to be suitable for the maximum working pressure and temperature. In addition to the Guidelines, the materials are to comply with the relevant requirements of CCS Rules for Materials and Welding. If new steel is utilized, the relevant information is to be submitted for approval and if necessary, special testing may be required.

3.3.1.2 Pipes, valves, fittings and other equipment contacting with ammonia are in any case not to utilize copper, copper-bearing alloy, zinc, zinc-bearing alloy and other materials containing cadmium or mercury which are susceptible to corrosion by ammonia. In addition, ammonia is an alkaline reducing agent which will react with acid, halogens and oxidants.

3.3.1.3 Anhydrous ammonia may cause stress corrosion cracking in fuel tanks and piping systems made of carbon-manganese steel or nickel steel. The risk of this occurring is to be minimize based on the materials considered and design conditions etc.

3.3.1.4 Where carbon-manganese steel is used, such as CL-II-2 and CL-III-2 which need a post-weld stress relief heat treatment, the fuel tanks, fuel piping and other tanks containing fuel or aqueous solution of ammonia are to be made of fine-grained steel with a specified minimum yield strength not exceeding 355 N/mm^2, and with an actual yield strength not exceeding 440 N/mm2. One of the following constructional or operational measures is also to be taken:

（1）lower strength material with a specified minimum tensile strength not exceeding 410 N/mm^2 is to be used; or

（2）fuel tanks, etc., are to be post-weld stress relief heat treated; or

（3）carriage temperature is to be maintained, preferably at a temperature close to the product's boiling point of -33°C, but in no case at a temperature above -20°C; or

（4）the ammonia is to contain not less than 0.1% w/w water.

3.3.1.5 If carbon-manganese steels with higher yield properties are used other than those specified in 3.3.1.4, the completed fuel tanks, piping, etc., are to be given a post-weld stress relief heat treatment.

3.3.1.6 Process pressure vessels and piping of the condensate part of the coolant pump system are to be given a post-weld stress relief heat treatment when made of materials mentioned in 3.3.1.3.

3.3.1.7 The tensile and yield properties of the welding consumables are to exceed those of the tank or piping material by the smallest practical amount.

3.3.1.8 Nickel steel containing more than 5% nickel and carbon-manganese steel, not complying with the requirements of 3.3.1.4 and 3.3.1.5, are not to be used in containment and piping systems for the carriage of ammonia.

3.3.1.9 When the temperature of materials is in compliance with 3.3.1.4 (3), nickel steel containing not more than 5% nickel may be used, such as nickel alloy 1.5 Ni or 2.25 Ni.

3.3.1.10 To minimize the risk of ammonia stress corrosion cracking, it is advisable to keep the dissolved oxygen content of ammonia fuel below 2.5 ppm w/w.

3.3.1.11 Gaskets and sealings are to be made of metals, rubbers and polymers etc. compatible with ammonia, such as spiral wound gaskets, polytetrafluoroethylene-PTFE.

3.3.1.12 Welding, post-weld heat treatment and non-destructive test are to be conducted according to a standard① accepted by CCS.

① Annex C.2.1 of NB/T 47012 Pressure Vessels for Refrigerant Device, or other existing national and industrial standards.

CHAPTER 4 FUEL CONTAINMENT SYSTEMS

Section 1 GENERAL PROVISIONS

4.1.1 Goal

4.1.1.1 The goal of this Chapter is to ensure a rational design for a fuel containment system where the risk to the ship, its crew and to the environment is minimized to a level that is at least equivalent to a conventional oil-fueled ship.

4.1.2 Functional requirements

4.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (1), (2), (5), (8) to (15), (17) and (18).

4.1.2.2 The fuel containment system and fuel supply system are to be so designed that safety actions after any gas leakage do not lead to an unacceptable loss of power.

4.1.2.3 The fuel tank, inerting system and gas-freeing system are to be so designed as to prevent a formation of flammable environment inside the fuel tank and its surrounding cofferdams.

4.1.2.4 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.

4.1.3 General requirements

4.1.3.1 All tank connections, fittings, flanges and tank valves are to be enclosed in gas tight tank connection spaces, unless the tanks are on open deck.

4.1.3.2 Where dangerous cargo intended to be carried will react with ammonia, a cofferdam is to be fitted between the fuel tank located in an enclosed space and its adjacent dangerous cargo tank. The fuel tanks located on open deck or in a semi-enclosed space are to be provided with a tank connection space mentioned in 4.1.3.1.

4.1.3.3 The fuel containment system is to be designed, analyzed and assessed according to Section 2 of Chapter 4 of CCS Rules for Ships Using Natural Gas Fuel. The design and thermal load of secondary barrier are to refer to Chapter 4 of Part 3 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk or Chapter 4 of Part 3 of CCS Rules for Construction and Equipment of Inland Waterways Ships Carrying Liquefied Gases in Bulk

4.1.3.4 The hull structure is to comply with the requirements for the longitudinal strength of CCS Rules.

4.1.3.5 In addition to 4.1.3.4, the hull structure is to comply with Chapter A4 of Part 2 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and CCS Rules for Classification of Sea-going Steel Ships, or Chapter A3 of Part 2 of CCS Rules for Construction and Equipment of Inland Waterways Ships Carrying Liquefied Gases in Bulk and CCS Rules for the Construction of Inland Waterways Steel Ships, if applicable.

4.1.3.6 The fuel containment system structural strength is to be designed with suitable safety margins to withstand the loads imposed by related structures and equipment. Fuel tanks are to accommodate contraction and expansion of the tank under temperature variations and hull deflections without undue stressing of the tank and the hull.

4.1.3.7 The fuel containment system is to be provided with an efficient thermal insulation system to keep the temperature of the ship structure to a safe level.

4.1.3.8 The fuel containment system is to be provided with mechanical protection to minimize the damage risk caused by the operations of the ship and/or cargo handling.

Section 2 PRESSURE RELIEF SYSTEMS

4.2.1 General requirements

4.2.1.1 All fuel tanks are to be provided with a pressure relief system appropriate to the design of the fuel containment system and the fuel being carried. Fuel storage hold spaces, interbarrier spaces, tank connection spaces and tank cofferdams, which may be subject to pressures beyond their design capabilities, are also to be provided with a suitable pressure relief system.

4.2.1.2 Fuel tanks are to be fitted with a minimum of 2 pressure relief valves (PRVs) allowing for disconnection of one PRV/ one group of PRVs in case of malfunction or leakage.

4.2.1.3 Interbarrier spaces are to be provided with pressure relief devices. For membrane systems, the designer is to demonstrate adequate sizing of interbarrier space PRVs.

4.2.1.4 The following temperature regulations apply to PRVs fitted to pressure relief systems:

（1）PRVs on fuel tanks with a design temperature below 0℃ are to be designed and arranged to prevent their becoming inoperative due to ice formation;

（2）the effects of ice formation due to ambient temperatures are to be considered in the construction and arrangement of PRVs;

（3）PRVs are to be constructed of materials with a melting point above 925°C. Lower melting point materials for internal parts and seals may be accepted provided that fail-safe operation of the PRV is not compromised; and

（4）sensing and exhaust lines on pilot operated relief valves are to be of suitably robust construction to prevent damage.

4.2.1.5 Shut-off valves are not to be arranged either upstream or downstream of the PRVs. Bypass valves may be provided.

4.2.1.6 In the event of a failure of a fuel tank PRV, a safe means of emergency isolation is to be available:

（1）procedures are to be provided and included in the operation manual;

（2）the procedures are to allow only one of the installed PRVs to be isolated, physical interlocks are to be included to this effect; and

（3）isolation of the PRV is to be carried out under the supervision of the master. This action is to be recorded in the ship's log, and at the PRV.

4.2.1.7 PRVs are to vent to a safe location on open deck.

4.2.1.8 The capacity of a PRV is to comply with 4.5.3 of CCS Rules for Ships Using Natural Gas Fuel.

4.2.1.9 Each PRV installed on a fuel tank is to be connected to a venting system. The fuel gas venting system is to be independent of those and air pipes of accommodation spaces, service spaces and control stations, or other non-hazardous areas.

4.2.1.10 Fuel tanks which may be subject to external pressures above their design pressure are to be fitted with vacuum protection systems.

4.2.1.11 The fuel tank vent system is to be connected to the highest point of each tank and vent lines are to be self-draining under all normal operating conditions.

4.2.1.12 The height of vent exits is not to be less than B/3 or 6 m, whichever is the greater, above the weather deck and 6 m above the raised gangway if located within 4 m from the raised gangway.

4.2.1.13 The arrangements for fuel tank ventilation are to be such as to minimize the hazards due to the dispersal of toxic and flammable vapours. The fuel tank ventilation system is to be exclusively for

ventilating and gas freeing purposes.

Section 3 TANK LOADING LIMITS

4.3.1 General requirements

4.3.1.1 The tank loading limit at an actual loading temperature is not to exceed that obtained from the following formula:

$$LL = \frac{FL \times \rho_R}{\rho_L}$$

where:

LL = loading limit, expressed in percent;

FL = filling limit, expressed in percent, here 98%;

ρ_R = relative density of fuel at the reference temperature; and

ρ_L = relative density of fuel at the loading temperature.

4.3.1.2 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 by CCS to allow a higher loading limit than calculated using the reference temperature, but never above 95%. This also applies in cases where a second system for pressure maintenance is installed.

Section 4 MAINTAINING OF FUEL STORAGE CONDITION

4.4.1 Control of tank pressure and temperature

4.4.1.1 With the exception of liquefied gas fuel tanks designed to withstand the full gauge vapour pressure of the fuel under conditions of the upper ambient design temperature, fuel tanks' pressure and temperature are to be maintained at all times within their design range by means acceptable to CCS, e.g. by one of the following methods:

（1）reliquefaction of vapours;

（2）thermal oxidation of vapours;

（3）pressure accumulation; or

（4）liquefied gas fuel cooling.

The method chosen is to be capable of maintaining tank pressure below the set pressure of the tank pressure relief valves for a period of 15 days assuming full tank at normal service pressure and the ship in idle condition, i.e. only power for domestic load is generated.

4.4.1.2 The vapour reliquefaction system, thermal oxidation system and their compatibility availability are to comply with Section 7 of Chapter 4 of CCS Rules for Ships Using Natural Gas Fuel.

4.4.1.3 For worldwide service, the upper ambient design temperature is to be sea 32℃ and air 45℃. For service in particularly hot or cold zones, these design temperatures are to be increased or decreased, to the approval of CCS.

Section 5 INERTING AND ATMOSPHERIC CONTROL

4.5.1 General requirements

4.5.1.1 A piping system is to be provided to enable each fuel tank to be safely gas-freed and purged and to be safely filled with fuel from a gas-free condition. The system is to be arranged to minimize the possibility of pockets of gas or air remaining after changing the atmosphere.

4.5.1.2 The design of internal tank structures and the arrange of vents are to minimize the possibility of vapour residue from a gas-free condition.

4.5.1.3 The system is to be designed to eliminate the possibility of a flammable mixture atmosphere existing in the fuel tank during any part of the atmosphere change operation, gas freeing or inerting by utilizing an inerting medium.

4.5.1.4 To prevent the return of toxic and flammable gas to any non-hazardous spaces, the inert gas supply lines are to be fitted with two shutoff valves in series with a venting valve in between (double block and bleed valves). In addition, a closable non-return valve is to be installed between the double block and bleed arrangement and the fuel system. These valves are to be located outside non-hazardous spaces.

4.5.1.5 Where the connections to the inert gas systems are non-permanent, two non-return valves may substitute for the valves required in 4.5.1.4.

4.5.1.6 Each inerted space is to be separately arranged. Isolation arrangements are to be fitted in the inert gas inlet pipe to individual tanks. The position of the isolation arrangements is to be immediately obvious to personnel entering the tank.

4.5.2 Atmospheric control within fuel storage hold spaces

4.5.2.1 Interbarrier and fuel storage hold spaces associated with fuel containment systems requiring full or partial secondary barriers are to be inerted with a suitable dry inert gas and kept inerted with make-up gas provided by a shipboard inert gas generation system, or by shipboard storage. When no inert gas generation device is fitted on board, the shipboard stored inert gas is to be sufficient for normal consumption for at least 30 days.

4.5.2.2 Alternatively, the spaces referred to in 4.5.2.1 requiring only a partial secondary barrier may be filled with dry air provided that the ship maintains a stored charge of inert gas or is fitted with an inert gas generation system sufficient to inert the largest of these spaces, and provided that the configuration of the spaces and the relevant vapour detection systems, together with the capability of the inerting arrangements, ensures that any leakage from the liquefied gas fuel tanks will be rapidly detected and inerting effected before a dangerous condition can develop. Equipment for the provision of sufficient dry air of suitable quality to satisfy the expected demand is to be provided.

4.5.2.3 Spaces surrounding type C independent tanks are to be filled with suitable dry air and be maintained in this condition with dry air provided by suitable air drying equipment. This is only applicable for fuel tanks where condensation and icing due to cold surfaces is an issue.

4.5.3 Inert gas systems

4.5.3.1 Inert gas containing carbon dioxide is not to be utilized to avoid a contamination of ammonia by carbamic acid ester formed by chemical reactions.

4.5.3.2 The inert gas generator is to be capable of producing inert gas with oxygen content at no time greater than 5% by volume. A continuous-reading oxygen content meter is to be fitted to the inert gas supply from the generator and to be fitted with an alarm set at a maximum of 5% oxygen content by volume.

4.5.3.3 An inert gas system is to have pressure controls and monitoring arrangements appropriate to the fuel containment system.

4.5.3.4 Where an inert gas generator is installed in a separate compartment outside of the engine-room, the separate compartment is to be fitted with an independent mechanical extraction ventilation system, providing a minimum of six air changes per hour. A low oxygen alarm is to be fitted.

4.5.3.5 Inert gas pipes are to be located on the open deck as far as practicable, and may be led through well ventilated spaces. Inert gas pipes in enclosed spaces are to:

（1）be fully welded;

（2）have only a minimum of flange connections as needed for fitting of valves, fittings and bends; and

（3）be as short as possible.

CHAPTER 5 BUNKERING

Section 1 GENERAL PROVISIONS

5.1.1 Goal

5.1.1.1 The goal of this Chapter 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.

5.1.2 Functional requirements

5.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (1) to (11), (13) to (15), (17) and (18). In particular the following apply:

(1) The piping system for transfer of fuel to the storage tank is to be designed such that any leakage from the piping system cannot cause danger to personnel, the environment or the ship.

5.1.3 General requirements

5.1.3.1 A portable means of communication is to be provided between the ships, such as suitable number of portable VHF-radiotelephones with an explosion-proof grade appropriate to the operational environment.

Section 2 BUNKERING STATIONS

5.2.1 General requirements

5.2.1.1 The bunkering station is to be located on open deck so that sufficient natural ventilation is provided. Enclosed or semi-enclosed bunkering stations are to be subject to a risk assessment, and the report is to be approved by CCS. The special consideration is as a minimum to include, but not be restricted to, the following design features:

（1）segregation towards other areas on the ship;

（2）hazardous area plans and toxic area zone classification for the ship;

（3）requirements for forced ventilation;

（4）requirements for leakage detection, e.g. gas detection and low temperature detection;

（5）safety actions related to leakage detection, e.g. gas detection and low temperature detection;

（6）access to bunkering station from non-hazardous areas through airlocks;

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

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

5.2.1.3 Enclosed or semi-enclosed bunkering stations are to be surrounded by gastight boundaries against their adjacent spaces.

5.2.1.4 Bunkering lines are not to be led through accommodation, control stations or service spaces. Where a bunkering pipe passes through an enclosed space other than those mentioned above, it is to be enclosed in the venting duct, and the venting duct is arranged in accordance with the requirements for those of fuel supply piping of the Guidelines.

5.2.1.5 Arrangements are to be made for safe management of fuel spills. A water sprinkler is to be fitted above the bunkering connection, and a drip tray is to be fitted below the bunkering connection together with a means of safely collecting and storing ammonia mixture.

5.2.1.6 All doors, windows and other openings and air inlets on the corresponding superstructure or deckhouse side are to be kept closed during the bunkering operation.

5.2.1.7 A means of processing vapour from the bunkering operation are to be provided with vapour return lines or ammonia processing systems.

5.2.1.8 A means is to be provided to prevent the surrounding hull or deck structures from unacceptable cooling in case of leakage during the bunkering operation of low temperature ammonia, e.g. water curtains.

5.2.2 Ships' bunkering hoses

5.2.2.1 Liquid and vapour hoses used for fuel bunkering are to be compatible with the fuel and suitable for the fuel temperature and to be designed according to their burst pressure. The pressure is not to be less than 5 times the maximum pressure that they might sustain during bunkering.

5.2.3 Fuel bunkering manifolds

5.2.3.1 The bunkering manifold is to be designed to withstand the external loads during bunkering. The connections at the bunkering station are to be of dry-disconnect type equipped with additional safety dry break-away coupling/self-sealing quick release. The couplings are to be of a standard type.

5.2.3.2 The arrangement of bunkering manifold is to comply with the relevant standards①.

Section 3 BUNKERING SYSTEMS

5.3.1 General requirements

5.3.1.1 A means is to be provided for draining any fuel from the bunkering pipes upon completion of operation.

5.3.1.2 An arrangement for purging fuel bunkering lines with inert gas is to be provided.

5.3.1.3 Bunkering lines are to be arranged for inerting and gas freeing. When not engaged in bunkering, the bunkering lines are to be free of gas, unless the consequences of not gas freeing is evaluated and approved by CCS.

5.3.1.4 A ship-shore link (SSL) or an equivalent means for automatic and manual ESD communication to the bunkering source is to be fitted for sea-going ships.

5.3.1.5 In the bunkering line, as close to the shore connection as possible, there is to be a manually operated stop valve and a remotely operated shutdown valve arranged in series. Alternatively, a combined manually operated and remote shutdown valve may be provided. It is to be possible to operate the remote valve in the control location for bunkering operations and/or from another safe location. The remote control valve is to be of the fail-to-close type.

5.3.1.6 In case bunkering lines are arranged with a cross-over it is to be ensured by suitable isolation arrangements that no fuel is transferred inadvertently to the ship side not in use for bunkering.

① E.g. SGMF TGN 06-04 Gas as a Marine Fuel - Manifold Arrangements for Gas-fuelled Vessels.

CHAPTER 6 FUEL SUPPLY

Section 1 GENERAL PROVISIONS

6.1.1 Goal

6.1.1.1 The goal of this Chapter is to ensure safe and reliable distribution of fuel to the consumers.

6.1.2 Functional requirements

6.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (1) to (6), (8) to (11), (13) to (15) and (17) to (18). In particular the following apply:

(1) the fuel supply system is to be so arranged that the consequences of any release of fuel will be minimized, while providing safe access for operation and inspection;

(2) the piping system for fuel transfer to the 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; and

(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.

6.1.3 General requirements

6.1.3.1 The fuel piping system is to be separate from all other piping systems on board.

6.1.3.2 The fuel piping system is to have purging function, and the purged fuel is to be stored in appropriate holding tank or to be handled by an ammonia processing system, if fitted.

6.1.3.3 All fuel piping is to be arranged for gas freeing and inerting.

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

6.1.3.5 For single fuel installations the fuel supply system is to be arranged with full redundancy and segregation all the way from the fuel tanks to the consumers, so that a leakage in one system does not lead to an unacceptable loss of power.

6.1.3.6 For single fuel installations, the fuel storage is to be divided between two or more tanks. The tanks are to be located in separate compartments.

6.1.3.7 For single fuel installations, two or more fuel tanks, if located on weather deck, are to be as far apart as practicable for preventing a fire in one tank affecting normal operation of other tanks.

6.1.3.8 For single fuel installations, one tank may be accepted for type C tank only if two completely separate tank connection spaces are installed.

6.1.3.9 For single fuel installations, two or more type C independent tanks may be located in one compartment provided that they are fitted and each of them is fitted with a separate tank connection space.

Section 2 ARRANGEMENT OF FUEL SUPPLY VALVES

6.2.1 General requirements

6.2.1.1 Fuel tank inlets and outlets are to be provided with remotely controlled shut-off valves located as close to the tank as possible.

6.2.1.2 Valves required to be operated under normal operation (e.g. when fuel is supplied to consumers and during bunkering operations) which are not accessible, are to be remotely operated.

6.2.1.3 A manually operated stop valve and a tank master valve in series, or a combined manually operated and tank master valve are to be fitted in each tank outlet, and to be located close to the tank as far as

possible.

6.2.1.4 The main fuel supply line to each fuel consumer or set of consumers is 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 master fuel valve is to be located outside the machinery space and close to the heater (if any) or heat exchanger as far as practicable.

6.2.1.5 The master fuel valve is to be operable from safe locations on escape routs inside a machinery space, the engine control room, if fitted, outside the machinery space, and from the navigation bridge.

6.2.1.6 Fuel supply lines to each engine are to be provided with a double block and bleed valve, and so do vapour return lines, which is to be arranged according to the following requirements:

（1）A set of two valves are to be fitted in series in the fuel pipe to the engine, and the third valve is to be fitted in the venting pipe between those two valves. The venting pipe is to lead to a safe location in the open air, e.g. ventilation masts.

（2）A failure mentioned in Table 11.4.1 (2) will cause the shutoff valves that are in series to close automatically and the ventilation valve to open automatically;

（3）The function of one of the two valves in series and the ventilation valve can be incorporated into one valve body, so arranged that the fuel supply will be automatically blocked and the ventilation be automatically opened when a failure mentioned in Table 11.4.1 (2) occurs;

（4）The three valves above are to be capable of manual reset;

（5）The two valves are to be of the fail-to-close type, while the ventilation valve is to be fail-to-open.

（6）Normal stop of the engine is to cause the shutoff valves that are in series to close automatically and the ventilation valve to open automatically.

6.2.1.7 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 assure safe isolation during maintenance on the engine.

6.2.1.8 The tank master valve and master fuel valve are to be of the fail-safe type.

Section 3 FUEL SUPPLY LINES IN MECHINERY SPACES

6.3.1 General requirements

6.3.1.1 Fuel piping is to be enclosed by a double pipe or duct, and the outer pipe or duct is to be gas tight.

6.3.1.2 The annular space between inner and outer pipe is to be fitted with a mechanical ventilation system of the extraction type, providing a ventilation capacity of at least 30 air changes per hour, and to be fitted with suitable gas and liquid leakage detection equipment. The ventilation outlet pipe for the double wall piping or duct is to connect to a suitable holding tank or process plant for collecting and processing the potential leakage.

6.3.1.3 Inerting of the annular space might be accepted as an alternative to ventilation. An appropriate means of detecting gas and liquid leakage into the annular space is to be provided. Suitable alarms are to be provided to indicate a loss of inert gas pressure in the annular space.

6.3.1.4 The design pressure of the outer pipe or duct of fuel supply pipes is not to be less than the maximum working pressure of the inner pipe. Alternatively, the design pressure of the duct is to be the greater of the followings for high pressure gas piping systems:

（1）the maximum built-up pressure: static pressure in way of the rupture resulting from the gas flowing in the annular space;

（2）local instantaneous peak pressure in way of the rupture p*: given by the following expression:

$$p^* = p_0\left(\frac{2}{k+1}\right)^{\frac{k}{k-1}}$$

where:

p_0——maximum working pressure of the inner pipe;

k——constant pressure specific heat divided by the constant volume specific heat, k = 1.30 for NH_3.

The tangential membrane stress of a straight pipe is not to exceed the tensile strength divided by 1.5 (Rm/1.5) when subjected to the above pressures. The pressure ratings of all other piping components are to reflect the same level of strength as straight pipes. As an alternative to using the peak pressure from the above formula, the peak pressure found from representative tests can be used. Test reports are then to be submitted.

Section 4 FUEL SUPPLY LINES OUTSIDE MECHINERY SPACES

6.4.1 General requirements

6.4.1.1 Fuel piping is not to be led directly through accommodation spaces, service spaces, electrical equipment rooms or control stations.

6.4.1.2 Fuel piping is not to pass through special category spaces, ro-ro spaces and vehicle spaces. If this is impracticable, the fuel piping is to be double wall piping, and an effective means is to be provided to protect the piping from damage due to vehicle collision.

6.4.1.3 A high pressure fuel supply line installed outside the engine room is to be protected to minimize the risk of injury to personnel in case of rupture.

6.4.1.4 For ships carrying dangerous chemicals in bulk, fuel piping is not to pass through tanks and cargo pump-rooms.

6.4.1.5 Where fuel pipes pass through a enclosed space other than the spaces mentioned in 6.4.1.1, they are to be double wall piping and to comply with 6.3.1. Double wall pipes may be dispensed with for tank connection spaces, fuel valve unit spaces and fuel preparation rooms.

6.4.2 Fuel heating

6.4.2.1 The temperature at the outlet of the heat exchanger is to be monitored. When the temperature is too low, an audible and visual alarm is to be given in the navigation bridge or at a manned location of the engine room, and the fuel transfer pump (if any) is to be automatically shutdown and the tank master valve is to be shutoff.

6.4.2.2 The circuit in which the primary heating medium is contained is to be fitted with an expansion tank or other means which would be equally effective. An expansion tank, if fitted, is to be provided with:

（1）a liquid meter, temperature gauge and vent pipe;

（2）a high and low liquid level alarm; and

（3）a means detecting ammonia vapour;

（4）the vents of heating circuit expansion tank leading to an open safe location or proceed by an ammonia processing system.

Section 5 FULE PREPARATION ROOMS

6.5.1 General requirements

6.5.1.1 Where the fuel preparation room is independent, its boundaries are to be gas tight.

6.5.1.2 Fuel preparation rooms are to be provided with detectors for fuel leakage and be mechanically ventilated by the extraction type.

6.5.1.3 Fuel pumps are to be protected against idling, e.g. to avoid running without fuel or servo oil. All pumps which are capable of developing a pressure exceeding the design pressure of the system are to be provided with relief valves. Each relief valve is to be located in a closed circuit, i.e. discharging back to the piping upstream of the suction side of the pump, in order to effectively limit the pump discharge pressure below the design pressure of the system.

6.5.1.4 Fuel preparation rooms are not to be adjacent to accommodation spaces, control stations, service spaces, special category spaces and ro-ro spaces.

6.5.1.5 Fuel preparation rooms are to be provided with a sprinkler system with nozzles located above the parts in high leakage, such as compressors, fuel pumps and valves. The sprinkler system are to be arranged according to 2.4.3.

6.5.1.6 The fuel preparation room is to be provided and arranged according to the requirements for tank connection spaces unless it is located on the weather deck.

6.5.1.7 Fuel preparation rooms are to have regard to the impact of leaked low temperature fuel.

CHAPTER 7 AMMONIA ENGINES

Section 1 GENERAL PROVISIONS

7.1.1 Goal

7.1.1.1 The goal of this Chapter is to provide safe and reliable delivery of mechanical, electrical or thermal energy.

7.1.2 Functional requirements

7.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (1), (11), (13), (17) and (18).

7.1.3 General requirements

7.1.3.1 This Chapter is applicable to ammonia engines for main propulsion and driving of generators or important auxiliary equipment.

7.1.3.2 In addition to this Chapter and Chapter 11 of the Guidelines, the engines are to be designed, manufactured, installed and tested according to the appropriate requirements for diesel engine certification in CCS Rules, and to have a Marine Products Certificate.

7.1.3.3 Unless designed with the strength to withstand the worst case over pressure due to ignited gas leaks, engine components or systems containing or likely to contain an ignitable gas and air mixture are to be fitted with suitable pressure relief systems. The explosion venting is to be led away from where personnel may normally be present.

7.1.3.4 Engine components through which ammonia fuel will run are to be effectively sealed to prevent the leakage into the machinery space.

7.1.3.5 Each engine cylinder is to have a separate fuel injection device to injecting the fuel into the cylinder or each inlet manifold.

7.1.3.6 Engine exhaust systems are to prevent accumulation of gaseous fuel, and not to be connected to the exhaust system of other engines or systems.

7.1.3.7 Risk analysis is to be conducted on all possible faults affecting operation safety of engine. Required engine monitoring items are to be determined based on the risk analysis results, and the report is to be submitted to CCS.

7.1.4 Safety protection

7.1.4.1 An air intake serving the engine, if located outside of the engine room, is to be at least 1.5 m far away from the boundary of any hazardous area.

7.1.4.2 For engines where the space below the piston is in direct communication with the crankcase, the crankcase is to be provided with an appropriate breathing apparatus. Its vent is to lead to a safe location in the open area, and its end is to be fitted with flame arresters. The fuel collected by the breathing apparatus is to be stored in a suitable collecting tank. The crankcases are to be provided with interfaces or other devices for inerting to readily maintain.

7.1.4.3 For engines where the space below the piston is in direct communication with the crankcase, a detailed evaluation regarding the hazard potential of fuel gas accumulation in the crankcase is to be carried out. If it cannot be demonstrated that the gas concentration in the crankcase will not exceed LEL in any case, the crankcase is to be provided with oil mist detectors or equivalent devices, such as bearing temperature detectors for each bearing, to monitor the heat points thereof,

7.1.4.4 The engine exhaust system is to be equipped with explosion relief valves sufficiently dimensioned to prevent excessive explosion pressures in the event of ignition failure of one cylinder followed by ignition of the unburned gas in the system, except that it can be demonstrated that the system can accommodate the pressure from the explosion.

7.1.4.5 In the case of an emergency engine stop or sudden engine failure in ammonia fuel mode, a means is to be provided for purging the exhaust pipes prior to restarting the engine, and the purged gas is to be disposed of properly.

7.1.4.6 Where fuel can leak directly into the auxiliary system medium (lubricating oil, cooling water), an appropriate monitoring and alarming device is to be fitted in the system, and a means is to be provided downstream of the media outlet to collect gas in order to prevent its dispersion. The fuel collected from auxiliary systems media is to be stored in a suitable storage tank.

7.1.4.7 A means is to be provided to monitor and detect poor combustion or misfiring in the engine. In the event that it is detected, continued operation in ammonia mode may be allowed, provided that the fuel supply to the concerned cylinder is shut off and provided that the operation of the engine with one cylinder cut-off is acceptable with respect to torsional vibrations.

7.1.4.8 The ammonia concentration at the exhaust pipe is to be monitored, and a means, e.g. an ammnoia processing system, is to be provided to the gas disposal properly in the case of the concentration exceeding the permissible exposure limit.

Section 2 DUAL FUEL ENGINES

7.2.1 General requirements

7.2.1.1 In case of shut-off of the fuel supply, the engines are to be capable of continuous operation by oil fuel only without interruption.

7.2.1.2 An automatic system is to be fitted to change over from ammonia fuel operation to oil fuel operation and vice versa with minimum fluctuation of the engine power. Acceptable reliability is to be demonstrated through testing. In the case of unstable operation on engines when ammonia firing, the engine is automatically change to oil fuel mode. Manual activation of fuel system shutdown is always to be possible.

7.2.1.3 In case of a normal stop or an emergency stop, the fuel supply is to be shut off not later than the pilot oil fuel. It is not to be allowed to shut off the pilot oil fuel without first or simultaneously closing the fuel supply to each cylinder or to the complete engine.

Section 3 SINGLE FUEL ENGINES

7.3.1 General requirements

7.3.1.1 For a spark ignition engine, the ignition system may be activated only if reaching the minimum ignition speed, and the fuel injection device may be activated only following the ignition.

7.3.1.2 If combustion has not been detected by the engine monitoring system within an engine specific time after the opening of the fuel injection device, the fuel supply unit is to be automatically shut off, and a means to ensure that any unburnt fuel mixture is purged away from the exhaust system is to be provided.

7.3.1.3 Unburnt combustible mixture in the exhaust gas pipe is to be purged after a failed start, and a means, e.g. an ammonia processing system, is to be provided for disposal of the combustible mixture. Restarting is not to be possible before the exhaust gas pipe has been completely purged.

7.3.1.4 In case of a normal stop or an emergency shutdown, the fuel supply is to be shut off not later than the ignition source or the ignition media. It is not to be allowed to shut off the ignition source or the ignition media without first or simultaneously closing the fuel supply to each cylinder or to the complete engine.

CHAPTER 8 VENTILATION

Section 1 GENERAL PROVISIONS

8.1.1 Goal

8.1.1.1 The goal of this Chapter is to provide for the ventilation required for safe working conditions for personnel and the safe operation of machinery and equipment.

8.1.2 Functional requirements

8.1.2.1This Chapter is related to functional requirements in 1.1.3.2 (2), (5), (8), (10), (12) to (14) and (18).

8.1.3 General requirements

8.1.3.1 Any ducting used for the ventilation of hazardous spaces is to be separate from that used for the ventilation of non-hazardous spaces. The ventilation is to function at all temperatures and environmental conditions the ship will be operating in.

8.1.3.2 Electric motors for ventilation fans are not to be located in ventilation ducts for hazardous spaces unless the motors are certified for the same hazard zone as the space served.

8.1.3.3 Ventilation fans serving spaces containing gas sources are not to produce a source of vapour ignition in either the ventilated space or the ventilation system associated with the space. Ventilation fans and fan ducts, in way of fans only, are to be of non-sparking construction required, and to comply with 3.3.5 of Chapter 3 of Part 6 of CCS Rules for Classification of Sea-going Steel Ships.

8.1.3.4 Ventilation systems required to avoid any vapour accumulation are to consist of independent fans, each of which has sufficient capacity, unless otherwise specified in the Guidelines. The ventilation system is to be of a mechanical extraction type,

8.1.3.5 Air inlets for hazardous spaces are to be taken from areas that, in the absence of the considered inlet, would be non-hazardous. Air inlets for non-hazardous enclosed spaces are to be taken from non-hazardous areas at least 1.5 m away from the boundaries of any hazardous area. Where the inlet duct passes through a more hazardous space, the duct is to be gastight and have over-pressure relative to this space.

8.1.3.6 Air outlets from non-hazardous spaces are to be located outside hazardous areas.

8.1.3.7 Air outlets from gas hazardous spaces are to be located in an open area that, in the absence of the considered outlet, would be of the same or lesser hazard than the ventilated space.

8.1.3.8 The required capacity of the ventilation plant is normally based on the total volume of the room. An increase in required ventilation capacity may be necessary for rooms having a complicated form.

8.1.3.9 Non-hazardous spaces with entry openings to a hazardous area are to be arranged with an airlock and be maintained at overpressure relative to the external hazardous area. The overpressure ventilation is to be arranged according to the following:

（1）during initial start-up or after loss of overpressure ventilation, before energizing any electrical installations not certified safe for the space in the absence of pressurization, it is to be required to:

① proceed with purging (at least five air changes) or confirm by measurements that the space is non-hazardous; and

② pressurize the space.

（2）operation of the overpressure ventilation is to be monitored and in the event of failure of the

overpressure ventilation:

① an audible and visual alarm is to be given at a manned location; and

② if overpressure cannot be immediately restored, automatic or programmed, disconnection of electrical installations according to a standard[①] accepted by CCS is to be required.

8.1.3.10 Non-hazardous spaces with entry openings to a hazardous space are to be arranged with an airlock and the hazardous space is to be maintained at underpressure relative to the non-hazardous space. Operation of the extraction ventilation in the hazardous space is to be monitored and in the event of failure of the extraction ventilation:

（1）an audible and visual alarm is to be given at a manned location; and

（2）if underpressure cannot be immediately restored, automatic or programmed, disconnection of electrical installations according to a standard[②] accepted by CCS is to be required.

8.1.3.11 The ventilation system is to ensure a good air circulation in the spaces served, and in particular ensure that any formation of air-pockets in the room is avoided.

8.1.3.12 Any ducting used for the ventilation of hazardous spaces is not to be through accommodation space, service space or other similar space.

8.1.3.13 Mobile ventilation plants are to be provided in hazardous spaces where crew do not enter often, such as cofferdams or similar places. Ventilation is to be provided before entrance into such places with the notice board of ventilation. The explosion-proof degree of a mobile ventilation plant is to be matched with the level of the hazardous area and to hold a marine products certificate.

8.1.3.14 Ventilation fans associated with the hazardous space are to be fitted with substitutes.

8.1.3.15 The shell of the fan is to be earthed.

8.1.3.16 Suitable protective screens of not more than 13 mm square mesh are to be fitted on vent outlets of hazardous spaces.

8.1.3.17 A suitable means is to be provided to prevent ventilation circuits formed by the pipes where the fan is located and the pipes where other fans are located in case of failure of a fan or a group of fans.

8.1.3.18 For mechanical ventilation systems of the extraction type for hazardous spaces, inlets of each air duct are to be arranged according to the area where combustible gas may be accumulated and are to be generally located on the top of the space.

8.1.4 Machinery spaces

8.1.4.1 The ventilation system for machinery spaces containing fuel consumers is to be independent of all other ventilation systems.

8.1.4.2 Machinery spaces containing fuel consumers are to have emergency ventilation with a capacity of at least 15 air changes per hour. If gas is detected in the machinery space, the normal ventilation may be changed into the emergency ventilation.

8.1.5 Fuel preparation rooms

8.1.5.1 Fuel preparation rooms, are to be fitted with effective mechanical ventilation system of the underpressure type, providing a ventilation capacity of at least 30 air changes per hour.

8.1.5.2 The number and power of the ventilation fans are to be such that the capacity is not reduced by more than 50% if a fan with a separate circuit from the main switchboard or emergency switchboard or a group of fans with common circuit from the main switchboard or emergency switchboard is inoperable.

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① Refer to IEC 60092-502:1999 Electrical Installations in Ships – Tankers – Special Features, Table 5 (ch8.4.5).

② Refer to IEC 60092-502:1999 Electrical Installations in Ships – Tankers – Special Features, Table 5 (ch8.4.5).

8.1.5.3 Ventilation systems for fuel preparation rooms are to be in operation when pumps or other fuel treatment equipment are working.

8.1.6 Bunkering stations

8.1.6.1 Bunkering stations that are located in enclosed or semi-enclosed spaces are to be suitably ventilated to ensure that any vapour being released during bunkering operations will be removed outside. If the natural ventilation is not sufficient, mechanical ventilation is to be provided in accordance with the risk assessment required by 5.2.1.1.

8.1.7 Double pipes

8.1.7.1 Ducts and double pipes containing fuel piping are to be fitted with an effective mechanical ventilation system of the extraction type, providing a ventilation capacity of at least 30 air changes per hour.

8.1.7.2 The ventilation system for double piping or ducts is to be independent of all other ventilation systems.

8.1.7.3 The ventilation inlet for the double piping or duct is always to be located in a non-hazardous area away from ignition sources. The inlet opening is to be fitted with a suitable wire mesh guard and protected from ingress of water.

8.1.7.4 The number and power of the ventilation fans are to be such that the capacity is not reduced by more than 50% if a fan with a separate circuit from the main switchboard or emergency switchboard or a group of fans with common circuit from the main switchboard or emergency switchboard is inoperable.

8.1.8 Fuel valve unit spaces

8.1.8.1 The ventilation system for fuel valve unit spaces is to comply with the requirements for ventilation systems of double piping specified in 8.1.7.

8.1.9 Tank connection spaces

8.1.9.1 The tank connection space is to be provided with an effective mechanical forced ventilation system of extraction type. A ventilation capacity of at least 30 air changes per hour is to be provided. The rate of air changes may be reduced if other adequate means of explosion protection is installed. The equivalence of alternative installations is to be demonstrated by a risk assessment.

8.1.9.2 Approved automatic fail-safe fire dampers are to be fitted in the ventilation trunk for the tank connection space.

8.1.9.3 The number and power of the ventilation fans are to be such that the capacity is not reduced by more than 50%, if a fan with a separate circuit from the main switchboard or emergency switchboard or a group of fans with common circuit from the main switchboard or emergency switchboard, is inoperable.

CHAPTER 9 FIRE SAFETY

Section 1 GENERAL PROVISIONS

9.1.1 Goal

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

9.1.2 Functional requirements

9.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (2), (4), (5), (7), (12), (14), (15) and (18).

9.1.3 General requirements

9.1.3.1 The following "other spaces with high fire risk" is as a minimum to be considered, but not be restricted to:

(1) cargo spaces except cargo tanks for liquids with flashpoint above 60°C（If cargo heating is provided, the heating temperature is to be lower than the temperature corresponding to the flash point minus 15°C） and except cargo spaces exempted in accordance with SOLAS regulations II-2/10.7.1.2 or II-2/10.7.1.4; For inland waterways ships, cargo spaces except cargo tanks for liquids with flashpoint above 60°C（If cargo heating is provided, the heating temperature is to be lower than the temperature corresponding to the flash point minus 15°C）, if cargo is heated and to be heated to the temperature more than 15°C below its flashpoint, and except cargo spaces for ore, coal, grain, unseasoned timber, non-combustible cargoes or cargoes, in the opinion of the Administration, constitute a low fire risk,and fitted with steel hatch covers and cargo spaces with all efficient means for ventilation outlets and openings to other cargo spaces closed.

(2) vehicle, ro-ro and special category spaces;

(3) service spaces (high risk): galleys, pantries containing cooking appliances, saunas, paint lockers and store-rooms having areas of 4 m2 or more, spaces for the storage of flammable liquids and workshops other than those forming part of the machinery space, as provided in SOLAS regulations II-2/9.2.2.4, II-2/9.2.3.3 and II-2/9.2.4; For inland waterways ships, service spaces (high risk) as provided in 3.3.4 of Part 5 of the Technical Regulations for the Statutory Surveys on Inland Waterways Ships

(4) accommodation spaces of greater fire risk: saunas, sale shops, barber shops and beauty parlours and public spaces containing furniture and furnishing of other than restricted fire risk and having deck area of 50 m2 or more, as provided in SOLAS regulation II-2/9.2.2.3. For inland waterways ships, accommodation spades as provided in 3.3.4 and saunas, sale shops, barber shops and beauty parlours and public spaces containing furniture and furnishing of other than restricted fire risk as provided in 3.3.8 of Part 5 of the Technical Regulations for the Statutory Surveys on Inland Waterways Ships.

Section 2 FIRE PROTECTION

9.2.1 General requirements

9.2.1.1 Fuel preparation rooms

(1) Fuel preparation spaces are to be considered as machinery spaces of category A (for sea-going ships) / essential machinery spaces (for inland waterways ships) for the purpose of fire protection.

(2) The boundary of the fuel preparation room adjacent to machinery space of category A (for sea-going ships) /essential machinery space (for inland waterways ships) is to be insulated to 'A-60' class standard.

9.2.1.2 Fuel tanks

(1) Any boundary of accommodation spaces, service spaces, control stations, escape routes and machinery spaces, facing fuel tanks on open deck, is to be shielded by A-60 class divisions. These class divisions are to extend up to the underside of the deck of the navigation bridge or up to the true height of the bulkhead. Fuel tanks on the open deck are to be segregated from cargo in accordance with the requirements of IMDG Code where the fuel tanks are regarded as bulk packaging, and to comply with the stowage and segregation requirements for a class 2.3 package of the IMDG Code.

(2) Fuel tanks, if located on the open deck above machinery spaces of category A (for sea-going ships) / essential machinery spaces (for inland waterways ships) or other rooms with high fire risk, are to be properly insulated from these spaces.

(3) Isolation is to be provided between the fuel storage hold space and the machinery space of category A (for sea-going ships) /essential machinery space (for inland waterways ships) or other rooms with high fire risk, which is to be done by a cofferdam of at least 900 mm with insulation of A-60 class. When determining the insulation of the fuel storage hold space from other spaces with lower fire risks, the fuel storage hold space is to be considered as a machinery space of category A (for sea-going ships)/essential machinery space (for inland waterways ships) for fire protection purposes. The boundary between fuel storage hold spaces is to be either a cofferdam of at least 900 mm or A-60 class division.

9.2.1.3 Bunkering stations

(1) Any boundary of machinery spaces of category A (for sea-going ships)/essential machinery spaces (for inland waterways ships), accommodation spaces, control stations and space of greater fire risk, facing the bunkering station, is to be shielded by A-60 class divisions. The A-60 class divisions are to extend up to the underside of the deck of the navigation bridge or up to the actual height of the bulkhead. But the boundaries of a liquid tank, void, auxiliary machinery space and sanitary and other similar space of minor fir risk may be reduced to class A-0 . The A-0 class divisions are to extend up to the underside of the deck of the navigation bridge or up to the actual height of the bulkhead.

(2) For ships on domestic voyages, the insulation of the bunkering station, if located on the open deck and its bunkering connection is more than 10 m far away from the bulkheads of the spaces mentioned in 9.2.1.3 (1), may be reduced to class A-0. Where the bunkering connection is located at the sunken part of the superstructure or deckhouse, this may be considered as being located on the open deck, provided that the depth of the sunken part does not exceed 1 m.

9.2.1.4 The fire protection of fuel pipes led through ro-ro spaces are to be subject to special consideration by CCS depending on the use and expected pressure in the pipes.

Section 3 FIRE EXTINGUISHING

9.3.1 General requirements

9.3.1.1 Fuel preparation rooms, gas compressor rooms and gas pump rooms (if fitted) are to comply with the fire extinguishing requirements for cargo compressor rooms and cargo pump rooms of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

9.3.1.2 Enclosed spaces containing fuel preparation arrangements, such as pumps, compressers or other potential ignition sources, are to be provided with a fixed fire-extinguishing system complying with SOLAS II-2/10.4.1.1 and the Fire Safety Systems Code or 3.8 of Part 5 of the the Technical Regulations for the Statutory Surveys on Inland Waterways Ships for inland waterways ships, taking into account the concentrations/application rate required for extinguishing gas fires.

9.3.2 Fire main

9.3.2.1 When the fire main is located on the open deck and passes through the tank area thereof, isolating valves are to be fitted in the fire main in order to isolate damaged sections of the fire main. Isolation of a section of fire main is not to deprive the fire line ahead of the isolated section from the supply of water.

9.3.2.2 At least two fire pumps are to be provided. The capacity and pressure of each pump are to such that at least two jets of water not emanating from the same hydrant are ejected at least 12 m away.

9.3.2.3 The water spray system may be connected to the fire main and supplied with water through the fire pump, provided that the capacity and pressure of the fire pump are sufficient for operating of the required number of hydrants and the water spray system specified in 9.3.3 simultaneously.

9.3.2.4 Nozzles are to be of a dual-purpose type (i.e. jet/spray type) incorporating a shutoff.

9.3.3 Water spray systems

9.3.3.1 A water spray system is to be provided for cooling, fire protection and crew protection. In addition to the exposed parts of the tank on the deck, the system is to protect the boundaries of superstructures, fuel preparation rooms, cargo control rooms, bunkering control stations, bunkering stations and other normally occupied deckhouses, facing the tank, unless the boundaries are 10 m or more (5 m or more on inland waterways ships) far away from the tank.

9.3.3.2 The system is to be designed to cover all areas as specified above with an application rate of 10 L/min/m2 for horizontal projected surfaces and 4 L/min/m2 for vertical surfaces.

9.3.3.3 Stop valves are to be fitted in the water spray application main supply line(s), at intervals not exceeding 40 metres, for the purpose of isolating damaged sections. Alternatively, the system may be divided into two or more sections that may be operated independently, provided the necessary controls are located together in a readily accessible position not likely to be inaccessible in case of fire in the areas protected.

9.3.3.4 The capacity of the water spray pump is to be sufficient to deliver the required amount of water to the areas protected.

9.3.3.5 The water spray system is to be connected to the ship’s fire main through a stop valve arranged in a safe location outside of the engine room.

9.3.3.6 Pump starting and valve operation of the water spray system are to be located in a readily accessible position which is not likely be inaccessible in case of fire in the areas protected.

9.3.3.7 The nozzles are to be of an approved type and they are to be arranged to ensure an effective distribution of water throughout the space being protected.

9.3.4 Dry chemical powder fire-extinguishing systems

9.3.4.1 Where the tank is located on the open deck, at least two portable dry powder extinguishers of at least 5 kg capacity are to be located near the tank.

9.3.4.2 Where the tank is located in an enclosed or semi-enclosed space, at least one portable dry powder extinguisher of at least 5 kg capacity is to be located at the entrance of the tank.

9.3.4.3 A permanently installed dry chemical powder fire-extinguishing system is to be installed in the bunkering station area to cover all possible leak points. The capacity is to be at least 3.5 kg/s for a minimum of 45 s. The system is to be arranged for easy manual release from a safe location outside the protected area. Ships on domestic voyages, if this is impracticable, may be provided with a large dry chemical wheeled fire extinguisher having the same capacity.

9.3.4.4 In addition to any portable extinguishers that may be required by the Administration, at least one portable dry powder extinguisher of at least 5 kg capacity is to be located near the bunkering station and the fuel preparation room respectively.

9.3.4.5 At least one portable dry powder extinguisher of at least 5 kg capacity respectively is to be provided near the ammonia engine and at the entrance of the machinery space where the engine is located.

Section 4 FIRE DETECTION AND FIRE ALARM SYSTEMS

9.4.1 General requirements

9.4.1.1 Fire detection

(1) A fixed fire detection and fire alarm system complying with the Fire Safety Systems Code are to be provided for the fuel storage hold spaces and the ventilation trunk for fuel tank, and for all other rooms of the fuel system where fire cannot be excluded.

(2) Smoke detectors alone are not to be considered sufficient for a fixed fire detection and fire alarm system.

(3) If individual detector cannot be identified, each detector is to be set up to be a single loop.

9.4.1.2 Alarm and measures for safety

(1) On detection of fire in the spaces mentioned above, safety measures specified in Table 11.4.1 (2) are to be adopted.

CHAPTER 10 EXPLOSION PREVENTION AND TOXIC AREA CLASSIFICATION

Section 1 GENERAL PROVISIONS

10.1.1 Goal

10.1.1.1 The goal of this Chapter is to provide for the prevention of explosions and for the limitation of effects from explosion, as well as for minimizing the risks arising from toxic release sources.

10.1.2 Functional requirements

10.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (1) to (5), (7), (8), (11) to (14) and (17) to (19).

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

(1) reducing the number of sources of ignition;

(2) reducing the probability of formation of ignitable mixtures; and

10.1.2.3 Unauthorized persons are not allowed to move close to toxic release sources.

10.1.3 General requirements

10.1.3.1 Hazardous areas on open deck and other spaces not addressed in this Chapter are to be decided based on a standard① accepted by CCS. The electrical equipment fitted within hazardous areas is to be according to the same standard.

10.1.3.2 Electrical equipment and wiring are in general not to be installed in hazardous areas unless essential for operational purposes based on a standard② accepted by CCS.

10.1.3.3 Life-saving equipment, muster stations and means of escape are not to be located within toxic areas.

10.1.3.4 An operation and emergency procedure is to be provided for guiding the safe operation and evacuation of the crew in toxic areas.

Section 2 HAZARDOUS AREA ZONGS CLASSIFICATION

10.2.1 General requirements

10.2.1.1 Area classification is a method of analysing and classifying the areas where explosive gas atmospheres may occur. The object of the classification is to allow the selection of electrical apparatus able to be operated safely in these areas.

10.2.1.2 In order to facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are divided into zones 0, 1 and 2③. See also 10.2.2.

10.2.1.3 Ventilation ducts are to have the same area classification as the ventilated space.

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① Refer to IEC 60092-502, part 4.4 Tankers carrying flammable liquefied gases as applicable.

② Refer to IEC standard 60092-502: Electrical Installations in Ships – Tankers – Special Features and IEC 60079-10-1: Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres, according to the area classification.

③ Refer to IEC 60079-10-1: Explosive atmosphers Part 10-1: Classification of areas – Explosive gas atmospheres and guidance and informative examples given in IEC 60092-502:1999, Electrical Installations in Ships – Tankers – Special Features for tankers.

10.2.2 Hazardous area zones

10.2.2.1 Hazardous area zone 0

This zone includes, but is not limited to the interiors of fuel tanks, any pipework for pressure-relief or other venting systems for fuel tanks, pipes and equipment containing fuel.

10.2.2.2 Hazardous area zone 1[①]

This zone includes, but is not limited to:

(1) tank connection spaces, fuel storage hold spaces[②] and interbarrier spaces;

(2) fuel preparation rooms;

(3) areas on open deck or semi-enclosed spaces on deck, within 1.5 m of fuel preparation room entrances, fuel preparation room ventilation inlets and other openings into zone 1 spaces;

(4) areas on open deck, or semi-enclosed spaces on deck, within 3 m of any fuel tank outlet, gas or vapour outlet[③], bunker manifold valve, other fuel valve, fuel pipe flange, fuel preparation room ventilation outlets, zone 1 ventilation outlets and fuel tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation;

(5) spaces on the open deck within the drip tray or the coamings including bunker manifold valves and 3 m beyond them, up to a height of 2.4 m above the drip tray'bottom;

(6) enclosed or semi-enclosed spaces in which pipes containing fuel are located, e.g. double walled pipe around fuel pipes, semi-enclosed bunkering stations;

(7) a space protected by an airlock is considered as non-hazardous area during normal operation, but will require equipment required to operate following loss of differential pressure between the protected space and the hazardous area to be certified as suitable for zone 1; and

(8) except for type C tanks, an area within 2.4 m of the outer surface of a fuel containment system where such surface is exposed to the weather.

10.2.2.3 Hazardous area zone 2[④]

This zone includes, but is not limited to:

(1) areas within 1.5 m surrounding open or semi-enclosed spaces of zone 1.

(2) spaces containing bolted hatch to tank connection space.

Section 3 ELECTRICAL INSTALLATIONS

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① Instrumentation and electrical apparatus installed within these areas are to be of a type suitable for zone 1.

② Type C independent tank spaces are in general not to be considered as Zone 1. For the purposes of hazardous area classification, fuel storage hold spaces containing type C tanks with all potential leakage sources in a tank connection space and having no access to any hazardous area, are to be considered non-hazardous. Where the fuel storage hold spaces include potential leakage sources, e.g. tank connections, they are to be considered hazardous area zone 1. Where the fuel storage hold spaces include bolted access to the tank connection
space, they are to be considered hazardous area zone 2.

③ Such areas are, for example, all areas within 3 m of fuel tank hatches, ullage openings or sounding pipes for fuel tanks located on open deck and gas vapour outlets.

④ Instrumentation and electrical apparatus installed within these areas are to be of a type suitable for zone 2.

10.3.1 General requirements

10.3.1.1 Electrical installations are to be in compliance with a standard① at least equivalent to those acceptable to CCS.

10.3.1.2 The explosion group and temperature class of explosion proof equipment used for an explosive gas atmosphere which may contain ammonia vapour are not to be lower than IIA， T1.

10.3.1.3 Equipment within a hazardous area are to be assessed and certificated or registered by the authorities approved by CCS.

10.3.1.4 The installation on board of the electrical equipment units is to be such as to ensure the safe bonding to the hull of the units themselves.

10.3.1.5 The submerged pump is to be provided with a device that gives an alarm in low-liquid level and automatically shuts down the motors in the event of low-low liquid level. The automatic shutdown may be accomplished by sensing low pump discharge pressure, low motor current, or low-liquid level. This shutdown is to give an audible and visual alarm on the navigation bridge, continuously manned central control station or onboard safety centre.

10.3.1.6 Submerged fuel pump motors and their supply cables may be fitted in fuel containment systems. Fuel pump motors are to be capable of being isolated from their electrical supply during gas-freeing operations or when not submerged to make it not energized in an explosive atmosphere.

Section 4 TOXIC AREAS CLASSIFICATION

10.4.1 General requirements

10.4.1.1 In order to reduce the risk from toxic release sources, generally referring to pressure relief valves, hazardous area ventilation outlets, bunkering stations and other potential release sources protected by drip tray, toxic areas are classified as below:

(1) areas within 25 m or *B* surrounding ventilation mast outlets of fuel tanks, whichever is less;

(2) areas on open deck or semi-enclosed spaces on deck, within 10 m of any fuel tank outlet, gas or vapour outlet, other outlet of valve, fuel pipe flange and engine crankcase ventilation outlets (OTTO cycle), and ventilation outlets of hazardous area zone 1;

(3) areas on the open deck within 10 m surrounding spillage coamings, including bunker manifold valves;

(4) areas on open deck or semi-enclosed spaces on deck, within 10m of fuel preparation room entrances, fuel preparation room ventilation inlets and other openings into zone 1 spaces;

10.4.1.2 Alternative to 10.4.1.1, it may be demonstrated that the toxic areas classification is reasonable by using gas dispersion analysis or other equivalent means.

10.4.1.3 Air intakes, air outlets or opening to accommodation, service and control spaces, or other non-hazardous area are not to be located within a toxic area.

10.4.1.4 In particular, the risk assessment in 1.1.4 is to consider the risks of the toxic areas mentioned above. CCS may require a gas dispersion analysis to verify the safety of the ship's arrangement.

① Refer to IEC 60092 series standards, as applicable.

CHAPTER 11 CONTROL, MONITORING AND SAFETY SYSTEMS

Section 1 GENERAL PROVISIONS

11.1.1 Goal

11.1.1.1 The goal of this Chapter is to provide for the arrangement of control, monitoring and safety systems that support an efficient and safe operation of the fuel consumption installation as covered in the other chapters of the Guidelines.

11.1.2 Functional requirements

11.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (1), (2), (11), (13) to (15), (17) and (19).

11.1.2.2 The control, monitoring and safety systems of the fuel consumers are to be so arranged that the remaining power for propulsion and power generation is in accordance with 6.1.3.5 in the event of single failure;

11.1.2.3 A fuel safety system is to be arranged to close down the fuel supply system automatically, upon failure in systems as described in Table 11.4.1 (1) and Table 11.4.1 (2) and upon other fault conditions which may develop too fast for manual intervention.

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

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

11.1.2.6 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 safety systems.

11.1.3 General requirements

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

11.1.3.2 Liquid leakage detection is to be provided for annular spaces of double pipe, fuel preparation rooms, tank connection spaces and other enclosed spaces containing fuel piping or fuel equipment without double piping.

11.1.3.3 A bilge well in each tank connection space of an independent fuel tank is to be provided with both a level indicator and a temperature sensor. Alarm is to be given at high level in the bilge well. Low temperature indication is to activate the safety system.

Section 2 MONITORING AND CONTROL

11.2.1 General requirements

11.2.1.1 Fuel tanks

(1) Level indicators

① Each tank is to be fitted with liquid level gauging device(s), arranged to ensure a level reading is always obtainable whenever the fuel tank is operational. The device(s) is(are) to be designed to operate throughout the design pressure range of the fuel tank and at temperatures within the fuel

operating temperature range.

② Where only one liquid level gauge is fitted, it is to be arranged so that it can be maintained in an operational condition without the need to empty or gas-free the tank.

③ Fuel tank liquid level gauges may be of the following types:

(a) indirect devices, which determine the liquid level of fuel by means such as weighing or in-line flow metering; or

(b) closed devices not extended into the tank, such as devices using radio-isotopes or ultrasonic devices;

(c) closed devices extended into the tank (only on sea-going ships engaged on domestic voyages and inland waterways ships), which are part of the closed system and to prevent fuel spillage, such as float-type systems, electronic probes, magnetic probes and bubbler tube type indicators. Where the closed device is not directly installed on the tank, a shutoff valve is to be fitted near the tank as far as practicable.

(2) Overflow control

① Each liquefied gas fuel tank is to be fitted with a high liquid level alarm operating independently of other liquid level indicators and giving an audible and visual warning when activated.

② An additional sensor for each fuel tank is to be fitted to automatically actuate a shutoff valve when high-high liquid level to avoid excessive liquid pressure in the bunkering line and prevent the fuel tank from becoming liquid full. This sensor is to be independent from the liquid level sensor required in 11.2.1.1(2)①.

(3) Pressure monitoring

① The vapour space of each fuel tank is to be provided with a direct reading gauge. Additionally, an indirect indication is to be provided on the navigation bridge, continuously manned central control station or onboard safety centre.

② The pressure indicators are to be clearly marked with the highest and lowest pressure permitted in the fuel tank.

③ A high-pressure alarm and, if vacuum protection is required, a low-pressure alarm are to be provided on the navigation bridge and at a continuously manned central control station or onboard safety centre. Alarms are to be activated before the set pressures of the safety valves are reached.

④ Each fuel pump or compressor discharge line and each liquid and vapour fuel manifold are to be provided with at least one local pressure indicator.

⑤ Local-reading manifold pressure indicator are to be provided to indicate the pressure between ship's manifold valves and hose connections to the shore.

⑥ Fuel storage hold spaces and interbarrier spaces without open connection to the atmosphere are to be provided with pressure indicator.

⑦ At least one of the pressure indicators provided is to be capable of indicating throughout the operating pressure range.

(4) Temperature monitoring

Each fuel tank is to be provided with devices to measure and indicate the temperature of the fuel in at least three locations: at the bottom and middle of the tank as well as the top of the tank below the highest

allowable liquid level.

11.2.1.2 Bunkering

(1) Control of the bunkering is to be possible from a safe location remote from the bunkering station. At this location:

① the tank pressure, tank temperature and tank level are to be monitored;
② remotely controlled valves required by 5.3.1.5 and 9.3.3.6 are to be capable of being operated;
③ overfill alarm and automatic shutdown are also to be indicated.

(2) If the ventilation in the ducting enclosing the bunkering lines stops, an audible and visual alarm is to be activated at the bunkering control location.

(3) If fuel leakage is detected in the ducting around the bunkering lines, an audible and visual alarm and automatic shutdown are to be provided.

11.2.1.3 Gas compressors

(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 fault.

(2) Temperature monitoring for the bulkhead shaft glands and bearings is to be provided, which automatically give a continuous audible and visual alarm on the navigation bridge or in a continuously manned central control station.

11.2.1.4 Fuel pumps

(1) Fuel pumps are to be fitted with audible and visual alarms in the navigation bridge, the engine control room and the fuel preparation room. As a minimum the alarms are to include low fuel output pressure and pump operation fault.

11.2.1.5 Heat exchangers

(1) The temperature and circulation of heat mediums of heat exchangers are to be monitored. Low temperature alarms are to be activated at the actual heat medium's temperature below the design permissible value. If the heat medium cycle stops, an automatic shutdown of tank master valve and stop of fuel pump are to be activated to avoid icing of the heat medium.

(2) The temperature of the heated medium at the heat exchanger outlet is to be monitored.low temperature indication is to activate an alarm. When the temperature is too low, the shutoff valve on the pipe supplying to the heat exchanger is to be automatically shutoff.

11.2.1.6 Engines

(1) In addition to the diesel monitoring system provided in accordance with Part C, Chapter II-1 of SOLAS and CCS Rules for Classification of Sea-going Steel Ships (for ships engaged on international voyages) or CCS Rules for Classification of Sea-going Steel Ships and CCS Rules for the Construction of Inland Waterways Steel Ships (for ships engaged on domestic voyages), indicators are to be fitted on the navigation bridge and the engine control room and near the engine for:

① condition of the engine operation in case of single fuel engines; or
② condition and mode of the engine operation in the case of dual fuel engines.

11.2.1.7 Ventilation monitoring

(1) Any loss of the required ventilating capacity according to Chapter 8 of the Guidelines is to give an audible and visual alarm on the navigation bridge or in a continuously manned central control station or safety centre.

(2) For tank connection spaces, fuel preparation rooms and double walled pipes (ventilation ducts), the failure of internal ventilation is to activate the safety system.

Section 3 GAS DETECTION

11.3.1 General requirements

11.3.1.1 Gas detection

(1) Permanently installed gas detectors are to be fitted in:

① all ducts around double pipes;
② fuel preparation rooms;
③ tank connection spaces;
④ cofferdams adjacent to the tank;
⑤ other enclosed spaces containing fuel piping without double wall pipes;
⑥ other machinery spaces containing fuel piping, fuel equipment or fuel consumers;
⑦ airlocks;
⑧ ammonia heating circuit expansion tanks;
⑨ enclosed/semi-enclosed bunkering stations;
⑩ vent piping of dedicated ammonia waste tank;
⑪ venting piping of bilge tank containing a potential release source space;
⑫ other enclosed or semi-enclosed spaces where fuel vapours may accumulate;
⑬ ventilation inlets to accommodation and machinery spaces, if required based on the risk assessment required.

(2) The number of detectors in each space is to be considered taking into account the size, layout and ventilation of the space.

(3) The detection equipment is to be located where gas may accumulate and/or in the ventilation outlets.

(4) Gas detection equipment is to be designed, installed and tested in accordance with a standard① accepted by CCS.

(5) An audible and visible alarm is to be activated at a fuel vapour concentration of 30 ppm (150 ppm in double wall piping). The safety system is to be activated at a fuel vapour concentration of 300 ppm.

(6) Audible and visible alarms from the gas detection equipment are to be located on the navigation bridge or in the continuously manned central control station.

(7) Gas detection required by this section is to be continuous without delay.

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① Refer to IEC 60079-29-1 – Explosive atmospheres – Gas detectors – Performance requirements of detectors for flammable detectors.

(8) In addition to fixed gas detection systems, manual liquid ammonia leakage alarm senders are to be provided outside of the machinery space/fuel preparation room.

(9) At least two portable gas detect equipment are to be provided for the crew to detect ammonia vapour in the related spaces.

Section 4 SAFETY SYSTEMS

11.4.1 General requirements

11.4.1.1 Safety actions are to be adopted in the event of a failure mentioned in Table 11.4.1(1) and Table 11.4.1 (2). Alarms mentioned in Table 11.4.1 (1) are to be located in the navigation bridge and the bunkering control location. Alarms mentioned in Table 11.4.1 (2) are to be located in the navigation bridge or a continuously manned control room or the onboard safety centre.

11.4.1.2 If the fuel supply is shut off due to activation of an automatic stop valve, the fuel supply is not to be opened until the reason for the disconnection is ascertained and the necessary precautions are 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.

11.4.1.3 If a fuel leak leading to a fuel supply shutdown occurs, the fuel supply is not to be operated until the leak has been found and dealt with. Instruction to this effects are to be placed in a prominent position in the machinery space and at the fuel supply control location.

11.4.1.4 A caution placard or signboard is to be permanently fitted in the machinery space containing ammonia engines stating that heavy lifting operation that may cause danger and damage to the fuel pipes, is not to be carried out when the engine(s) is running on ammonia.

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

(1) navigating bridge;

(2) cargo control room;

(3) onboard safety centre;

(4) engine control room;

(5) fire control stations; and

(6) adjacent to the exit of fuel preparation rooms.

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

11.4.1.6 For single fuel systems, the following actions are also to be taken in the case of loss of ventilation required or loss of inert gas pressure:

(1) For electrical propulsion systems serving for multiple engine rooms, the other engine is to start. The first engine is to automatically shutdown in the event of connection of the second engine to the busbar.

(2) For direct propulsion systems serving for multiple engine rooms, the engines contained in the machinery space with loss of ventilation are to manually shutdown where there are at least 40% of the effective propulsion power and normal power supply serving for navigation.

(3) For single engine room, the master fuel valve and double block and bleed valves on fuel supply pipes are to automatically shutdown in case of loss of ventilation of double walled pipes or pressure loss of inert

gas, provided that the other fuel supply pipe has been ready.

Monitoring of Fuel Bunkering Table 11.4.1 (1)

Parameter	Alarm	Automatic shutdown of stop valve of bunkering manifold	Comments
Fuel detection in double wall pipe (duct), if applicable	×	×	
Failure of ventilation of double wall pipe (duct), if applicable	×	×	
Reducing of ventilation capacity of double wall pipe (duct), if applicable	×		
Gas detection in double wall pipe (duct) above 150 ppm, if applicable	×		
Gas detection on two detectors① in double wall pipe(duct) above 300 ppm, if applicable	×	×	
Gas detection in enclosed or semi-enclosed bunkering station above 30 ppm	×		
Gas detection in enclosed or semi-enclosed bunkering station above 300 ppm	×	×	
High level in fuel tank	×		
High-high level in fuel tank	×	×	Alarm only not in the bunkering conditions
Manual emergency shutdown of fuel supply	×	×	
Loss of driving power of bunkering manifold remote shut-off valve	×		
①Two independent gas detectors located close to each other are required for redundancy reasons. If the gas detector is of self-monitoring type, the installation of a single gas detector can be permitted.			

Monitoring of Fuel Supply Table 11.4.1 (2)

Parameter	Alarm	Automatic shutdown of tank master valve	Shutdown of master fuel valve and double block and bleed valve, and opening of automatic venting valve	Comments
Fuel tanks and dedicated ammonia waste tanks				
Low level in fuel tank	×			
High level in dedicated ammonia waste tank	×			
High pressure in fuel tank	×			
Low pressure in fuel tank	×			
Low level in submerged pump	×			Stop of fuel pump
Fuel storage hold spaces, tank connection spaces and cofferdams				
Gas detection in cofferdam at 30 ppm	×			
Gas detection on two detectors① in cofferdam at 300 ppm	×	×		
Gas detection in tank connection space at 30 ppm	×			
Gas detection on two detectors① in tank connection space at 300 ppm	×	×		
Fuel leakage detection in tank connection space	×	×②		
Bilge well high level in tank connection space	×			
Bilge well low temperature in tank connection space	×	×		
Failure of ventilation in tank connection space	×	×②		Stop of fuel pump at the same time
Reducing of ventilation capacity in tank connection space;	×			
Fire detection in fuel storage hold space	×	×⑧		
Fire detection in ventilation trunk of fuel containment system below deck	×			
Gas detection in interbarrier space at 30 ppm	×			

Gas detection in tank storage hold space at 30 ppm	×			
Fuel preparation rooms				
Gas detection at 30 ppm	×			
Gas detection on two detectors① at 300 ppm	×	×②		
Failure of ventilation	×	×		
Reducing of ventilation capacity	×			
Fire detection	×	×		
Start of sprinkler system	×	×		
Low compressor inlet pressure	×			
Low compressor output pressure	×			
High compressor discharge pressure	×			
Low temperature of the heat-transfer medium of the heat exchanger	×			
Stop of the heat medium of the heat exchanger	×	×		
Low outlet temperature of the heat exchanger	×			
Low-low outlet temperature of the heat exchanger	×	×	×	
Bilge well high level in fuel preparation room	×			
Bilge well low temperature in fuel preparation room	×	×		
High temperature of bulkhead shaft gland and bearing	×			
Gas supply lines located between the tank and the machinery space				
Gas detection in double wall pipe (duct) at 150 ppm	×			
Gas detection on two detectors① in double wall pipe (duct) at 300 ppm	×	×②		
Liquid fuel leakage detection in double walll pipe	×	×②		
Failure of ventilation in double wall pipe (duct)	×		×②	
Reducing of ventilation capacity in double wall pipe (duct)				
Fuel valve unit spaces				
Gas detection in the space above 30 ppm	×			

Gas detection on two detectors[①] in the space above 300 ppm	×		×[③]	
Liquid fuel leakage detection in the space	×		×[③]	
Failure[⑤] of ventilation in the space	×		×[③⑥]	
Reducing of ventilation capacity in the space				
Machinery spaces containing ammonia engines				
Fire detection in the space	×			
Liquid leak detection in double wall pipe (duct)	×		×[⑦]	
Gas detection in double wall pipe (duct) at 150 ppm	×			
Gas detection on two detectors[①] in double wall pipe (duct) at 300 ppm	×		×[③]	
Gas detection in the space at 30 ppm[⑨]	×			
Gas detection on two detectors[①] in the space at 300 ppm	×		×[③]	
Failure[⑤] of ventilation in double wall pipe (duct) in the space	×		×[③]	
Reducing[⑤] of ventilation capacity in double wall pipe (duct) in the space	×			
Miscellaneous				
Abnormal pressure in fuel supply line	×			
Failure of working medium of controling valve	×		×[④]	Time delayed as found necessary
Automatic shutdown of engine (engine failure)	×		×[④]	
Manually activated emergency shutdown of engine	×		×	
Gas detection in the following spaces or positions at 30 ppm: -airlocks -ammonia heating circuit expansion tanks -vent piping of dedicated ammonia waste tank -vent piping of bilge tank containing a potential ammonia release source space	×			
Manually activated emergency shutdown of compressor, pump and fuel supply	×		×	See 11.4.1.5

①Two independent gas detectors located close to each other are required for redundancy reasons. If the gas detector is of self-monitoring type, the installation of a single gas detector can be permitted.

②If the tank is supplying gas to more than one engine and the different supply pipes are completely separated and fitted in separate ducts and with the master fuel valves fitted outside of the duct, only the master fuel valve on the supply pipe leading into the duct where gas or loss of ventilation is detected is to close.

③If the fuel is supplied to more than one engine and the different supply pipes are completely separated and fitted in separate ducts and with the master fuel valves fitted outside of the duct and outside of the machinery space containing engines, only the master fuel valve on the supply pipe leading into the duct where gas or loss of ventilation is detected is to close.

④Only double block and bleed valves to close, and venting valves to automatically open.

⑤If the duct is protected by inert gas (see 6.3.1.3) then loss of inert gas pressure is to lead to the same actions as given in this table.

⑥Only applicable to dual fuel engines.

⑦May be a stop valve specially used in the case of rapture of the fuel supply piping.

⑧If automatic shutdown of tank master valve will cause loss power of the ship, the tank master valve is not to automatically shutdown.

⑨If gas is detected in the machinery space, the normal ventilation may be changed into the emergency ventilation.

CHAPTER 12 PERSONNEL PROTECTION

Section 1 GENERAL PROVISIONS

12.1.1 Goal

12.1.1.1 The goal of this Chapter is to protect crew members engaged in ammonia fuel operations.

12.1.2 Functional requirements

12.1.2.1 This Chapter is related to functional requirements in 1.1.3.2 (16).

12.1.3 Protective equipment

12.1.3.1 Suitable protective equipment, including eye protection to a recognized national or international standard, is to be provided for protection of crew members, taking into account the characteristics of ammonia fuel.

12.1.3.2 Safety and emergency equipment required in this Chapter is to be kept in suitable, clearly marked lockers located in readily accessible places.

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

12.1.4 Safety equipment

12.1.4.1 Sufficient, but not less than three complete sets of safety equipment are to be provided. Each set is to provide adequate personal protection to permit entry and work in a gas-filled space. This equipment is to take into account the nature of ammonia fuel.

12.1.4.2 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 *l* of free air;

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

(3) Steel-cored rescue line with belt; and

(4) explosion-proof lamp.

12.1.4.3 The facility capable of supplying adequate compressed air is to be provided and is to consist of:

(1) at lest one fully charged spare air bottle for each breathing apparatus required by 12.1.4.1;

(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 air bottles for the breathing apparatus required by 12.1.4.1.

12.1.5 Emergency equipment

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

(1) filter-type respiratory gas mask is unacceptable;

(2) self-contained breathing apparatus is to have at least a duration of service of 15 min; and

(3) emergency escape respiratory gas mask is not to be used for firefighting or other purposes and is to be marked to that effect.

12.1.5.2 The ship is to have onboard medical first-aid equipment, including oxygen resuscitation equipment and suitable antidote, based on a recognized standard①.

12.1.5.3 A stretcher that is suitable for hoisting an injured person from spaces below deck is to be kept in a readily accessible location.

12.1.5.4 One or mare suitably marked decontamination showers and eyewash stations are to be available on deck, in machinery space and fuel preparation room, near bunkering station. The showers and eyewashes are to be operable in all ambient conditions.

① Refer to the Medical First Aid Guide for Use in Accidents involving Dangerous Goods (MFAG), which provides advice on the treatment of casualties in accordance with the symptoms exhibited as well as equipment and antidotes that may be appropriate for treating the casualty.

CHAPTER 13 TECHNICAL REQUIREMENTS FOR AMMONIA FUEL POWER SYSTEM READY

Section 1 GENERAL PROVISIONS

13.1.1 Application

13.1.1.1 This Chapter applies to newly constructed ships for which an ammonia fuel power system (excluding ammonia fuel cell) ready plan is adopted and modification and installation of ammonia fuel power system is intended in the future. Such ships are also to comply with the relevant requirements (if any) of the Administration of the flag State.

13.1.1.2 This Chapter specifies the requirements of ammonia fuel power system device and its design, arrangement, structural strengthening, space reservation and survey where the ship adopts an ammonia fuel power system ready plan.

13.1.1.3 Conventional ship systems and/or equipment shared with ammonia fuel power systems are to comply with the requirements of relevant conventions, regulations and CCS Rules.

13.1.2 Goal and functional requirements

13.1.2.1 The goal of this Chapter is to define the ready requirements for ammonia fuel power system ships and provide technical guidance for the subsequent conversion to use ammonia fuel as power on ships.

13.1.2.2 For ammonia fuel power system ready, the following functional requirements are to be complied with:

(1) The ready arrangement and design of an ammonia fuel power system are to consider that the probability and consequences of ammonia fuel-related hazards can be limited to a minimum;

(2) In the event of ammonia fuel leakage or failure of the risk reducing measures, initiation of necessary safety actions are to be considered, taking into account that risk reducing measures and safety actions do not lead to an unacceptable loss of power;

(3) The ready arrangement of an ammonia fuel power system is to consider that hazardous areas 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;

(4) Fuel containment systems and machinery spaces containing liquid fuel or vapour release sources are to be arranged and located such that a fire or explosion in either will not lead to an unacceptable loss of power or render equipment in other compartments inoperable.

Section 2 READY REQUIREMENTS

13.2.1 General requirements

13.2.1.1 For ammonia fuel power system ready, due consideration is to be given to the impact of fitting of fuel tanks, fuel containment, bunkering and supply system and fuel using equipment on the ship at the design and construction stage.

13.2.1.2 Propulsion and power machinery including supply systems is to be provided such that any single

failure of fuel supply and fuel leakage will not lead to an unacceptable loss of power.

13.2.2 Ship arrangement

13.2.2.1 Ships applying for the class notation AFD Ready 1 are to comply with the requirements of 13.2.2.2 to 13.2.2.7 below. In addition to the requirements of 13.2.2.2 to 13.2.2.7, ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X) are to comply with the applicable requirements in Chapter 2 of the Guidelines.

13.2.2.2 Adequate space is to be reserved at the ready stage for the installation and arrangement of fuel tanks, fuel preparation rooms, tank connection space (if any), bunkering stations, air locks (if any) and gas valve unit spaces.

13.2.2.3 Assembly stations, life-saving equipment and escape routes are not to be located in the toxic area, the scope of which is described in Section 4, Chapter 10 of the Guidelines.

13.2.2.4 Fuel tanks are to be protected against external damage due to collision or grounding. The arrangement of fuel tanks is to comply with the requirements in Section 2, Chapter 2 of the Guidelines.

13.2.2.5 All tank connections, fittings, flanges and tank valves must be enclosed in gas tight tank connection spaces, unless the tank connections are on open deck. For ships intended to carry dangerous goods, if the fuel tanks are reserved for arrangement in enclosed spaces, cofferdams are to be used to separate the fuel tanks from adjacent dangerous goods compartments; If the fuel tanks are reserved for arrangement on open deck or semi-enclosed area, a tank connection space is also to be provided to avoid hazardous reactions between ammonia fuel and the cargo to be carried.

13.2.2.6 The reserved arrangement of fuel preparation rooms is generally to be located on the open deck. If the location is below the freeboard deck, an independent access leading directly from the open deck to the compartment or space reserved for an independent access is to be provided as far as possible. Where an independent access is not practicable, space can also be reserved for fitting an airlock.

13.2.2.7 The access to the tank connection space is to be independent and lead directly to the open deck, otherwise a gastight bolted hatch cover is to be provided, and the space containing the bolted hatch cover is to be regarded as hazardous space.

13.2.3 Hull structural strength

13.2.3.1 Ships applying for the class notation AFD Ready 1 are to consider that the hull structure after the modification of ammonia fuel power system is to comply with the requirements for longitudinal strength in CCS Rules.

13.2.3.2 In addition to the requirements of 13.2.3.1, ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X) are to comply with the applicable requirements in Chapter A4, PART TWO of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and the Rules for Classification of Sea-going Steel Ships, or CCS Rules for Construction and Equipment of Inland Waterways Ships Carrying Liquefied Gases in Bulk and Rules for the Construction of Inland Waterways Steel Ships.

13.2.4 Fuel containment system

13.2.4.1 Ships applying for the class notation AFD Ready 1 are to consider the following requirements of

13.2.4.3 to 13.2.4.9.

13.2.4.2 In addition to the requirements of 13.2.4.3 to 13.2.4.9, ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X) are to comply with the relevant requirements of the applicable tank types in Chapter 4 of the Guidelines and Chapter A4 of PART TWO of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

13.2.4.3 The design life of the fuel containment system is not to be less than the design life of the ship or 20 years, whichever is greater.

13.2.4.4 The structural strength of the fuel containment system is to have a safety margin and to be able to withstand the loads applied by the relevant structures and equipment. The shrinkage and expansion of the fuel tank due to temperature changes and hull deformation is not to cause excessive stress of the hull and fuel tank structure.

13.2.4.5 The fuel containment system is to be provided with an effective insulation system to maintain the temperature of the hull structure at a safe level.

13.2.4.6 The fuel containment system is to be fitted to provide mechanical protection and minimize the risk of possible damage due to operations such as ship and/or cargo operations.

13.2.4.7 The fuel containment system is to prevent all potential leakage of the primary barrier and prevent damage to the ship's structure, persons on board and the environment due to fuel leakage. The measures taken after leakage is not to lead to an unacceptable loss of power. Safe treatment method of fuel leakage is also to be considered.

13.2.4.8 Direct release of ammonia vapour to control fuel tank pressure is not acceptable, but it is permissible to release ammonia vapour to the atmosphere under failure conditions.

13.2.4.9 The fuel containment system is to be designed and constructed to ensure safety during operation, inspection and maintenance, with consideration for convenience of subsequent survey.

13.2.5 Dual fuel engine

13.2.5.1 Ships applying for the class notation AFD Ready 1 is to fully consider the arrangement space of dual fuel engines, associated interfaces and system arrangement position.

13.2.5.2 For ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X), dual fuel engines are to comply with the applicable requirements for dual fuel engines in Chapter 9 of PART THREE of CCS Rules for Classification of Sea-going Steel Ships and Chapter 7 of the Guidelines. NO_X emission compliance of ammonia fuels and the applicable requirements of engine manufacturers regarding the use of ammonia fuel are also to be considered.

13.2.6 Dual fuel boiler

13.2.6.1 Ships applying for the class notation AFD Ready 1 is to fully consider the arrangement space of dual fuel boilers, associated interfaces and system arrangement position.

13.2.6.2 For ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X), in addition to the applicable requirements for boilers in Chapter 6 of PART 3 of CCS Rules for Classification of Sea-going Steel Ships, dual fuel boilers are to comply with the applicable requirements of boiler manufacturers

regarding the use of ammonia fuel.

13.2.7 Fuel bunkering and supply

13.2.7.1 Ships applying for the class notation AFD Ready 1 is to fully consider:

(1) The arrangement space of the fuel bunkering station and the location of the drip tray are to be reserved on the open deck. Components of the fuel bunkering and supply system that may cause ammonia leakage are to be provided at a safe distance from the air inlet, outlet or opening of accommodation spaces, service spaces, machinery spaces, control stations or other non-hazardous areas with due regard to the toxic hazard after leakage. Consideration is also to be given to the arrangement space of related firefighting facilities involving fuel bunkering and supply.

(2) Space is to be reserved for fuel bunkering and supply systems. Fuel piping is to be arranged in accordance with the applicable requirements in Chapter 6 of the Guidelines, with consideration for adequate space for the design and arrangement of double-wall piping ventilation or inerting.

(3) Influence of modification type of ammonia fuel power system on the arrangement of machinery space. The arrangement type of machine space is to be fully considered for modification of ammonia fuel piping system in the future. The machinery space is generally to be arranged as the gas safe machinery space. The type and arrangement position of the gas valve unit is to be fully considered and adequate space is to be reserved according to the type.

(4) If a pump/compressor room (fuel preparation room) is provided, corresponding space is to be reserved for arrangement and the ventilation and fire protection requirements of the pump/compressor room (fuel preparation room) is to be considered.

13.2.7.2 For ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X), in addition to the above requirements, the bunkering and supply system is to comply with the following requirements:

(1) The design and installation of fuel piping is to comply with the requirements in Sections 1 and 2 of Chapter 3 of the Guidelines;

(2) The manufacture, process and test of fuel piping is to comply with the applicable requirements in Chapter 13 of CCS Rules for Ships Using Natural Gas Fuel;

(3) The fuel bunkering system is to comply with the requirements in Chapter 5 of the Guidelines;

(4) The fuel supply system is to comply with the requirements in Chapter 6 of the Guidelines.

13.2.8 Power supply and distribution systems

13.2.8.1 For ships applying for the class notation AFD Ready 1, the relevant electrical equipment such as compressor, inert gas system, etc. of ammonia fuel supply system is to be fully considered at the ready stage to reserve adequate capacity of the power station onboard as far as possible, so that it is unnecessary to increase the number or capacity of generators after the installation of such equipment. Meanwhile, space for power supply switches for such equipment is to be reserved in the switchboard or power distribution box.

13.2.9 Gas hazardous areas

13.2.9.1 For ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X), hazardous area

classification and electrical equipment arranged within hazardous areas are to comply with the applicable requirements in Chapter 10 of the Guidelines.

13.2.10 Fire safety

13.2.10.1 Ships applying for the class notation AFD Ready 1 are to comply with the requirements of 13.2.10.3 to 13.2.10.5 below.

13.2.10.2 In addition to the requirements of 13.2.10.3 to 13.2.10.5, ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X) are to comply with the applicable requirements in Chapter 9 of the Guidelines.

13.2.10.3 For the purpose of fire protection, any spaces containing ready fuel preparation equipment such as pumps, compressors, heat exchangers, vaporizers and pressure vessels are to be regarded as machinery spaces of category A (for sea-going ships)/essential machinery spaces (for inland waterways ships).

13.2.10.4 The separation is to be done between the spaces containing fuel tank and machinery spaces of category A (for sea-going ships) /essential machinery spaces (for inland waterways ships) or other high fire risk spaces by a cofferdam of at least 900 mm. A-60 class fire division is to be provided at the side close to the cofferdam in machinery spaces of category A (for sea-going ships) /essential machinery spaces (for inland waterways ships) or other high fire risk spaces. When determining the fire division between the space containing fuel tank and other spaces with lower fire risks, the space containing fuel tank is to be regarded as a machinery space of category A (for sea-going ships) /an essential machinery space (for inland waterways ships) for the purpose of fire protection. The boundary between spaces containing fuel tank is to be either a cofferdam of at least 900 mm or A-60 class division.

13.2.10.5 Where the reserved fuel preparation rooms are adjacent to machinery spaces of category A (for sea-going ships)/essential machinery spaces (for inland waterways ships) or other spaces with high fire risk, A-60 class fire division is to be provided on the side of machinery spaces of category A (for sea-going ships)/essential machinery spaces (for inland waterways ships) or other spaces with high fire risk.

13.2.11 Ventilation and venting

13.2.11.1 Ships applying for the class notation AFD Ready 1 are to comply with the requirements of 13.2.11.3.

13.2.11.2 In addition to the requirements of 13.2.11.3, ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X) are to comply with the applicable requirements in Section 2, Chapter 4 and Chapter 8 of the Guidelines.

13.2.11.3 In order to prevent ammonia fuel gas from entering accommodation spaces, service spaces, control stations or other non-hazardous areas, the air inlet/outlet or opening of such spaces are to be located as far as possible away from the toxic area, the scope of which is described in Section 4, Chapter 10 of the Guidelines.

13.2.12 Control, monitoring and safety systems

13.2.12.1 For ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X), control, monitoring and safety systems are to comply with the applicable requirements in Chapter 11 of the Guidelines.

13.2.13 Materials

13.2.13.1 For ships applying for the class notation AFD Ready 2 or AFD Ready 2 (X), fuel tanks, secondary barriers and pressure vessels for treatment are to comply with the applicable requirements in Section 3, Chapter 3 of the Guidelines.

Section 3 PLANS AND DOCUMENTS

13.3.1 Plans and documents to be submitted for approval for the class notation AFD Ready 1

13.3.1.1 In addition to those specified in CCS Rules, the following plans and documents are at least to be submitted for approval for ships applying for the class notation AFD Ready 1:

(1) General arrangement plan, including:

① reserved arrangement for fuel tank;
② reserved arrangement for fuel bunkering system.

(2) Structural fire protection arrangement plan of spaces reserved for fuel tank, tank connection space, fuel preparation room (if any) and bunkering station (if applicable).

13.3.1.2 The following plans and documents are to be submitted for information:

(1) Instructions for ammonia fuel power system ready and arrangement;

(2) Calculation of longitudinal strength (considering the influence of ammonia fuel tank etc. on weight distribution of ship).

13.3.2 Plans and documents to be submitted for approval for the class notation AFD Ready 2

13.3.2.1 In addition to those specified in 13.3.1.1 and CCS Rules, the following plans and documents are at least to be submitted for approval for ships applying for the class notation AFD Ready 2:

(1) Ship arrangement

① arrangement of machinery spaces and boiler rooms;
② arrangement of spaces containing fuel tank;
③ arrangement of fuel bunkering systems;
④ arrangement of accesses, vent pipes and other openings of fuel tank spaces / fuel tank connection spaces;
⑤ arrangement of ventilation pipes, doors and openings in hazardous areas;
⑥ arrangement of entrance, air inlet and opening of accommodation spaces, service spaces and control stations;
⑦ air lock (if any) and its structures
⑧ gastight bulkhead penetration (if any);
⑨ classification of hazardous areas;
⑩ toxic area zones classification.

(2) Piping systems

① system diagram of fuel piping, including fuel supply, bunkering, pressure relief valve and vent pipes, etc.;

② cooling water systems or hot water systems relating to fuel systems (if any);
③ arrangement of bilge and drainage systems for the fuel preparation room and fuel tank space (if any);
④ arrangement and instruction of gas freeing and inert gas purging systems.

(3) Ventilation systems

① arrangement of mechanical ventilation systems in hazardous areas;
② ventilation system of double wall pipes.

(4) Fire-fighting appliances and systems

① arrangement and instruction of water mist system (capacity calculation, etc.);
② fire detection system and arrangement;
③ structural fire protection arrangement of fuel tanks and fuel tank spaces and their vent pipes, bunkering stations (if applicable);
④ chemical dry powder fire extinguishing system.

(5) Electrical systems

① arrangement of electrical installations in the hazardous area;
② verification information of intrinsically safe circuits.

(6) Control, monitoring and safety systems

① fuel vapor detection and alarm system and arrangement;
② fuel tank monitoring and control system and arrangement;
③ fuel pump control and monitoring system (if any) and arrangement;
④ ammonia engine control and monitoring system and arrangement;
⑤ electrical system and monitoring list related to fuel supply system and bunkering system.

(7) Fuel tanks

① fuel tank and its support structure;
② calculation of temperature field distribution.

13.3.2.2 In addition to those specified in 13.3.1.2 and CCS Rules, the following plans and documents are at least to be submitted for information for ships applying for the class notation AFD Ready 2:

(1) Ship arrangement

① instruction of coaming, drip trays or other protection means;
② arrangement of fuel preparation room (if any).

(2) Piping systems

① plans and instruction of the flanges, valves and other devices in fuel piping systems;
② material specifications of fuel piping, valves and other devices;
③ technical documents of the means for removing fuel from fuel bunkering pipes before the bunkering joint is cut off;
④ capacity calculation of piping pressure relief valve.

(3) Fuel tank

① strength calculation of fuel tank and its supporting structure;
② material specification for fuel tank and connecting piping;
③ capacity calculation of fuel tank pressure relief valve.

13.3.3 Plans and documents to be submitted for approval for the class notation AFD Ready 2(X)

13.3.3.1 In addition to those specified in 13.3.1 and 13.3.2, the following plans and documents are at least to be submitted to CCS field surveyors for examination and confirmation:

(1) ships applying for the class notation AFD Ready 2 (T)

① fuel tank welding procedure document and post-weld stress relief heat treatment document;
② non-destructive testing plan and report of fuel tank;
③ documents of strength and tightness test of fuel tank.

(2) ships applying for the class notation AFD Ready 2 (M)

① CCS marine product certificate for ammonia engines.

(3) ships applying for the class notation AFD Ready 2 (P)

① fuel piping welding procedure document and post-weld stress relief heat treatment document;
② non-destructive testing plan and report of fuel piping;
③ documents of pressure testing (strength and tightness test) of fuel piping;
④ functional testing programme for piping (including valves, fittings and equipment relating to fuel operation);
⑤ technical documents of the branch pipes, bends, expansion joints, bellows or similar devices;
⑥ technical documents of electrical earthing of piping.

(4) ships applying for the class notation AFD Ready 2 (D)

① List of explosion-proof certificates of electrical equipment.

Section 4 SURVEY

13.4.1 General requirements

13.4.1.1 All survey procedures, survey methods, types of survey, intervals between the surveys, survey conditions, preparations before survey, survey and testing requirements and preservation of the drawings and documentation, certificates, records and reports etc., are to comply with the requirements of 1.4.1.

13.4.2 Special requirements

13.4.2.1 For ammonia fuel power system ready ships applying for the class notation AFD Ready2 (X), surveys during and after construction are to be conducted in accordance with the applicable requirements in Section 4 of Chapter 1 of the Guidelines.

13.4.2.2 The equipment related to the ammonia fuel power system installed at the ready stage of the ship is to hold a product certificate, the survey basis of which is to include the relevant survey requirements of CCS for the ammonia fuel power system.