GUIDANCE NOTES
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International Ship Classification

Guidelines for Inspection of Alternative Fuel Conversion for Ships
(2025)

Effective Date: 12/1, 2025

Contents

Chapter 1 General

Section 1 General Provisions

1.1.1 Scope of application

1.1.1.1 The Guidelines for Inspection of Alternative Fuel Conversion for Ships (the Guidelines for short) applies to the conversion of existing sea-going ship main propulsion installations, generator sets and boilers that use methanol/ethanol fuel, LNG fuel and ammonia fuel.

1.1.1.2 This guideline's requirements for ammonia fuel conversion only apply to vessels outside the framework of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code).

1.1.1.3 The requirements of this guideline do not supersede the applicable requirements of the "RULES FOR SHIPS USING NATURAL GAS FUELS ", "Guidelines for Ships Using Methanol/Ethanol Fuels" and "Guidelines for Ships Using Ammonia Fuel", etc.

1.1.1.4 The Guidelines are mainly used to guide the drawing review and survey of ship alternative fuel conversions.

1.1.1.5 If the conventions of this guide involve changes to the ship type, they should also meet the applicable requirements of the "Guidelines for Implementation of Major Conventions of Ships".

1.1.1.6 The convention of domestic navigation sea vessels' main propulsion installations, generator sets and boilers to use methanol/ethanol fuel, LNG fuel and ammonia fuel shall be implemented in accordance with the Guidelines .

1.1.2 General requirements

1.1.2.1 Drawing review and survey shall be carried out in accordance with the conventions, rules, specifications and other applicable standards agreed in the service agreement. At the kick-off meeting, all parties involved shall formulate survey and test plans to ensure quality and construction progress based on the actual capabilities and relevant requirements of the shipyard.

1.1.2.2 The definitions mentioned in the Guidelines are consistent with the conventions, specifications, and guidelines listed in Section 2 of this chapter.

1.1.2.3 The pictures, diagrams, numerical parameters and tables in the Guidelines are currently acceptable practices for alternative fuel conversion of ships and are for reference only.

1.1.2.4 Automatic/manual welding operations shall be completed by qualified operators/welders who comply with approved welding procedure and undergo strict and effective training at the shipyard.

1.1.2.5 Non-destructive testing (NDT) operators shall perform NDT on welds with tools to evaluate the quality of welds. This operator must obtain a qualification certificate issued by a third-party institution that is recognized by ISC or accepted by ISC and complies with the requirements of ISO 9712:2012. The non-destructive testing procedures should be evaluated by personnel who are qualified at level II or above and comply with ISO 9712 or equivalent standards.

Section 2 Requirements of Conventions and Normative Guidelines

1.2.1 General requirements

1.2.1.1 Ship alternative fuel conversion shall generally meet the relevant requirements of the following conventions, rules, specifications, guidelines and standards, which shall be subject to the service agreement, including but not limited to:

(1) IMO International Convention for the Safety of Life at Sea (1974) and its amendments (hereinafter referred to as "SOLAS Convention")

(2) IMO International Convention for the Prevention of Pollution from Ships and its amendments (hereinafter referred to as "MARPOL")

(3) IMO International Convention on Load Lines 1966 - Amending Resolutions since 1988 and its amendments

(4) IMO International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and its amendments (hereinafter referred to as "IGC Code") (if applicable)

(5) IMO International Convention on Tonnage Measurement of Ships 1969 and its amendments;

(6) IMO International Code on Intact Stability 2008 and its amendments

(7) IMO International Management Code for the Safe Operation of Ships and for Pollution Prevention and its amendments (hereinafter referred to as the "ISM Code") (if applicable)

(8) Convention on the International Regulations for Preventing Collisions at Sea 1972 and its amendments

(9) International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code) and its amendments

(10) International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1995 (STCW) and its amendments(if applicable)

(11) ILO Occupational Safety and Health (Dock Work) Convention, 1979

(12) ILO Guide to Safety and Health in Dock Work, 1976, as amended in 1979

(13) ISC Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (if applicable)

(14) ISC Rules for Classification of Sea-going Steel Ships

(15) ISC Rules for Materials and Welding

(16) ISC Rules for Natural Gas Fuel Used in Ships

(17) Interim Guidelines for the Safety of Ships Using Ammonia as Fuel (MSC.1/Circ.1687)

(18) Interim Guidelines for the Safety of Ships Using Methanol/Ethanol as Fuel (MSC.1/Circ.1621)

(19) ISC Guidelines for Hazardous Area Classification and Electrical Installations of Tankers

(20) ISC Guidelines for Design and Installation of Gas Fuel Engine Systems for Liquefied Gas Carriers

(21) ISC Rules for Certification of Safety Management System for Safe Operation of Ships and Pollution Prevention

(22) ISC Guidelines for Implementation of Statutory Surveys;

(23) ISC Guidelines for Ships Using Methanol/Ethanol Fuels

(24) ISC Guidelines for Ships Using Ammonia Fuel

(25) ISC Guidelines for Ships with Natural Gas Fuel Power Systems

(26) Technical Rules for Control of Nitrogen Oxide Emissions from Marine Diesel Engine

(27) Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009

(28) Regulation (EU) No. 1257/2013

(29) Relevant statutory requirements of the competent authority of the flag state;

(30) Acceptable recognized pressure vessel standards, such as GB150 "Pressure Vessels", AD2000;

(31) Other relevant standards.

Section 3 Conversion Process

1.3.1 General requirements

1.3.1.1 The ship alternative fuel conversion process shall be carried out in accordance with the requirements of 1.3.2 to 1.3.4 of this section, as shown in Figure 1.3.1.

1.3.1.2 Consider the impact of changes in the empty ship weight before and after the convention of alternative fuels on the stability of the vessel. Consider the influence of changes in the loading condition of the vessel after adding fuel tanks or LNG fuel containment systems on the stability of the vessel.

1.3.1.3 Consider the impact of alternative fuels convention on the total tonnage and net tonnage of ships.

1.3.1.4 Consider the impact of adding an LNG fuel containment system on the ship's navigational visibility, wind exposure area, and ice formation calculations.

1.3.2 Application

1.3.2.1 Ships with ISC class or intending to apply for ISC class shall submit a conversion survey application and submit drawings and materials of the converted parts and related parts to ISC for review.

1.3.2.2 For application for "alternative design and layout", the conversion plan shall meet the applicable requirements of Article 55, Chapter II-1 of SOLAS on alternative design and layout plans, unless otherwise specified by the competent authority.

1.3.2.3 Both "alternative fuel conversion" and "alternative design and layout" ， in addition to obtaining ISC approval，shall be submitted to the authority for approval. The ship must keep the approved document of the alternative design recognized by the authorities on board, except for LNG fuel conventions.

1.3.3 Preparation before conversion

1.3.3.1 The designer and/or shipyard shall prepare a design conversion plan and consult with ISC in sufficient time before the conversion starts to preliminarily evaluate its feasibility, and prepare drawings and order important equipment and raw materials involved in the conversion in accordance with the Guidelines and relevant ISC specifications.

1.3.3.2 The engine shall be converted by the engine manufacturer, patent owner or authorized organization of the patent owner.

1.3.3.3 For shipyards that carry out alternative fuel conversion for the first time, a shipyard assessment shall be conducted, and specific evaluation and confirmation shall be carried out in accordance with the requirements of ISC on shipyard assessment management.

1.3.3.4 Alternative fuel engines shall have obtained ISC design approval or type approval.

1.3.3.5 The ISC ship drawing reviewer shall determine whether the conversion is a major conversion based on the content. The flag state authority will ultimately decide whether it constitutes a major convention.

1.3.3.6 The convention of ships to use alternative fuels should consider conducting a risk assessment. The detailed information of various risks and the methods to mitigate these risks should be documented and submitted to ISC.

1.3.4 Implementation of conversion

1.3.4.1 The ISC product drawing approval unit shall be responsible for the approval of drawings for engine conversion and related new systems/products, and the ISC ship drawing approval unit shall be responsible for the approval of relevant ship conversion drawings. If the ship to be converted was reviewed and surveyed during construction by ISC, the conversion drawings shall be submitted to the original ISC ship approval unit; if the ship is transferred from other classification societies to ISC, the conversion drawings shall be submitted to the ISC ship approval unit of the conversion site.

1.3.4.2 The converted engine shall be tested in accordance with the applicable requirements of Chapter 9, Part 3 of the *Rules for Classification of Sea-Going Steel Ships*.

1.3.4.3 After the engine passes the survey, ISC will issue a marine product certificate and EIAPP certificate for the modified engine and approve the NO_x technical file.

1.3.4.4 Materials required for conversion of ship structures, fuel tanks, etc., including but not limited to ship structural steel plates, 9% Ni alloy steel, 36.5% Ni alloy steel, plywood, thermal insulation materials, and low-temperature stainless steel, must meet the requirements of ISC *Rules for Materials and Welding*, and material certification must meet the requirements of Chapter 3, Part 1 of ISC *Rules for Classification of Sea-Going Steel Ships*.

1.3.4.5 Except for engines, the systems, equipment, piping, valves and other products required for conversion shall obtain ISC product certificates and meet the requirements of Chapter 3, Part 1 of ISC *Rules for Classification of Sea-Going Steel Ships* and ISC *Product Survey Guidelines*. The specific list of certified products shall meet the requirements of Appendix to Chapter 3, Part 1 of ISC *Rules for Classification of Sea-Going Steel Ships*.

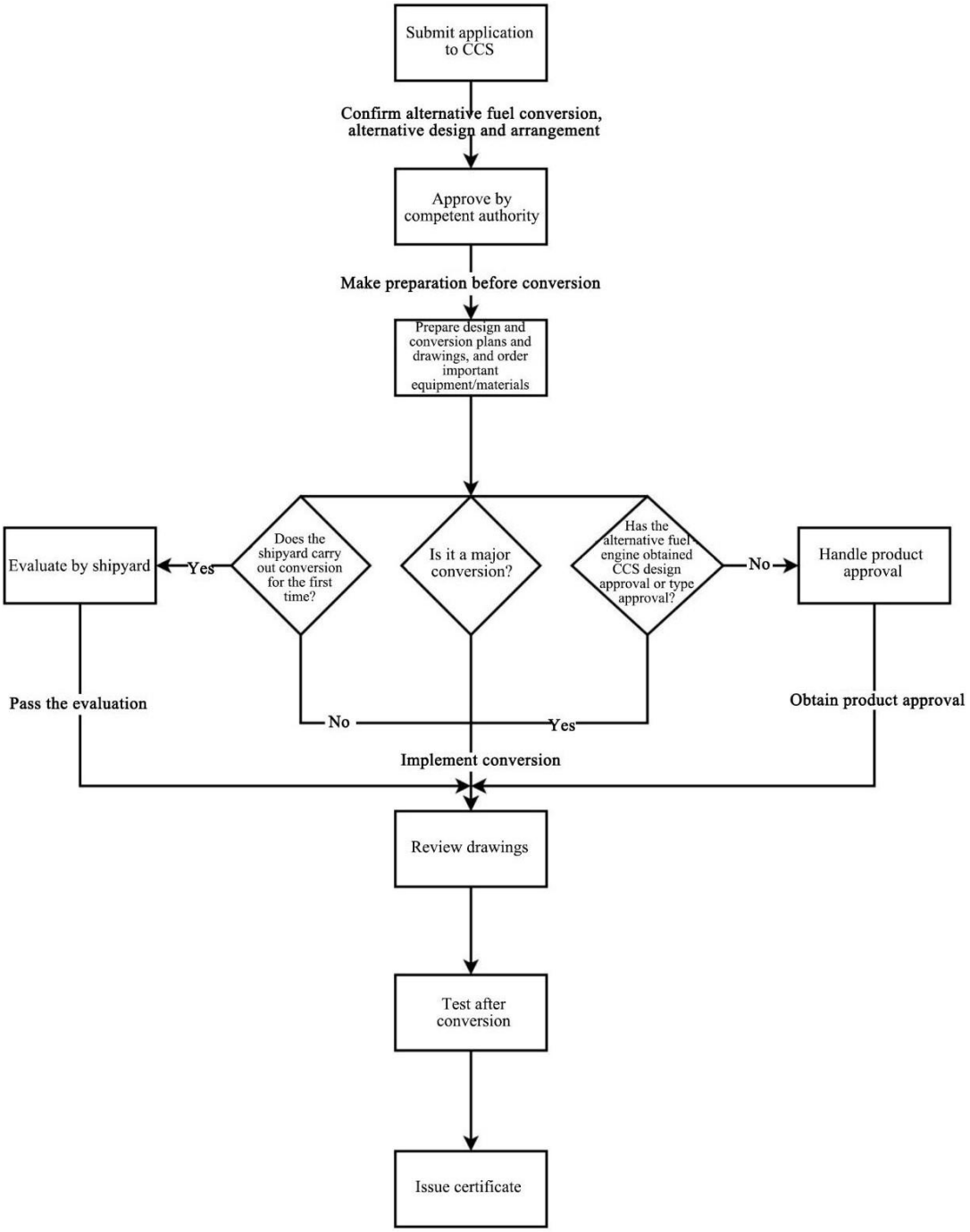

Figure 1.3.1 Conversion Process

Chapter 2 Review of Ship Conversion Drawings

Section 1 Methanol/Ethanol Fuel Conversion for Ships

2.1.1 List of drawings submitted for review - methanol/ethanol fuel class notations

2.1.1.1 The list of drawings submitted for review shall meet the requirements of 1.2.1 of ISC *Guidelines for Ships Using Methanol/Ethanol Fuels* (hereinafter referred to as "Methanol/Ethanol Guidelines").

2.1.1.2 In addition to drawings and materials to be submitted in accordance with the requirements of relevant ISC specifications, for ships whose main propulsion systems use methanol/ethanol as fuel, drawings and materials required by 2.1.1.3 to 2.1.1.9 of this section shall also be submitted to ISC for approval.

2.1.1.3 Ship arrangement

(1) Arrangement plans of machinery space and boiler room, accommodation space, service space and control station;

(2) Arrangement plans of methanol/ethanol fuel tank/methanol/ethanol fuel tank space;

(3) Arrangement plan of fuel preparation room (if any);

(4) Arrangement plan of fuel bunkering system (including bunkering connection);

(5) Arrangements of entrances and exits, vent pipes and other openings in the methanol/ethanol fuel tank space and the methanol/ethanol fuel tank connection space;

(6) Arrangements of ventilation ducts, doors and openings in hazardous areas;

(7) Arrangements of entrances, air inlets and openings to accommodation spaces, service spaces and control stations;

(8) Location and structure diagram of air lock (if any);

(9) Airtight bulkhead penetration diagram (if any);

(10) Description of coamings, drip trays or other protection measures;

(11) Zoning plan of hazardous areas

2.1.1.4 Piping system

(1) Detailed drawings or descriptions of the fuel piping system, including pressure relief valves and vent lines;

(2) Technical documents for branch pipes, elbows, expansion joints, bellows, and similar installations;

(3) Drawings and descriptions of flanges, valves and other devices in the fuel pipeline system;

(4) Technical documents for materials, welding, PWHT, and NDT of fuel pipelines;

(5) Technical documents for fuel pipeline pressure test (strength and tightness test);

(6) Function test program of all piping systems, including valves, accessories, and fuel (liquid or vapor) operation-related equipment;

(7) Technical documents for electrical grounding of pipelines;

(8) Technical documentation of measures to remove fuel from the fuel bunkering pipe before cutting off the bunkering connection;

(9) Cooling water system or hot water system related to the fuel system (if any);

(10) Arrangement plans and descriptions for degassing and inert gas purging systems;

(11) Arrangement plan for bilge and drainage system of the fuel preparation room and

methanol/ethanol fuel tank space (if any);

(12) Displacement calculation sheet of pipeline pressure relief valve;

2.1.1.5 Ventilation system

(1) Arrangement plans and descriptions of mechanical ventilation system in hazardous areas, including the capacity and arrangement plan of fans and their motors, drawings and technical documents of materials for rotating parts and outer covers of ventilators;

(2) Arrangement plan of double wall pipes (ventilation ducts).

2.1.1.6 Firefighting equipment and system

(1) Arrangement plan and description (capacity calculation, etc.) of the water spray system (including pipelines, valves, nozzles, and accessories);

(2) Arrangement plan of fire detection system;

(3) Arrangement plans for structural fire protection of the methanol/ethanol fuel tank/methanol/ethanol fuel tank spaces and their ventilation ducts and bunkering stations (if applicable);

(4) Arrangement plan of foam fire extinguishing device ;

(5) Fixed fire extinguishing system diagram

2.1.1.7 Electrical system

(1) Arrangement plan of all electrical equipment in hazardous areas;

(2) Intrinsically safe circuit single line diagram;

(3) List of qualified explosion-proof equipment.

2.1.1.8 Control, monitoring and safety systems

(1) Arrangement plans and descriptions for the gas detection and alarm system, including arrangement plans of probes, alarm devices and alarm points;

(2) Arrangement plans and descriptions for monitoring system for methanol/ethanol fuel tank, including arrangements of sensors and alarm points, etc.;

(3) Arrangement plans and descriptions for fuel pump control and monitoring systems (if any);

(4) Arrangement plans and descriptions for methanol/ethanol engine control and monitoring systems;

(5) Electrical schematic diagram and monitoring list of fuel supply system and bunkering system.

2.1.1.9 Independent methanol/ethanol fuel tank

(1) Detailed drawings of the methanol/ethanol fuel tank, including internal structure, insulation (if any), piping, valves and joints;

(2) Support and fixing structure drawings for independent fuel tanks/fastening and installation arrangement plans of portable methanol/ethanol fuel tanks

(3) Material instructions for the methanol/ethanol fuel tank and connecting pipelines;

(4) Technical documents for design loads and structural analysis of methanol/ethanol fuel tanks;

(5) Complete stress analysis data of methanol/ethanol fuel tank;

(6) Displacement calculation sheets for pressure relief valves in methanol/ethanol fuel tanks;

(7) Data on NDT, strength and tightness tests of welds in methanol/ethanol fuel tanks;

(8) Welding procedure specification for methanol/ethanol fuel tank

2.1.2 List of drawings submitted for review - M/E FR (X_1, ..., X_n) class notations

2.1.2.1 The list of drawings submitted for review shall meet the requirements of 15.3.1 of the Methanol/Ethanol Guidelines.

2.1.2.2 Ships using the methanol/ethanol fuel preset scheme shall apply for M/E FR class notations. In addition to drawings and materials to be submitted in accordance with the relevant ISC specifications, drawings and materials required by 2.1.2.3 to 2.1.2.16 of this section shall be submitted to ISC for approval.

2.1.2.3 Ship arrangement

(1) General arrangement plan and tank capacity plan;
(2) Arrangement plan of engine room;
(3) Loading manuals and damage stability calculation sheets under three typical conditions (if applicable);
(4) Outfitting quantity calculation sheet (if applicable).
(5) Fire control plan

2.1.2.4 Hull structure

(1) Calculation sheet of total longitudinal strength of hull under three typical conditions（if need）;
(2) Calculation sheet of the structural strength of the compartment section after arrangement of methanol/ethanol/ethanol fuel tank/tank.

2.1.2.5 fuel tank

(1) Arrangement plan of methanol/ethanol fuel tank or methanol/ethanol fuel tank space;
(2) Detailed drawings and strength assessment report of methanol/ethanol fuel tank and its supporting structure.

2.1.2.6 Fuel bunkering system

(1) Arrangement plan of bunkering station and bunkering system (including bunkering connector);
(2) Schematic diagram of bunkering system.

2.1.2.7 Fuel pipeline system

(1) Detailed drawings and instructions of the fuel piping system, including joints, valves, vents, etc.;
(2) Arrangement of fuel preparation room and detailed drawings of internal fuel piping system (if any);
(3) Technical documents for materials, welding, PWHT, and NDT of fuel pipelines (if any);
(4) Technical documents for pressure and tightness test of fuel pipeline (if any);
(5) Arrangement plan of ventilation system;
(6) Arrangement plans and descriptions for degassing and inert gas purging systems

2.1.2.8 Dual-fuel main and auxiliary engines

(1) Arrangement plan of engine room;
(2) Arrangement plans and descriptions for engine control and monitoring systems;
(3) Engine operating procedures and maintenance manual.

2.1.2.9 Main engine or auxiliary engine to be converted to/replaced with methanol/ethanol fuel engine

(1) Supporting documents or instructions for engine conversion/replacement.

2.1.2.10 Dual-fuel boiler

(1) Arrangement plan of boiler room;

(2) Drawing of boiler fuel supply piping system;

(3) Drawing of condensate and exhaust steam piping;

(4) Drawing of boiler feed water pipe system and discharge pipe system;

(5) Arrangement plan of boiler room ventilation pipeline.

2.1.2.11 Boilers to be converted to/replaced with methanol/ethanol boilers :

(1) Supporting documents or instructions for boiler conversion/replacement.

2.1.2.12 Fuel cell system

(1) Arrangement plan of the fuel cell power generation system, indicating the location of composition equipment in the fuel cell power generation system;

(2) Zoning plan of hazardous areas;

(3) Drawings of control, monitoring and safety systems related to fuel cells.

2.1.2.13 Power distribution system:

(1) Power system diagram and single line diagram (including power switch parameters, cable model and cross-sectional area of relevant electrical equipment of methanol/ethanol fuel supply system);

(2) Power load calculation sheet (including the rated power and service conditions of relevant electrical equipment of methanol/ethanol fuel supply system).

2.1.2.14 Hazardous area:

(1) Zoning plan of hazardous areas;

(2) Arrangement plan of mechanical ventilation in hazardous areas.

2.1.2.15 Control, monitoring and safety systems

(1) Diagram and arrangement plan of fuel gas detection and alarm system;

(2) Diagram and arrangement plan of methanol/ethanol fuel tank monitoring system;

(3) Diagram (if any) and arrangement plan of fuel pump control and monitoring system;

(4) Diagram and arrangement plan of methanol/ethanol fuel engine control and monitoring system;

(5) Electrical system diagram and monitoring list related to the fuel supply system and bunkering system.

2.1.2.16 In addition to drawings and materials to be submitted in accordance with the relevant ISC specifications, for ships applying for M/E FR class notations, at least the following drawings and materials shall be submitted for information:

(1) Tonnage calculation sheet;

(2) Hull instructions;

(3) Machinery specifications;

(4) Preset design and arrangement instructions for methanol/ethanol fuel power system;

(5) Mechanical equipment calculation sheet.

2.1.3 Key points for review of methanol/ethanol fuel conversion drawings

2.1.3.1 The hull structure shall meet the requirements of section 13, Chapter 2, Part 2 of the *Rules for Classification of Sea-Going Steel Ships*. Major structural conversions to be focused on:

(1) New methanol/ethanol fuel tank structure;

(2) New cofferdam structure;

(3) New structure of fuel preparation room (including methanol/ethanol daily service tank);

(4) Structure change of compartment;

(5) New deck outfitting equipment arrangement (bollard) structure and reinforcement (if any);

(6) New container column structure and reinforcement, including corresponding platforms, handrails, vertical ladders, etc. (if any);

(7) Cancelled hatch cover (if any);

(8) Cancelled fixing fasteners (if any);

(9) Cancelled inclined and vertical ladders (if any);

(10) The structural strength after conversion shall meet the relevant requirements of specification descriptiveness, compartment finite element and whole ship finite element.

2.1.3.2 The statutory requirements of 8.2.1.1, Chapter 8 of the Methanol/Ethanol Guidelines shall be met. The following shall be met:

(1) The bulkhead between the methanol/ethanol tank cofferdam and the cargo hold shall be provided with A-60 insulation.

2.1.3.3 The methanol/ethanol engine shall meet the requirements of section 7, Chapter 7 of the Methanol/Ethanol Guidelines. For the parameters and specifications of methanol/ethanol engine, please refer to the main diesel engine documents. The specifications and requirements of systems involved in methanol/ethanol engine conversion shall be emphasized:

(1) New double-walled duct ventilation system;

(2) New inerting measure as an alternative measure for mechanical ventilation of the annular space between the inner and outer pipes (if any);

(3) New methanol/ethanol degassing and inert gas purge system;

(4) Methanol/ethanol fuel supply system;

(5) Pilot fuel system (if any);

(6) Sealing oil system (if any);

(7) Relevant parameters for methanol/ethanol engine operation in methanol/ethanol mode.

2.1.3.4 The fuel system shall meet the requirements of 4.2， Chapter 4, Part 3 of the *Rules for Classification of Sea-Going Steel Ships*.

(1) When methanol/ethanol is used as fuel, the fuel system shall be able to supply pilot fuel (if any) to the methanol/ethanol engine;

(2) Appropriate devices shall be provided to prevent overheating of the fuel when the fuel supply unit supplies pilot fuel.

2.1.3.5 The heat exchange system shall meet the requirements of Chapter 4, Part 3 of the *Rules for Classification of Sea-Going Steel Ships*.

(1) The heat balance of the heat exchange system shall be recalculated based on the heat exchange capacity and heat exchanger power of the new low flash point fuel supply system (LFSS), as well as the heat exchange data of the methanol/ethanol mode of the methanol/ethanol engine;

(2) The capacity of the central cooler, main seawater pump, cylinder jacket water cooling system, main engine lubricating oil cooler and other related heat exchange equipment shall be verified and adjusted according to the new heat balance calculation results.

2.1.3.6 The compressed air system shall meet the requirements of 9.4.5 and 9.5.1, Chapter 4, Part 3 of the *Rules for Classification of Sea-Going Steel Ships*.

(1) The double-walled pipe ventilation inlet of the methanol/ethanol engine shall be equipped with compressed air and pressure reducing valves to meet the requirements for double-walled pipe

intake of the methanol/ethanol engine (if any);

(2) The compressed air supply for systems such as double-walled pipe ventilation and low flash point fuel supply shall be provided or modified according to the requirements of the equipment manufacturer.

2.1.3.7 The fuel tank shall meet the requirements of Chapter 4 of the Methanol/Ethanol Guidelines.

(1) The methanol/ethanol fuel tank shall be equipped with a controlled ventilation system;

(2) The methanol/ethanol fuel tank ventilation system shall be independent of the air pipes and ventilation systems in accommodation space, service space, control stations or other non-hazardous spaces;

(3) The front and rear ends of the pressure/vacuum relief valve shall not be equipped with globe valves, but bypass valves can be installed;

(4) The dimensions of the methanol/ethanol fuel tank ventilation system shall be such that the methanol/ethanol fuel tank will not be overpressurized at the design bunkering rate.

(5) All methanol/ethanol fuel tanks shall be able to remain inert at all times during use;

(6) The loading limit of the methanol/ethanol fuel tank shall be greater than 98% under any circumstances;

(7) The cofferdams shall be arranged to allow for purging or water injection through non-fixed connections. The cofferdam shall use a separate emptying system, such as a bilge water jet pump.

2.1.3.8 The methanol/ethanol bunkering and delivery system shall meet the requirements of Chapter 5 and Chapter 6 of the Methanol/Ethanol Guidelines.

(1) The bunkering pipeline shall be capable of inerting and degassing. The bunkering pipeline shall be in a degassing state when no bunkering operation is performed;

(2) Ship-to-shore link (SSL) or equivalent means of automatic and manual emergency disconnection (ESD) communication with the fuel supply source shall be provided on board. The system shall be operable both on the filled ship and at the bunkering side;

(3) Each bunkering pipeline shall be installed in series with 1 manually operated stop valve and 1 remote control globe valve, or 1 manual operation and remote control combination valve as close to the shore connection as possible;

(4) There shall be a device for safe disposal of fuel leaks. A coaming and/or a drip pan shall be provided under the bunkering connection and deteachable joint to enable safe collection and storage of leaked fuel.

(5) Showers and eyewash stations for emergency use shall be arranged in areas close to places where possible fuel contact operations will be carried out.

(6) Showers and eyewash stations shall be operable and usable in all circumstances.

2.1.3.9 The methanol/ethanol supply system and equipment shall meet the requirements of Chapter 6 of the Methanol/Ethanol Guidelines.

(1) The propulsion units, generating sets and fuel supply systems shall be arranged so that a single failure of the fuel supply will not result in an unacceptable loss of power;

(2) The fuel supply piping system shall be independent of other piping systems on board;

(3) The piping system used to transfer fuel to the equipment shall be designed so that the failure of a barrier will not cause fuel to leak from the piping system into the surrounding area and cause harm to personnel on board, the environment or the ship;

(4) The outer pipe of the fuel pipeline shall be airtight and liquid-tight;

(5) The annular space between the inner and outer pipes of the fuel pipeline shall be ventilated by negative pressure mechanical draft, and the air outlet shall lead to an open-air area with a ventilation capacity of at least 30 air changes per hour. Appropriate gas and liquid leakage detection measures shall be arranged in the annular space;

(6) Inerting may be accepted as an alternative to mechanical ventilation in the annular space between the inner and outer pipes. Appropriate gas and liquid leakage detection measures should be arranged in the annular space. When the inert gas pressure in the annular space drops, an appropriate alarm signal should be issued.

(7) The design pressure of the outer pipe of the double-walled pipe shall not be lower than the maximum working pressure of the inner pipe; or as an alternative, the maximum cumulative pressure calculated when the inner pipe is ruptured can also be used;

(8) One automatically operated main fuel valve shall be provided on the main fuel supply line to each unit or group of equipment using fuel. The main fuel valve shall be arranged on the pipeline outside the machinery space containing equipment using methanol/ethanol/ethanol fuel;

(9) A remote control globe valve shall be installed on the fuel supply pipeline of each device;

(10) One manual globe valve shall be provided on the fuel supply line of equipment.

2.1.3.10 The valve unit shall meet the requirements of 6.5, Chapter 6 of the Methanol/Ethanol Guidelines.

(1) The fuel valve unit shall be airtight and liquid-tight.

2.1.3.11 The inert gas system arrangement shall meet the requirements of 4.4, Chapter 4 of the Methanol/Ethanol Guidelines.

(1) To prevent flammable liquids or vapors from entering the inert gas system, two globe valves with one breather valve in the middle (two globe valves + breather valve) shall be installed on the inert gas supply pipeline. In addition, a closable non-return valve shall be provided between the two globe valves + breather valve and the fuel system. These valves shall be located in hazardous areas;

(2) Each methanol/ethanol fuel tank inerting inlet line shall be provided with an isolation installation located at a location that is easily visible to the crew entering the methanol/ethanol fuel tank. Isolation shall be provided by means of removable short pipes;

(3) The inert gas on board shall be able to be used for a long time to ensure that the methanol/ethanol fuel tank is maintained inert, and inert gas supply shall be guaranteed for at least one port-to-port single voyage and 2 weeks in the port;

(4) The inert gas generating installation shall be capable of producing inert gas with an oxygen content not exceeding 5% by volume at any time. An oxygen content meter with continuous reading and an alarm installation that activates when the oxygen content exceeds 5% by volume shall be installed on the inert gas supply pipeline; The system design shall ensure that the inert gas release valve to the atmosphere shall open automatically when the oxygen concentration by volume is greater than 5%;

(5) Appropriate inert gas generating and storage installations may be provided on board;

(6) When the inert gas generating or storage installation is installed in a separate compartment outside the engine room, the separate compartment shall be equipped with an independent negative pressure mechanical ventilation installation with a ventilation capacity of at least 6 air changes per hour.

2.1.3.12 The water spray system shall meet the requirements of 8.3.2, Chapter 8 of the Methanol/Ethanol Guidelines.

(1) When the methanol/ethanol fuel tank is located on an open deck, a fixed water spray system shall be provided for dilution, cooling and fire protection;

(2) The water spray system shall cover all exposed parts of the methanol/ethanol fuel tank above deck;

(3) In addition to covering the exposed part of the methanol/ethanol fuel tank located above the deck, the water spray system shall also cover the boundaries facing the superstructure, fuel preparation room, cargo control room, bunkering control station, bunkering station and other deckhouses where people are usually present. However, when the distance between these boundaries and the methanol/ethanol fuel tank is greater than or equal to 10m, they do not need to be covered.

2.1.3.13 Fixed fire extinguishing systems shall meet the requirements of 8.3.3, Chapter 8 of the Methanol/Ethanol Guidelines.

(1) When the methanol/ethanol fuel tank is arranged on an open deck, the ship shall be equipped with a fixed foam fire extinguishing system with alcohol-resistant fire extinguishing agent;

(2) The foam fire extinguishing system shall be able to cover the maximum deck area where a leak from the methanol/ethanol fuel tank would spread;

(3) An approved foam system (with an alcohol-resistant fire extinguishing agent) shall be provided for Category A machinery spaces (sea-going ships)and fuel preparation rooms containing methanol/ethanol. It shall cover the inner bottom plating and the bilge area under the plating;

(4) The bunkering station shall be equipped with a fixed anti-alcohol foam fire extinguishing system.

2.1.3.14 The ventilation system shall meet the requirements of Chapter 12 of the Methanol/Ethanol Guidelines.

(1) Any ventilation duct used in hazardous spaces shall be separated from the ventilation duct used in non-hazardous spaces;

(2) The area where the air inlet of hazardous spaces is located shall be a non-hazardous area if no such air inlet is provided;

(3) The air outlet of hazardous spaces shall be located in an open-air area. If there is no such air outlet, the danger of this area shall be equal to or less than that of ventilated spaces;

(4) The air inlet of non-hazardous enclosed spaces shall be at least 1.5m away from the boundary of any hazardous area;

(5) The air outlet of non-hazardous spaces shall be located outside the hazardous area;

(6) Ventilation ducts in hazardous spaces shall not pass through accommodation space, service space or other similar spaces;

(7) The fuel preparation room shall be equipped with an effective negative pressure mechanical ventilation system, and its ventilation capacity shall be at least 30 air changes per hour;

(8) When the bunkering station is arranged in enclosed and semi-enclosed spaces, it shall be properly ventilated to ensure that any vapor leaked during the bunkering operation can be discharged outside the bunkering station;

(9) Ventilation ducts or double-walled pipes containing fuel piping shall be equipped with an

effective negative pressure mechanical ventilation system, of which the ventilation capacity shall be at least 30 air changes per hour;

(10) The ventilation system of the fuel valve unit space shall meet the requirements for double-walled pipe ventilation systems;

(11) The ventilation system at the joints of methanol/ethanol fuel tanks shall meet the requirements for double-walled pipe ventilation systems.

2.1.3.15 The bilge water system shall meet the requirements of 2.3.4, Chapter 2 of the Methanol/Ethanol Guidelines.

(1) The bilge water system in an area where fuel leaks may occur shall be independent of those in other spaces;

(2) One or more dedicated collection tanks shall be provided for collecting drainage and fuel that may leak from fuel pumps, valves, and the inner pipes of double-walled pipes.The dedicated collection tank should comply with the relevant layout requirements of the fuel tank and should provide measures to safely transport the contaminated liquid fuel to the onshore receiving device;

(3) The bilge water system in the fuel preparation room shall be operable from outside the fuel preparation room;

2.1.3.16 The arrangement of compartments, spaces and piping systems shall meet the requirements of section 3, Chapter 2 of the Methanol/Ethanol Guidelines.

2.1.3.17 Methanol/ethanol fuel tank

(1) The methanol/ethanol fuel tank shall not be located in accommodation spaces or Category A machinery spaces (sea-going ships);

(2) The methanol/ethanol fuel tank and its cofferdam shall be located behind the anti-collision bulkhead and before the aft peak bulkhead.

2.1.3.18 bunkering station

(1) The bunkering station general may be located on an open deck to provide adequate natural ventilation. Risk assessment shall be carried out for enclosed or semi-enclosed bunkering stations, and the assessment report shall be approved by ISC;

(2) Entrances, air inlets and openings to accommodation spaces, service spaces, machinery spaces and control stations shall not face the bunkering station;

(3) The boundary between the enclosed and semi-enclosed bunkering stations and the surrounding spaces shall be airtight and liquid-tight;

(4) The bunkering pipeline shall not pass through the accommodation space, service space or control station. bunkering piping through enclosed spaces in non-hazardous areas shall be double walled or surrounded by airtight ducts.

2.1.3.19 The fuel preparation room shall be located outside the Category A machinery space (sea-going ships).

2.1.3.20 Any fuel pipe system shall not be less than 800mm from the ship side. Fuel piping shall not pass directly through accommodation spaces, service spaces, electrical equipment rooms or control stations.

2.1.3.21 Independent and portable methanol/ethanol fuel tanks shall meet the requirements of 2.2.3 and 2.2.4, Chapter 2 of the Methanol/Ethanol Guidelines.

(1) Located on the open deck, it shall be equipped with a liquid collection tray and a water spray system for emergency cooling;

(2) Independent methanol/ethanol fuel tanks can be arranged in enclosed spaces or open

decks;

(3) The impact of the portable methanol/ethanol fuel tank on the structural strength and stability of the ship shall be taken into account.

2.1.3.22 The electrical part shall meet the requirements of Chapter 10 and Chapter 11 of the Methanol/Ethanol Guidelines.

2.1.3.23 After conversion, hazardous areas will be added near the methanol/ethanol fuel tank, fuel preparation room, bunkering station, methanol/ethanol pipeline and corresponding ventilation outlets and entrances. The specific requirements are as follows:

(1) Explosion-proof of electrical equipment:

① If it is unavoidable to use electrical equipment in hazardous areas, qualified and certified explosion-proof electrical equipment suitable for the hazardous area shall be used;

② The explosion-proof category and temperature group of explosion-proof equipment used in explosive gas environments where methanol or ethanol may be mixed shall not be lower than IIA/T2;

③ The lighting system in the hazardous area shall have at least 2 branches. All switches and protective installations shall be capable of disconnecting all poles or phases and shall be located in non-hazardous areas.

(2) Monitoring and safety system upgrade:

① Installations for detecting liquid fuel leakage shall be provided in the cofferdam of methanol/ethanol fuel tank, between inner and outer double-walled pipes, in fuel preparation room, at joints of methanol/ethanol fuel tank and other enclosed spaces containing fuel piping systems or fuel equipment without double-walled pipes;

② Each methanol/ethanol fuel tank shall be equipped with an enclosed liquid level measuring installations, which shall so arranged that the liquid level reading can always be visible when the methanol/ethanol fuel tank is in use;

③ Leak detection shall be carried out between the inner and outer pipes of the double-walled pipe and the leak detector shall be connected to the alarm system;

④ It shall be possible to control the bunkering from a safe location away from the bunkering station;

⑤ When the ventilation in the double-walled pipe of the bunkering pipeline fails, an audible and visual alarm shall be sent at the bunkering control position;

⑥ When fuel leakage is detected in the double-walled pipe of the bunkering pipeline, an audible and visual alarm shall be sent and the fuel bunkering shall be automatically cut off;

⑦ When the concentration of combustible gas reaches 20% LEL, an audible and visual alarm shall be triggered. When the concentration of combustible gas detected by two detectors reaches 40% LEL, the safety system shall be triggered;

⑧ Fire detectors in the machinery space and methanol/ethanol fuel tank space of methanol/ethanol fuel engine shall be able to send audible and visual alarms to the bridge, continuously manned central control room or ship safety center and at the local location when detecting a fire;

⑨ When the ventilation capacity of the ventilation system decreases, audible and visual alarms shall be activated on the bridge, continuously manned central control room or ship safety center and at the local location;

Section 2 Ship LNG Fuel Conversion

2.2.1 List of drawings submitted for review - DFD/GF/natural gas fuel class notations

2.2.1.1 For ships applying for LNG fuel conversion and class notations such as DFD, GF and natural gas fuel, the list of drawings submitted for review shall meet the relevant requirements in 1.4, Chapter 1 of the *Guidelines for Design and Installation of Gas Fuel Engine Systems for Liquefied Gas Carriers*, 1.2.1, Section 2, Chapter 1 of the *Rules for Natural Gas Fuel Used in Ships* (hereinafter referred to as "Natural Gas Rules") and Chapter 3 of the Guidelines for Ships with Natural Gas Fuel Power Systems.

2.2.1.2 In addition to drawings and materials to be submitted in accordance with the requirements of relevant ISC specifications, for natural gas-fueled ships (except liquefied gas carriers), drawings and materials required by 2.2.1.4 to 2.2.1.9 of this section shall also be submitted to ISC for approval.

2.2.1.3 For liquefied gas carriers using natural gas as fuel, in addition to drawings and materials to be submitted in accordance with the requirements of relevant ISC specifications, drawings and materials required by 2.2.1.11 of this section shall also be submitted to ISC for approval.

2.2.1.4 Ship arrangement

(1) Arrangement plans of machinery space, accommodation space, service space and control station;

(2) Arrangement plans of LNG fuel containment system, including those of fuel tank support and fixing installations for portable liquefied gas fuel tanks;

(3) Arrangement plan of fuel preparation room (if any);

(4) Arrangement plan of gas fuel bunkering system (including bunkering connections);

(5) Arrangements of LNG fuel containment system space, and those of entrances and exits, vent pipes and other openings in LNG fuel containment system space;

(6) Arrangements of ventilation ducts, doors and openings in fuel preparation rooms and other gas hazardous areas;

(7) Arrangements of entrances, air inlets and openings to accommodation spaces, service spaces and control stations;

(8) Location and structural diagram of air lock (if any);

(9) Airtight Bulkhead Penetration Diagram (if any);

(10) Description of the drip pan or other protection measures;

(11) Zoning Plan of Hazardous Areas.

2.2.1.5 Piping System:

(1) Detailed drawings or descriptions of the gas fuel piping system, including pressure relief valves and vent lines;

(2) Technical documents for branch pipes, return pipes, elbows, expansion joints, bellows, and similar installations;

(3) Drawings and descriptions of flanges, valves, and other installations in the gas pipeline system;

(4) Technical documents for materials, welding, PWHT, and NDT of gas pipelines;

(5) Technical documents for gas pipeline pressure test (strength and tightness test);

(6) Function test program of all piping systems, including valves, accessories, and gas (liquid

or vapor) operation-related equipment;

(7) Technical documents for electrical grounding of pipelines;

(8) Technical documentation of measures to remove fuel from the fuel bunkering pipe before cutting off the bunkering connection;

(9) Cooling water system or hot water system (if any) related to the gas fuel system;

(10) Arrangement plans and descriptions for degassing and inert gas purging systems;

(11) Bilge and drainage system arrangement plan of the fuel preparation room and LNG fuel containment system connection space (if any);

(12) Displacement calculation sheet of pipeline pressure relief valve;

(13) For portable liquefied gas fuel tanks, detailed drawings or descriptions of the fuel supply connection pipeline, vent connection pipeline, and heating medium supply connection pipeline of the heat exchanger (if any) are also included.

2.2.1.6 Ventilation System:

(1) Arrangement plan and description of mechanical ventilation system in hazardous areas (displacement calculation, etc.), including the capacity and arrangement plan of fans and their motors, drawings and technical documents of materials for rotating parts and outer covers of ventilators;

(2) Arrangement plan of double wall pipes (ventilation ducts).

2.2.1.7 Firefighting Equipment and Systems:

(1) Arrangement plan and description (capacity calculation, etc.) of the water spray system (including pipelines, valves, nozzles, and accessories);

(2) Fire Detection System Diagram and Arrangement Plan;

(3) Structural Fire Protection Arrangement Plan of LNG fuel containment system Space, LNG fuel containment system Connection Space and its Ventilation Pipe, Bunkering Station (if applicable);

(4) Arrangement Plan of Dry Powder Fire Extinguishing Installation;

(5) Fixed fire extinguishing system diagram (if any).

2.2.1.8 Electrical System:

(1) The Arrangement Plan of Electrical Equipment in Hazardous Areas should include the explosion-proof type, explosion-proof category, temperature group, protection level, and hazard category of all electrical equipment in hazardous areas.

(2) Verification data of intrinsically safe circuits, including verification of voltage, current, capacitance and inductance.

(3) List of Qualified Explosion-proof Equipment.

2.2.1.9 Control, Monitoring and Safety Systems:

(1) Gas Detection and Alarm System Diagram and Arrangement Plan, including Arrangement Plan of Probes, Alarm Installation, and Alarm Point;

(2) LNG fuel containment system and Monitoring System Diagram and Arrangement Plan, including sensor, alarm point layout, etc.;

(3) Gas Compressor Control and Monitoring System Diagram and Arrangement Plan (if any);

(4) Electrical Schematic Diagram and Monitoring List of Gas Fuel Bunkering and Supply System;

(5) For portable liquefied gas fuel tanks, detailed drawings or instructions for the connection of the control, monitoring, and safety systems of the fuel tank to the ship's system are also

included.

2.2.1.10 In addition to the drawings and documents required by the relevant ISC Rules, the following drawings and documents shall also be submitted for information:

(1) Thermal stress analysis report of pipelines with design temperature lower than -110°C;

(2) Description of thermal insulation arrangement for cryogenic pipeline;

(3) Relevant risk analysis report (if applicable);

(4) For portable liquefied gas fuel tanks, instructions for connecting hoses and connecting joints are also included.

2.2.1.11 For the liquefied gas transport ship to be equipped with a gas fuel engine power system, the following drawings and materials shall also be submitted for approval:

(1) Arrangement Plan of Gas Fuel Engine Room;

(2) Arrangement Plan of Electrical Equipment and Lighting in the Gas Fuel Engine Room;

(3) Ventilation system for gas fuel engine rooms. For ESD-protected gas fuel engine rooms, Ventilation Volume Calculation Sheets should also be included;

(4) Fixed gas detection and alarm system;

(5) Gas fuel piping system, including double-layer pipes or ventilation pipes (if applicable), materials, sizes, types, design pressures, and design temperatures of pipelines and related components;

(6) Control and safety protection systems related to the use of gas fuels;

(7) Exhaust system diagram, including the layout of explosion-proof facilities;

(8) List of alarm and display points related to gas fuel use;

(9) List of Qualified Explosion-proof Equipment in the Gas Fuel Engine Room;

(10) Electrical grounding layout of gas fuel pipelines;

(11) Other drawings and materials deemed necessary by ISC.

2.2.2 List of drawing submitted for review - DFDR (X_1, ..., X_n) class notation

2.2.2.1 For LNG fuel conversion ships applying for DFDR class notation, the list of drawings submitted for review shall meet the relevant requirements of Chapter 3 of the "Guidelines for Ships with Natural Gas Fuel Power Systems".

2.2.2.2 For ships that intend to apply for the pre-installation of natural gas fuel power system, at least the following drawings should be submitted for review:

(1) General arrangement plans and tank capacity plans before and after conversion;

(2) Engine room arrangement plans before and after conversion;

(3) Typical working condition loading manual and damage stability calculation book under three possible operating conditions;

(4) Tonnage calculation sheet and outfitting quantity calculation sheet (if necessary);

(5) Natural gas fuel tank/vessel layout and related calculations;

(6) Machinery manual (including main engine, auxiliary engine, boiler, and pipeline system, etc.);

(7) Pre-design and layout instructions for natural gas fuel power system.

2.2.2.3 According to the different preset degrees of the ship's natural gas fuel power system, in addition to the drawings submitted in accordance with 2.2.2.2, the relevant drawings and materials required by 2.2.2.4 to 2.2.2.8 of this section should also be submitted to ISC for review.

2.2.2.4 Hull structural reinforcement and LNG fuel containment system :

(1) Calculation sheet of internal pressure, sloshing and liquid filling limit of LNG fuel

containment system/vessel;

(2) Detailed drawings of LNG fuel containment system/vessel accessories and supporting structures and their strength assessment reports;

(3) Material specification.

2.2.2.5 Main engine and auxiliary systems :

(1) Conversion instructions for the future dual-fuel main engine and auxiliary system;

2.2.2.6 Pipeline system, the following drawings should at least contain relevant system direction, layout, and space information:

(1) Natural Gas Fuel Piping System Diagram;

(2) Ventilation System (Natural Gas Fuel Related) Diagram;

(3) Degassing and Inert Gas Purge System Diagram;

(4) Natural Gas Heating System Diagram;

(5) Vent System (Natural Gas Fuel Related) Diagram;

(6) Fire Protection System (Natural Gas Fuel Related) Diagram;

(7) Gas Detection System Diagram.

2.2.2.7 Power distribution system:

(1) Power System Diagram and Single Line Diagram (including power switch parameters, cable model, and cross-sectional area of relevant electrical equipment of the gas fuel supply system);

(2) Power load calculation sheet (including the rated power and service conditions of relevant electrical equipment of gas fuel supply system).

2.2.2.8 Hazardous area:

(1) Zoning Plan of Hazardous Areas;

(2) Mechanical Ventilation Arrangement Plan in Hazardous Areas;

(3) Fire-resistant Structure Diagram of Gas Tank and Filling Station Layout.

2.2.3 Key points for review of LNG fuel conversion drawings

2.2.3.1 The layout of the LNG fuel containment system shall meet the requirements of Chapter 2, Section 2, 2.2.1.1, 2.2.1.2, 2.2.1.3, Chapter 2, Section 4, 4.1.3.5, Chapter 6, Section 1, 6.1.3.4 and Chapter 8, Section 2, 8.2.2.4 of the Natural Gas Rule. Specific attention is as follows:

(1) The LNG fuel containment system should be protected to prevent mechanical damage;

(2) LNG fuel containment systems and/or equipment located on open decks should be arranged to ensure adequate natural ventilation to prevent the accumulation of escaping gases;

(3) The LNG fuel containment system should be protected to prevent external damage caused by collision or grounding, with particular attention to the clearances from the side and stern of the ship;

(4) No machinery or equipment that may pose a fire hazard should be installed in the LNG fuel containment system space;

(5) For a single gas fuel power system, if a C-type independent LNG fuel containment system is used and two completely independent LNG fuel containment system joints are provided, it is acceptable to set up only one LNG fuel containment system;

(6) If the LNG fuel containment system is set on an open deck, a drip pan should be installed to protect the hull structure from low temperature damage caused by leakage of LNG fuel containment system joints and other potential release sources. The design temperature of the drip pan material should be compatible with the fuel temperature loaded at atmospheric pressure. For

the low temperature protection of the hull structure, the possible impact of the normal operating pressure of the LNG fuel containment system should be taken into account.

2.2.3.2 The layout of the LNG fuel containment system connection space and fuel preparation room shall meet the requirements of Chapter 2, Section 3, 2.3.5.1 and Section 4, 4.1.3.4 of the Natural Gas Rule, with specific attention to the following:

(1) Unless the LNG fuel containment system joint is located on an open deck, all LNG fuel containment system joints, accessories, flanges, and valves shall be enclosed in an airtight LNG fuel containment system connection space that can safely contain fuel leaking from the LNG fuel containment system joint;

(2) Unless the fuel preparation room is arranged on an open deck, it should be arranged and set up as required for the connection space of the LNG fuel containment system.

2.2.3.3 The arrangement of entrances and other openings to enclosed spaces shall meet the requirements of Chapter 2, Section 3, 2.3.8.1 to 2.3.8.5 of the Gas Code, with specific attention to the following:

(1) It is not allowed to set up entrances and exits directly from non-hazardous areas to hazardous areas. If such openings are necessary for operational reasons, an airlock should be installed;

(2) If the fuel preparation room is located below deck, it should be provided with independent access directly from the open deck to the compartment as far as practicable. If it is not feasible to set up an independent passage from the deck to the compartment, an airlock should be installed;

(3) Unless the access to the LNG fuel containment system connection space is independent and leads directly to the open deck, the access shall be equipped with a bolted compartment cover. Spaces containing bolted hatches should be hazardous spaces;

(4) If the ESD-protected machinery space has access to the space from other enclosed spaces, an airlock shall be installed at its entrance;

(5) For inerting spaces, their passages should be arranged to prevent accidental entry of personnel. If the passage of such spaces does not lead to an open deck, its sealing installation should ensure that inert gas cannot leak into adjacent spaces.

2.2.3.4 The layout of the airlock shall meet the requirements of Chapter 2, Section 3, 2.3.9 of the Natural Gas Rule, with specific attention to the following:

(1) The airlock is a place surrounded by an airtight bulkhead. There are two steel doors on the bulkhead that can ensure airtightness. The distance between the two doors is at least 1.5m but not more than 2.5m. The shape of the airlock should be simple and the deck area should not be less than $1.5m^2$.

2.2.3.5 Fire protection should meet the requirements of Chapter 8, Section 2, 8.2.2.1, 8.2.2.2, 8.2.2.3, and 8.2.3.1 of the Natural Gas Rule. Specific attention is as follows:

(1) When the LNG fuel containment system is located on an open deck, the boundary surfaces of the accommodation spaces, service spaces, control stations, escape routes, and machinery spaces facing the LNG fuel containment system shall utilize Class A-60 fire protection division. This insulation should extend to the bottom of the bridge deck, or the actual height of the bulkhead. In addition, the LNG fuel containment system located on the open deck should be regarded as a bulk package according to the IMDG Code and should meet the stowage and isolation requirements of the IMDG Code for dangerous goods in Class 2.1 packaging;

(2) The LNG fuel containment system space should be isolated from Category A machinery

spaces/important machinery spaces, or other spaces with a greater risk of fire. This isolation should be a cofferdam of at least 900 mm in width, having Class A-60 fire protection division. The Class A-60 fire protection division should be arranged as close to the side of the cofferdam as possible in Category A machinery spaces/important machinery spaces, or other places with a greater risk of fire. When determining the fire protection division between the LNG fuel containment system space and other spaces with a small risk of fire, from the perspective of fire protection, the LNG fuel containment system space should be regarded as Category A machinery space/important machinery space;

(3) For type C independent LNG fuel containment system, when the minimum distance between the boundary surface (if any) of the LNG fuel containment system shell or the LNG fuel containment system joint and the Class A-60 fire protection division is not less than 900mm, the LNG fuel containment system space can be regarded as a cofferdam;

(4) Class A-60 fire protection division shall be adopted for the boundaries of Category A machinery spaces/important machinery spaces, accommodation spaces, control stations, and spaces with greater fire risk facing the bunkering station. However, such boundaries of liquid tanks, void spaces, auxiliary machinery spaces, toilets, and other similar spaces with less fire risk can be reduced to Class A-0.

2.2.3.6 The hull structure shall meet the requirements of Article 1.5, Chapter 1, Part 2 of the Rules for Classification of Sea-Going Steel Ships, focusing on the following contents:

(1) The structural strength of the LNG fuel containment system shall be checked by a direct calculation method, including model selection, boundary condition setting, design load, calculation conditions, and other elements;

(2) The supporting structure strength of the LNG fuel containment system should be verified by a direct calculation method;

(3) The impact of adding LNG fuel containment system on the total longitudinal strength and local strength of ships;

(4) Loading limit of LNG fuel containment system;

(5) Add fuel preparation room, isolation compartment, airlock (if any), and other structures.

2.2.3.7 Gas fuel engines shall meet the requirements of Chapter 7 of the Natural Gas Rule.

(1) Gas fuel intake mode of engine:

① For premixed engines where gas fuel is mixed with air before the supercharger, it should be arranged in an ESD-protected machinery space;

② Gas fuel enters the cylinder through the intake manifold. An explosion-proof safety valve should be installed on the intake manifold or other explosion-proof measures should be taken, unless there is information to prove that the strength of the system is sufficient to withstand the explosion under the worst conditions; if the gas fuel is mixed with air before the supercharger, an explosion-proof safety valve should also be installed on the supercharger or intercooler, unless there is evidence that the strength of the supercharger and intercooler is sufficient to withstand the explosion under the worst conditions;

③ If the engine air inlet is located in the engine room, it should be as far away from the gas supply pipeline as possible to reduce the risk of leaked gas fuel being sucked into the air inlet; if the air inlet is located outside the engine room, it should be at least 1.5m away from the boundary of any dangerous area;

④ An explosion pressure release system shall be installed (if there is information to prove

that the strength of the exhaust pipe is sufficient to withstand the explosion under the worst conditions, it can be exempted); when the engine stops in gas mode, measures should be taken to sweep away possible combustible gases in the exhaust pipe.

(2) Auxiliary systems (fuel/lubricating oil system, cooling water system, and compressed air system):

① If gas fuel may leak directly into the engine auxiliary system medium (lubricating oil, cooling water), appropriate measures should be taken to collect the gas behind the outlet of these media to avoid diffusion. The gas collected from the auxiliary system medium should be released to a safe location in the open air;

② For a single gas fuel supply system, when the automatic or remote control valve in the system utilizes compressed air as the pneumatic control power source, the compressed air system should utilize a redundant layout;

③ For gas engines that need to be fueled, the setting of the fuel tank should meet the requirements of 4.2.1.8 in Chapter 4, Part 3 of the Rules for Classification of Sea-Going Steel Ships.

2.2.3.8 LNG fuel containment system and Auxiliary Equipment:

(1) The layout of the LNG fuel containment system and auxiliary equipment should make the dangerous area on board as small as possible;

(2) The layout of the LNG fuel containment system shall meet the relevant requirements of Chapter 2, Section 2 of the Natural Gas Rule;

(3) Verify that the layout of the LNG fuel containment system connection space meets the requirements of 4.1.3.4 of Chapter 4 of the Natural Gas Rule;

(4) When the LNG fuel containment system is arranged on an open deck, a drip pan should be set in accordance with 4.1.3.5 of Chapter 4 of the Natural Gas Rule;

(5) For single-fuel power systems, attention should be paid to the redundant layout and isolation requirements of the LNG fuel containment system and its connection spaces, fuel preparation rooms, etc.

2.2.3.9 The LNG bunkering and transportation system shall meet the requirements of 5.3.1.3 and 5.3.1.10 of Chapter 5 of the Natural Gas Rule, with specific attention to the following:

(1) The bunkering pipeline should be installed in series with 1 manual globe valve and 1 remote control globe valve, or 1 combination valve of manual operation and remote control near the shore connection. It should be possible to operate the remote control valve at the control position and/or other safe position of the fuel bunkering operation;

(2) The bunkering pipeline should be arranged to allow for inerting and degassing, and an installation for purging the fuel bunkering pipeline with inert gas should be provided;

(3) Attention should be paid to the layout direction of the injection pipeline from the bunkering station to the LNG fuel containment system. If the bunkering pipeline passes through the enclosed space, it should be surrounded by a ventilation duct. The setting of the ventilation duct should meet the requirements of this specification for the ventilation duct of the gas supply pipeline. Continuous ventilation and gas detection should be carried out during the bunkering process. If ventilation fails or gas is detected in the ventilation duct, visual and audible alarms should be issued at the bunkering control position.

2.2.3.10 The layout of the bunkering station shall meet the requirements of 5.2.1 of Chapter 5 of the Natural Gas Rule.

(1) Attention should be paid to the layout of the bunkering station: the bunkering station should be located on the weather deck so that it has sufficient natural ventilation. Risk assessment shall be carried out for enclosed or semi-enclosed bunkering stations, and the assessment report shall be approved by ISC;

(2) A drip pan should be installed below the LNG bunkering connection and any possible leakage location. The drip pan should be equipped with measures to safely deal with leakage, such as discharging it overboard through a discharge pipe downward and close to the water surface;

(3) Measures such as water curtains and protective covers shall be provided to prevent LNG from leaking into the surrounding hull or deck during bunkering and causing low-temperature damage.

2.2.3.11 The LNG supply system and equipment shall meet the relevant requirements of Chapter 6 of the Natural Gas Rule, with specific attention to the following:

(1) Clearly identify whether the gas-consuming equipment operates on single fuel or dual fuel, and pay attention to the redundancy requirements for the fuel supply system;

(2) Specify the type of machinery space (intrinsically safe or ESD-protected);

(3) Pay attention to the pressure level of the fuel supply system, adjust the pressure according to the safety valve or pressure regulating valve on the air intake pipeline of the gas-consuming equipment, determine the air intake pressure, and whether it is a high-pressure or low-pressure air supply system (a gas supply system is classified as high-pressure when its maximum operating pressure exceeds 1.0 MPa);

(4) Pay attention to the requirements for valves installed on gas fuel supply pipelines:

(5) Each gas fuel engine is equipped with a separate main gas fuel valve. The functions of the main gas fuel valve and the double block-and-bleed valve can be combined; that is, the main gas fuel valve can be used as one of the globe valves in the double block-and-bleed valve to cut off the gas fuel supply;

(6) The main gas fuel valve should be able to be operated from a safe position on the escape route in the engine room, the engine room control room (if applicable), outside the machinery space, and the bridge;

(7) Pay attention to the type (ventilation or inerting) and layout of double-walled pipes in intrinsically safe machinery spaces;

(8) Pay attention to the layout of the operating power source of the remote control valve or automatic valve (LNG fuel containment system main valve, main gas fuel valve, double stop breather valve, etc.) on the gas supply pipeline.

2.2.3.12 The nitrogen system shall meet the requirements of 4.2.3, Chapter 4, Part 6 of the Rules for Classification of Sea-Going Steel Ships.

2.2.3.13 Piping System Requirements:

(1) The design pressure of the piping system should be clearly defined, and the minimum design pressure of pipelines, piping systems, and components should be 1.0MPa, but for pipelines with open pipe ends, the design pressure should not be less than 0.5MPa;

(2) For pipeline materials, they should be selected according to the design temperature, and stress analysis should also be performed on low-temperature pipelines;

(3) Pipeline connections shall be made using different types based on design temperature, pipe diameter, and other parameters, with welded connections preferred to minimize the use of flange joints.

2.2.3.14 Water-based fire protection system:

(1) At least 2 fire pumps shall be provided regardless of tonnage, and the displacement and pressure of each fire pump shall ensure that at least 2 water columns with a range of not less than 12m are maintained at any fire hydrant;

(2) All fire water guns should be dual-purpose (water spray/water column type) with switches;

(3) When the fire water main passes through the LNG fuel containment system area arranged on the open deck, an isolation valve should be installed to isolate the damaged area in the pipe.

2.2.3.15 Water Spray System:

(1) The water supply pump of the water spray system can be set up separately, or it can be supplied by a fire pump (if the displacement and pressure of the fire pump are sufficient to meet the water supply requirements for operating the water spray system and the water-based fire extinguishing system at the same time);

(2) The water spray system shall cover the exposed part of the LNG fuel containment system located on the open deck and the boundaries of the superstructure, compressor room, pump room, goods control room, bunkering/bunkering control station, bunkering station and other deckhouses normally occupied facing the LNG fuel containment system on the open deck. However, when the distance between these boundaries and the LNG fuel containment system is greater than or equal to 10m, they do not need to be covered;

(3) The displacement of the water supply pump of the water spray system should be checked according to the area of the protected area. Its water spray rate is 10 $L/min \cdot m^2$ for horizontal protection surfaces and $4L/min \cdot m^2$ for vertical protection surfaces.

2.2.3.16 Dry powder fire extinguishing system:

(1) The bunkering station should be equipped with a fixed dry powder fire extinguishing system, which should cover all possible leakage points. Its fire extinguishing capacity should ensure that it can be released at a rate of not less than 3.5kg/s for at least 45s;

(2) At least 1 portable dry powder fire extinguisher with a capacity of not less than 5 kg should be installed near the bunkering station and in the fuel preparation room respectively; at least 1 portable dry powder fire extinguisher with a capacity of not less than 5 kg should be installed near the gas fuel engine and at the entrance of the machinery space where it is located. These fire extinguishers should be in addition to the portable fire extinguishers required by regulations;

(3) When the LNG fuel containment system is located on an open deck, at least 2 portable dry powder fire extinguishers with a capacity of not less than 5kg should be installed near the LNG fuel containment system; when the LNG fuel containment system is located in an enclosed or semi-enclosed space, at least 1 portable dry powder fire extinguisher with a capacity of not less than 5kg should be installed at the entrance of the LNG fuel containment system.

2.2.3.17 Ventilation system:

(1) Attention should be paid to the relationship between the design pressure, maximum allowable working pressure and maximum allowable regulated value of the pressure relief valve of the LNG fuel containment system: The regulated pressure of the pressure relief valve should not be higher than the maximum vapor pressure used in the design of the LNG fuel containment system; the maximum allowable regulated value (MARVS) of the pressure relief valve of the LNG fuel containment system should not be greater than 1.0MPa for seagoing vessels; the maximum

allowable working pressure (MAWP) of the LNG fuel containment system should not exceed 90% of the MARVS of the pressure relief valve;

(2) The LNG fuel containment system shall be equipped with at least 2 units/groups of pressure relief valves (PRVs). One unit/group of pressure relief valves can be disconnected in the event of failure or leakage;

(3) The space between the barriers should be equipped with a pressure relief installation;

(4) Attention should be paid to the arrangement of vent outlets for pressure relief valves and all other fuel vent pipes: the height should normally not be less than the larger of B/3 or 6 meters above the weather deck, whichever is greater, and 6 m above the working area and walkway, and at least 10m from openings in non-hazardous areas and exhaust ports of machinery and equipment.

2.2.3.18 Ventilation system:

(1) Any ventilation duct used in hazardous spaces shall be separated from the ventilation duct used in non-hazardous spaces;

(2) The air outlet of gas-safe spaces should be located outside the hazardous area; the air outlet of gas-hazardous spaces should be located in an open-air area. If there is no such air outlet, the danger of this area should be equal to or less than that of ventilated spaces;

(3) The area where the air inlet of gas gas-hazardous space is located shall be a non-hazardous area if no such air inlet is provided. The air inlet of the gas-safe space should be set in a safe area, at least 1.5m away from the boundary of any dangerous area;

(4) When the air intake pipe passes through a more dangerous space, the pipe should be airtight and have positive pressure relative to the space it passes through;

(5) Ventilation ducts in hazardous spaces should not pass through accommodation, service or other similar spaces;

(6) For the suction mechanical ventilation system in hazardous places, the air outlet of each air inlet pipe of the fan should be arranged according to the area where gas fuel may accumulate, and should generally be arranged at the upper part of the compartment;

(7) Appropriate isolation measures should be taken to prevent the pipeline where the fan is located from forming a ventilation loop with the pipelines where other fans are located when 1 unit or 1 group of fans in the ventilation system fail;

(8) The ventilation frequency of LNG fuel containment system connection spaces, fuel preparation rooms, double-walled pipes containing fuel piping systems and ESD-protected machinery spaces should be at least 30 times/h; the number and power of fans in the above spaces and double-walled pipes should meet: when one fan powered by an independent line from the main switchboard or emergency switchboard fails, or a group of fans powered by a common line from the main switchboard or emergency switchboard fails, the ventilation capacity should not decrease by more than 50% of the total ventilation capacity;

(9) The spaces with bolted compartment covers leading to the joints of the LNG fuel containment system should be equipped with an independent suction mechanical ventilation system, and the ventilation capacity should be at least 8 air changes per hour;

(10) When the bunkering station is not arranged on an open deck, it should be properly ventilated to ensure that any gas leaking during the bunkering operation can be removed outside the station. If natural ventilation is insufficient, mechanical ventilation installations should be installed according to the results of risk assessment;

(11) The gas valve unit space can usually be regarded as part of the double-walled pipe to meet ventilation requirements;

(12) The ventilation system of the machinery space containing gas fuel equipment should be independent of other ventilation systems.

2.2.3.19 The explosion-proof of electrical equipment should meet the relevant requirements of Chapter 9 of the Natural Gas Rule. Specific attention is as follows:

(1) Attention should be paid to the selection of electrical equipment in hazardous areas:

① Identify different categories of hazardous areas, and the explosion-proof type of electrical equipment corresponds to a specific category of hazardous areas.

② The explosion-proof category and temperature group of explosion-proof equipment used in hazardous areas should not be lower than IIA T2.

(2) Attention should be paid to the division of hazardous areas:

① Identify various release sources in accordance with the requirements of Chapter 9, Section 9.2.2.2 of the Natural Gas Rule;

② Pay attention to the pipeline layout from the LNG fuel containment system to the fuel-using equipment. If the pipeline passes through enclosed and semi-enclosed spaces, the inner and outer pipe spaces of double-walled pipes are considered dangerous areas;

③ Attention shall be paid to the regional classification of ventilation ducts, which shall be the same as the ventilated space;

④ Delineate the classification of hazardous areas based on the layout of isolated release sources, ventilation ducts and fuel pipelines;

⑤ For places with openings leading to adjacent dangerous areas, airlock measures can be taken. Attention shall be paid to the relevant requirements such as airlock layout, positive pressure ventilation and electrical equipment cut-off;

⑥ Apart from selecting electrical equipment that can operate safely in these areas, the overall principle of hazardous area classification is to confine the hazardous areas to the smallest possible extent.

2.2.3.20 The electrical system shall meet the relevant requirements of Chapter 11 of the Natural Gas Rule, with specific attention to the following:

(1) Attention shall be paid to the overall situation of the fuel system used by ships, including: the type of engine room (intrinsically safe or ESD), the type of fuel used in the engine (whether it is a single fuel), the layout of the LNG fuel containment system (weather deck or arranged in an enclosed space), the layout of the bunkering station (open or enclosed space), etc.;

(2) The power supply of the electronic control system, gas control system and gas safety system of the gas fuel engine shall meet the requirements of Article 11.1.3.12 of Chapter 11 of the Natural Gas Rule. The focus shall be on the power supply and power supply time of two-way power supply, battery power supply or uninterruptible power supply UPS (except backup UPS);

(3) If the fuel supply system uses a supply pump and adopts a submersible pump type, it shall meet the requirements of Articles 11.1.3.7 and 11.1.3.8 of Chapter 11 of the Natural Gas Rule. Attention shall be paid to whether the submersible pump motor and its power supply cable can be installed in the fuel tank, as well as the requirements for power cut-off of the submersible pump;

(4) The lighting system in hazardous areas shall meet the requirements of Article 11.1.3.5 of Chapter 11 of the Natural Gas Rule. The emergency lighting equipment near the bunkering station shall meet the requirements of Article 11.1.3.11 of Chapter 11 of the Natural Gas Rule;

(5) Ships shall be equipped with safe and reliable portable communication measures, which shall meet the requirements of Article 5.1.3.1 of Chapter 5 of the Natural Gas Rule;

(6) Pay attention to the locations where fire detection and fire alarm systems are set up, as well as related alarms. In LNG fuel containment system spaces and ventilation trunks for fuel tanks below deck, as well as in all other gas fuel system compartments where fire risks cannot be ruled out (such as machinery spaces containing gas-fueled engines), 1 fixed fire detection and fire alarm system complying with the Code for Fire Safety Systems shall be provided. The use of smoke detectors alone shall not be considered as providing adequate rapid fire detection capability. When a fire is detected in the above-mentioned places, an alarm shall be issued in the gas safety system and ventilation shall be stopped.

2.2.3.21 The control, monitoring and safety systems shall meet the relevant requirements of Chapter 12 of the Natural Gas Rule, with specific attention to the following:

(1) Attention shall be paid to the isolation of control, monitoring and safety systems, including power supply and signal sources;

(2) Special attention shall be paid to the independence of the control, monitoring and safety systems within each gas supply when multiple gas supply systems are installed;

(3) The installation of compressors, pumps, and manual remote emergency cut-off devices for fuel supply shall comply with the requirements of Article 12.4.1.4 of Chapter 12 of the Natural Gas Rule;

(4) The control position of the main gas fuel valve shall meet the requirements of Article 6.2.1.4, Chapter 12 of the Natural Gas Rule;

(5) The override of the gas safety system shall meet the requirements of Article 12.4.1.8 of Chapter 12 of the Natural Gas Rule;

(6) When the ship uses a single fuel, the layout of the fuel supply system (including monitoring system and security system) shall meet the requirements of 6.1.3.1 in Chapter 6 and 12.1.2.1 (1) and 12.4.1.6 in Chapter 12 of the Natural Gas Rule;

(7) When the ship engine uses a single fuel, attention shall be paid to maintaining the remaining power of the ship's power system after performing security actions to shut down the engine.

Section 3 Ship Ammonia Fuel Conversion

2.3.1 List of drawings for approval - class notations for ammonia fuel

2.3.1.1 For ammonia-fueled ships, in addition to the drawings and documents required by the relevant ISC Rules, drawings and documents required by 2.3.1.2 to 2.3.1.8 of this section shall also be submitted to the ISC for approval.

2.3.1.2 Ship arrangement:

(1) Arrangement plans of machinery space and boiler room, accommodation space, service space and control station;

(2) Arrangement plan of ammonia fuel tank/ammonia fuel tank space;

(3) Arrangement plan of fuel bunkering system (including bunkering connection);

(4) Arrangements of entrances and exits, vent pipes and other openings in the ammonia fuel tank space and ammonia fuel tank connection space;

(5) Arrangements of ventilation ducts, doors and openings in hazardous areas;

(6) Arrangements of entrances, air inlets and openings to accommodation spaces, service spaces and control stations;

(7) Location and structure diagram of air lock (if any);

(8) Airtight bulkhead penetration diagram (if any);

(9) Zoning plan of hazardous areas;

(10) Zoning plan of toxic areas.

2.3.1.3 For ammonia fuel tank, drawings shall be submitted in accordance with the applicable requirements for drawing submission of cargo containment systems in the "Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk".

2.3.1.4 Piping system:

(1) System diagram of the fuel piping system, including fuel supply, bunkering, pressure relief valve and vent pipelines, etc.;

(2) Drawings and descriptions of flanges, valves and other installations in the fuel pipeline system;

(3) Technical documentation of measures to remove fuel from the fuel bunkering pipe before cutting off the bunkering connection;

(4) Cooling water system or heat exchange system related to the fuel system (if any);

(5) Arrangement plans and descriptions for degassing and inert gas purging systems;

(6) Arrangement plan for bilge and drainage system of the fuel preparation room and ammonia fuel tank space (if any);

(7) Displacement calculation sheet of pressure relief valve.

(8) Schematic diagram of ammonia post-treatment system

2.3.1.5 Ventilation system:

(1) Arrangement plans and descriptions for mechanical ventilation systems in hazardous areas, including technical documents such as the capacity and layout of fans and their motors;

(2) Arrangement plan of double wall pipes (ventilation ducts).

2.3.1.6 Firefighting equipment and systems:

(1) Arrangement plan and description (capacity calculation, etc.) of the water spray system (including pipelines, valves, nozzles, and accessories);

(2) Arrangement plan of fire detection system;

(3) Arrangement plans for structural fire protection of the ammonia fuel tank/ammonia fuel tank spaces and their ventilation ducts and bunkering stations (if applicable);

(4) Arrangement plans for dry powder and other fire extinguishing installations (if any).

2.3.1.7 Electrical system:

(1) Arrangement plan of all electrical equipment in hazardous areas;

(2) Verification data of intrinsically safe circuits, including verification of voltage, current, capacitance and inductance.

2.3.1.8 Control, monitoring and safety systems:

(1) Arrangement plans and descriptions for the fuel vapor detection and alarm system, including arrangement plans of probes, alarm installations and alarm points;

(2) Arrangement plans and descriptions for monitoring system for ammonia fuel tank, including arrangements of sensors and alarm points, etc.;

(3) Arrangement plans and descriptions for fuel pump control and monitoring systems (if any);

(4) Arrangement plans and descriptions for ammonia engine control and monitoring systems;

(5) Electrical schematic diagram and monitoring list of fuel supply system and bunkering system.

2.3.1.9 In addition to the drawings and documents required by the relevant ISC Rules, the following drawings and documents shall also be submitted for reference:

(1) Risk analysis reports (e.g., ammonia engine risk analysis (such as FMEA—Failure Modes and Effects Analysis) report);

(2) Tonnage calculation sheet (if applicable);

(3) Outfitting quantity calculation sheet (if applicable).

2.3.2 List of drawings for approval - preset class notations for ammonia fuel power system

2.3.2.1 Drawings and documents to be submitted for approval when applying for AFD Ready 1 class notation

(1) In addition to the drawings and documents required by the relevant ISC Rules, for ships applying for AFD Ready 1 class notation, the following drawings and documents shall at least be submitted for approval:

① General arrangement plan, including the reserved layout of ammonia fuel tank and the reserved layout of fuel bunkering system;

② Arrangement plans for structural fire protection of reserved spaces in the ammonia fuel tank space, ammonia fuel tank connection space, fuel preparation room (if any) and bunkering station (if applicable).

(2) The following drawings and documents shall be submitted for reference:

① Ammonia fuel power system preset and layout instructions;

② Calculation sheet of total longitudinal strength (considering the influence of ammonia fuel tank and others on ship weight distribution).

2.3.2.2 Drawings and documents to be submitted for approval when applying for AFD Ready 2 class notation

(1) In addition to the drawings and documents required by the above 2.3.2.1.1 and the relevant ISC Rules, for ships applying for AFD Ready 2 class notation, the following drawings and documents shall at least be submitted for approval:

① Arrangement plans of machinery space and boiler room;

② Arrangement plan of ammonia fuel tank/ammonia fuel tank space;

③ Arrangement plan of fuel bunkering system;

④ Arrangements of entrances and exits, vent pipes and other openings in the ammonia fuel tank space and ammonia fuel tank connection space;

⑤ Arrangements of ventilation ducts, doors and openings in hazardous areas;

⑥ Arrangements of entrances, air inlets and openings to accommodation spaces, service spaces and control stations;

⑦ Location and structure diagram of air lock (if any);

⑧ Airtight bulkhead penetration diagram (if any);

⑨ Zoning plan of hazardous areas;

⑩ Zoning plan of toxic areas;

11 System diagram of the fuel piping system, including fuel supply, bunkering, pressure relief valve and vent pipelines, etc.;

12 Cooling water system or hot water system related to the fuel system (if any);

13 Arrangement plan for bilge and drainage system of the fuel preparation room and ammonia fuel tank space (if any);

14 Arrangement plans and descriptions for degassing and inert gas purging systems;

15 Arrangement plan of mechanical ventilation system in hazardous areas;

16 Double-wall pipe ventilation system diagram;

17 Arrangement plan and description for water spray system (capacity calculation, etc.);

18 Fire detection system diagram and arrangement plan;

19 Arrangement plans for structural fire protection of the ammonia fuel tank/ammonia fuel tank spaces and their ventilation ducts and bunkering stations (if applicable);

20 Chemical dry powder fire extinguishing system diagram;

21 Arrangement plan of electrical equipment in hazardous areas;

22 Intrinsically safe circuit verification data;

23 Fuel vapor detection and alarm system diagram and arrangement plan;

24 Ammonia fuel tank monitoring system diagram and arrangement plan;

25 Fuel pump control and monitoring system diagram (if any) and arrangement plan;

26 Ammonia engine control and monitoring system diagram and arrangement plan;

27 Electrical system diagram and monitoring list related to the fuel supply system and bunkering system;

28 Ammonia fuel tank and its supporting structure diagram;

29 Temperature field distribution calculation sheet.

(2) In addition to the drawings and documents required by the above (1) and the relevant ISC Rules, for ships applying for AFD Ready 2 class notation, the following drawings and documents shall at least be submitted for reference:

① Description of coamings, drip trays or other protection measures;

② Arrangement plan of fuel preparation room (if any);

③ Drawings and descriptions of flanges, valves and other installations in the fuel pipeline system;

④ Material specifications of fuel pipelines, valves and other devices;

⑤ Technical documentation of measures to remove fuel from the fuel bunkering pipe before cutting off the bunkering connection;

⑥ Displacement calculation sheet of pipeline pressure relief valve;

⑦ Strength calculation sheet of ammonia fuel tank and its supporting structure;

⑧ Material instructions for the ammonia fuel tank and connecting pipelines;

⑨ Displacement calculation sheet of the pressure relief valve of the ammonia fuel tank.

2.3.2.3 Drawings and documents to be submitted for approval when applying for AFD Ready 2 (X) class notation

(1) All drawings and documents required by 2.3.2.1 and 2.3.2.2 shall be provided.

2.3.3 Key points for review of ammonia fuel conversion drawings

2.3.3.1 The functional requirements for ship arrangements shall comply with Chapter 2, Section 1, 2.1.2 of the "Guidelines for Ships Using Ammonia Fuel" (hereinafter referred to as the "Ammonia Guidelines") and Article 5.2 of MSC.1/Circ.1687 Circular (hereinafter referred to as the "Ammonia Circular").

(1) Under normal operating conditions, ammonia is not allowed to be discharged directly into the atmosphere;

(2) Direct discharge of ammonia to control the pressure of the ammonia fuel tank is unacceptable. However, it is allowed to discharge ammonia into the atmosphere under emergency conditions;

(3) Ammonia fuel tank, fuel piping system and other fuel release sources shall be arranged so that the released fuel vapor is directed to a safe location in the open air and treated by an ammonia treatment system (if necessary);

(4) Passages leading to spaces containing fuel release sources or other openings on such spaces shall be arranged so that toxic gases or flammable vapors, asphyxiating gases cannot escape into other spaces where the risk of the presence of such gases is not taken into account in their design.

2.3.3.2 The layout of the ammonia fuel tank shall meet the requirements of Chapter 2, Section 2 of the Ammonia Guidelines and Articles 5.3 and 5.4 of the Ammonia Circular.

(1) Ammonia fuel tanks shall not be located in accommodation spaces and Category A machinery spaces (sea-going ships);

(2) The ammonia fuel tank and its cofferdam shall be located behind the anti-collision bulkhead;

(3) The independent ammonia fuel tank shall be fixed to the ship structure;

(4) The support and fixation of the ammonia fuel tank shall take into account the maximum static and dynamic tilt of the ship and the influence of the maximum acceleration of the ship's movement according to the characteristics of the ship and its layout position;

(5) The ammonia fuel tank shall be protected to prevent external damage due to collision or grounding, as detailed in the requirements of 2.2.1.7 and 2.2.1.8 of Chapter 2 of the Ammonia Guidelines.

2.3.3.3 The location and division of spaces shall meet the requirements of Chapter 2, Section 3 of the Ammonia Guidelines and Articles 5.5 to 5.11 of the Ammonia Circular.

(1) The fuel preparation room shall be located outside the Category A machinery space (sea-going ships);

(2) If an independent fuel preparation room is set up, its boundary surface shall be airtight;

(3) The fuel preparation room shall not be adjacent to the accommodation space, control station, service space, special space and roll-roll space;

(4) The low temperature effect of possible leaked fuel shall be considered in the fuel preparation room;

(5) The entrance to the fuel preparation room shall be provided with a threshold higher than the liquid level formed by the calculated maximum leakage, but in any case not less than 300 mm;

(6) The fuel preparation room located below the open deck shall be provided with an independent direct access to the open deck. If practical arrangements are not feasible, airlocks meeting the requirements of Chapter 2, 2.3.6 of the Ammonia Guidelines shall be provided;

(7) Where practicable, the ammonia fuel tank and the cofferdam shall be provided with direct access to the open deck for degassing, cleaning, maintenance, and inspection. If the ammonia fuel tank or cofferdam does not have direct access to the open deck, its access shall meet the requirements of 2.3.5.4 in Chapter 2 of the Ammonia Guidelines;

(8) There shall be enough space around the independent ammonia fuel tank for evacuation and rescue operations;

(9) Unless the access to the ammonia fuel tank connection space is independent and leads

directly to the open deck, the access shall be equipped with a bolted hatch cover;

(10) The passage of the machinery space shall not lead to toxic areas or toxic spaces;

(11) For the arrangement of fuel storage spaces, void spaces, ammonia fuel tanks, and other areas or spaces classified as hazardous/toxic, it shall be ensured that personnel wearing PPE and breathing apparatus can access any of the aforementioned spaces for inspection, and that an injured and/or unconscious person can be evacuated. The arrangement shall comply with the requirements of Ammonia Circular 5.10.4.

2.3.3.4 Hull structure:

(1) New ammonia fuel tank structure (the ammonia fuel tank shall be a fully cooled liquid tank);

(2) New cofferdam structure;

(3) New fuel preparation room structure (if any);

(4) New structural drawings of other converted parts (if any)

(5) New deck outfitting equipment layout structure and reinforcement (if any);

(6) Cancel some outfitting equipment drawings (if any);

(7) The structural strength after conversion shall meet the relevant requirements of specification descriptiveness, compartment finite element and whole ship finite element.

2.3.3.5 Fire protection shall meet the requirements of Chapter 9, Section 2 of the Ammonia Guidelines.

(1) For fire protection purposes, the fuel preparation room shall be regarded as Category A machinery space;

(2) When the fuel preparation room is adjacent to Category A machinery spaces (sea-going ships) or other spaces with a greater risk of fire, at least Class A-60 fire protection division shall be adopted;

(3) When the ammonia fuel tank is located on an open deck, the boundary surfaces of the accommodation spaces, service spaces, control stations, escape routes and machinery spaces facing the ammonia fuel tank shall adopt Class A-60 fire protection division. This insulation should extend to the bottom of the bridge deck, or the actual height of the bulkhead. The ammonia fuel tank located on the open deck shall be treated as bulk packaging according to the IMDG Code, shall be segregated from goods, and shall meet the stowage and segregation requirements for Class 2.3 packaged dangerous goods as per the IMDG Code;

(4) When the ammonia fuel tank is directly arranged on an open deck above Category A machinery spaces (sea-going ships) or other spaces with a greater risk of fire, appropriate measures shall be taken for thermal insulation between the ammonia fuel tank and the above-mentioned spaces;

(5) The ammonia fuel tank space shall be isolated from Category A machinery spaces (sea-going ships) or other spaces with a greater risk of fire. This isolation shall be a cofferdam of at least 900 mm in width, and Class A-60 fire protection division shall be used on the side close to the cofferdam in Category A machinery spaces (sea-going ships) or other spaces with a greater risk of fire. When determining the fire protection division between the ammonia fuel tank space and other spaces with a small risk of fire, from the perspective of fire protection, the ammonia fuel tank space shall be regarded as Category A machinery space (sea-going ships). A cofferdam of at least 900 mm or Class A-60 fire protection division shall be set between the ammonia fuel tank space and the ammonia fuel tank space;

(6) Class A-60 fire protection division shall be adopted for the boundary surfaces of Category A machinery spaces (sea-going ships), accommodation spaces, control stations and spaces with a greater risk of fire facing the bunkering station. This insulation should extend to the bottom of the bridge deck, or the actual height of the bulkhead. However, the boundary surfaces of liquid tanks, void spaces, auxiliary machine spaces, toilets and other similar spaces with a small risk of fire can be reduced to Class A-0 fire protection division. This insulation shall extend to the bottom of the bridge deck, or the actual height of the bulkhead.

2.3.3.6 Personnel protection shall meet the requirements of Chapter 12, Section 1 of the Ammonia Guidelines and Article 20 of the Ammonia Circular.

(1) Based on the characteristics of ammonia fuel, appropriate protective equipment, safety equipment and emergency equipment, including eye protection that complies with recognized national or international standards, shall be provided for crew members.

2.3.3.7 The arrangement of the machinery space shall meet the requirements of Chapter 2, 2.3.1 of the Ammonia Guidelines and Chapter 5, 5.5 of the Ammonia Circular.

(1) Machinery spaces with fuel-using equipment shall be gas-safe machinery spaces, and their arrangement shall be such that the space can be considered gas-safe under all conditions, including normal and abnormal conditions, that is, intrinsically gas-safe to reduce the possibility of gas leakage and explosion.

(2) A single failure in a gas-safe machinery space will not result in the leakage of gas fuel into that machinery space.

2.3.3.8 The arrangement of the fuel preparation room shall meet the requirements of Chapter 6, Section 5 of the Ammonia Guidelines and Chapter 5, 5.7.1 of the Ammonia Circular.

(1) The fuel preparation room shall be equipped with fuel leak detection equipment and negative pressure mechanical ventilation;

(2) The fuel processing equipment shall be arranged in the specified fuel preparation room. However, as an exception, the evaporator, heat exchanger and pump motor immersed in the ammonia fuel tank can also be arranged in the ammonia fuel tank connection space;

(3) The entrance to the fuel preparation room shall be equipped with a water curtain for continuous water supply. In the event of an ammonia leak, a water curtain shall be activated at a safe location outside the toxic area of the fuel preparation room. The water curtain shall be set outside the fuel preparation room. The arrangement shall include measures for the safe disposal of any ammonia wastewater generated during its operation.

2.3.3.9 The arrangement of the ammonia fuel tank connection space shall meet the requirements of Chapter 5, 5.7.2 of the Ammonia Circular.

(1) Ammonia fuel tank joints, flanges and valves shall be located within the ammonia fuel tank connection space arranged in accordance with the provisions of this Interim Guidelines. Ammonia fuel tank connection spaces and fuel preparation rooms shall not be combined, except for fuel processing equipment permitted in ammonia fuel tank connection spaces as defined in 5.7.1.1 of the Ammonia Circular;

(2) The ammonia fuel tank connection space shall be equipped with ventilation installations to ensure that the space can withstand any pressure accumulation caused by the gasification of liquefied fuel;

(3) The entrance to the ammonia fuel tank connection space shall be equipped with a water curtain for continuous water supply. In the event of an ammonia leak, a water curtain shall be

activated at a safe location outside the toxic area of the ammonia fuel tank connection space. The water curtain shall be set outside the ammonia fuel tank connection space. The arrangement shall include measures for the safe disposal of any ammonia wastewater generated during its operation.

2.3.3.10 The arrangement of the fuel bunkering station shall meet the requirements of Chapter 5, Section 2 of the Ammonia Guidelines and Chapter 5, 5.7.3 and Chapter 8, 8.3 of the Ammonia Circular.

(1) The location and arrangement of bunkering stations (including open, enclosed or semi-enclosed) shall be specially considered through risk assessment;

(2) The boundary surfaces between the enclosed or semi-enclosed bunkering station and the surrounding spaces shall be airtight;

(3) For the bunkering of low-temperature ammonia fuel, measures shall be taken to prevent the low-temperature ammonia fuel from leaking into the surrounding hull or deck during the bunkering process and causing low-temperature damage, such as setting up water curtains;

(4) A mechanical spray shielding installation shall be installed around the potential leakage source of the ammonia system at the bunkering station;

(5) Air inlets and openings in accommodation spaces, service spaces, engine rooms and control stations shall not be located in hazardous areas and toxic areas associated with bunkering stations.

2.3.3.11 The pressure relief system (including the displacement calculation sheet of the pressure relief valve) for ammonia fuel tank spaces, inter-barrier spaces, and ammonia fuel tank connection spaces shall meet requirements in the Section 2 of Chapter 4 of the Ammonia Guidelines and 6.7 of Chapter 6 of the Ammonia Circular.

(1) The ammonia fuel tank shall be equipped with at least 2/groups pressure relief valves (PRVs), one/groups of which can be disconnected in the event of failure or leakage;

(2) The inter-barrier space shall be equipped with a pressure relief installation. For thin-film systems, the designer shall demonstrate that the pressure relief valve in the inter-barrier space is of adequate size;

(3) The front or rear end of the pressure relief valve shall not be equipped with stop valves, but bypass valves can be installed;

(4) Each pressure relief valve installed on the ammonia fuel tank shall be connected to the ventilation system. The ventilation system of the ammonia fuel tank shall be independent of the air pipes and ventilation systems in accommodation spaces, service spaces, control stations or other non-hazardous areas;

(5) The displacement of the pressure relief system shall meet the requirements of 4.2.1.8, Chapter 4 of the Ammonia Guidelines and 6.7.3 of the Ammonia Circular;

(6) Fuel storage tanks that may be subjected to external pressure exceeding their design capacity shall be equipped with a vacuum protection system.

2.3.3.12 The loading limit of the ammonia fuel tank shall meet the requirements of Section 3, Chapter 4 of the Ammonia Guidelines and Section 6.8, Chapter 6 of the Ammonia Circular.

(1) The filling limit of the liquid ammonia storage tank shall not exceed 98% of the total amount at the reference temperature. The definition of reference temperature is given in 2.2.36 of the IGF Code;

(2) When the insulation and arrangement of the ammonia fuel tank minimize the possibility of the medium inside the tank being heated by an external fire, a higher loading limit (relative to

the calculation result using the reference temperature) may be permitted after special consideration, but in no case shall it exceed 95%.

2.3.3.13 The zoning of toxic areas shall meet the requirements of Section 4, Chapter 10 of the Ammonia Guidelines and Section 12bis, Chapter 12 of the Ammonia Circular.

(1) Air inlets, outlets or openings to accommodation spaces, service spaces, control stations or other non-hazardous areas shall not be located within toxic zones;

(2) In addition to the requirements for toxic areas specified in 12bis.4.1 of the Ammonia Circular, a dispersion analysis shall be conducted to determine the extent of the toxic zones;

(3) The boundary conditions for the dispersion analysis shall be approved by the competent authority. The analysis shall include discharges from pressure relief valves protecting the ammonia fuel tank, discharges from secondary barriers surrounding the ammonia fuel tank, and discharges from secondary barriers surrounding the ammonia leakage sources;

(4) Safe havens for personnel in the event of ammonia release shall be arranged within one or more enclosed spaces. The total capacity of these safe havens shall be sufficient to accommodate all personnel on board. Necessary safe havens shall be arranged at key positions for ship operation. The design of such spaces shall minimize the risk of exposure to ammonia in the event of ammonia release. Measures that can be taken include, but are not limited to, arranging a ventilation system or providing a self-contained air supply system for these spaces.

2.3.3.14 The fuel supply piping system shall meet the requirements of Chapter 6 of the Ammonia Guidelines and Chapter 9 of the Ammonia Circular.

(1) The fuel supply piping system shall be independent of other piping systems on board;

(2) The fuel supply piping system shall have a purging function, and the purged fuel shall be stored in a suitable collection tank or treated by an ammonia gas treatment system (if provided);

(3) All fuel pipelines shall be equipped with degassing and inerting measures;

(4) The distance between the fuel pipelines and the ship's side shall be no less than 800mm;

(5) For a single-fuel power system, the fuel supply system from the ammonia fuel tank to the engine shall be provided with sufficient redundancy and division so that a fuel leakage in one system does not result in unacceptable power loss;

(6) For a single-fuel power system, the fuel shall be stored separately in two or more ammonia fuel tanks. Each ammonia fuel tank shall be arranged separately in different compartments;

(7) For a single-fuel power system, if two or more ammonia fuel tanks are located on the weather deck, they shall be positioned as far apart from each other as possible to prevent a fire in one ammonia fuel tank from affecting the normal operation of all other ammonia fuel tanks;

(8) For a single-fuel power system, if a C-type independent ammonia fuel tank is used and two completely independent ammonia fuel tank connection spaces are provided, it is acceptable to set up only one ammonia fuel tank;

(9) For a single fuel power system, if two or more C-type independent ammonia fuel tanks are provided, each ammonia fuel tank is equipped with an independent ammonia fuel tank connection space, they may be arranged in one compartment;

(10) For ships carrying dangerous chemicals in bulk, fuel pipelines shall not pass through liquid cargo holds and cargo pump rooms;

(11) The circuit of the primary heating medium of the heat exchanger shall be equipped with an expansion tank/cabinet or facilities with equivalent functions. If expansion tanks/cabinets are

provided, they shall meet the requirements of 6.4.2.2 of Chapter 6 of the Ammonia Guidelines;

(12) When supplying gaseous ammonia fuel to the equipment, measures shall be taken to prevent ammonia condensate from entering the equipment;

(13) All fuel pipelines within the boundaries of machinery spaces shall be enclosed in an airtight enclosure, taking into account the requirements of 9.6 of Part A-1 of the IGF Code;

(14) Fuel pipelines outside the machinery space shall be protected by a secondary barrier. The barrier may be a ventilation duct or a double-walled piping system. The ventilation ducts or double-walled pipes shall be equipped with gas detection installations as required in 15.8 of the Ammonia Circular. Other alternative methods with the same level of safety may also be accepted by the competent authority;

(15) The provisions of 9.5.1 of the Ammonia Circular need not apply to fuel pipelines located in the fuel preparation room or ammonia fuel tank connection spaces.

(16) The provisions of 9.5.1 of the Ammonia Circular also apply to fuel vent pipes, except for fully welded open fuel vent pipes located in the open air.

2.3.3.15 The fuel bunkering system shall meet the requirements of Chapter 5 of the Ammonia Guidelines and Chapter 8 of the Ammonia Circular.

(1) Installations shall be provided to drain any fuel from the bunkering pipe after bunkering is completed;

(2) Installations shall be provided to purge the fuel bunkering pipeline with inert gas;

(3) The bunkering system shall be reasonably arranged so that no gas is discharged into the atmosphere during the bunkering phase of the storage tank. The expansion rate of the fuel during the bunkering operation shall be considered to reasonably determine the size of the vapor return pipe (if provided);

(4) A manually operated globe valve and a remotely operated globe valve, or a combination valve with both manual and remote operation capabilities, shall be provided near the connection point of each bunkering pipeline. The remotely operated valve shall be operable from the bunkering operation control position and/or another safe position;

(5) One bunkering safety link (BSL) or equivalent means shall be provided to achieve automatic and manual ESD communication with the bunkering source;

(6) Means shall be provided to drain any fuel from the bunkering pipelines after bunkering is completed;

(7) The bunkering pipelines shall be arranged to allow for inerting and degassing. Measures shall be provided to confirm that no liquid residues remain. When the bunkering pipeline is idle, there shall be no gas or residual liquid unless the consequences of not degassing have been evaluated and approved by the competent authority;

(8) If cross-pipelines are provided on the bunkering pipelines, reasonable isolation measures shall be taken to ensure that no fuel is inadvertently delivered to the non-bunkering side pipelines;

(9) Sampling valves (if provided) shall be provided at appropriate positions on the bunkering pipelines to implement verification procedures to confirm the safety of the bunkering pipeline before opening any flanges. Sampling valves on the bunkering pipelines shall be equipped with a double block and bleed, blind flanges, or plugging installations.

2.3.3.16 Materials and pipeline design shall meet the requirements of Chapter 3 of the Ammonia Guidelines and Chapter 7 of the Ammonia Circular.

(1) Pipelines, valves, accessories and other equipment in contact with ammonia shall not be

made of materials susceptible to ammonia corrosion such as copper, copper-containing alloy, zinc, zinc-containing alloy, cadmium-containing and mercury-containing materials. Ammonia is an alkaline reducing agent, which can react with acids, halogens and oxidizing agents;

(2) Anhydrous ammonia may cause stress corrosion cracking in containment systems and treatment systems made of carbon-manganese steel or nickel steel. To minimize the likelihood of such hazards, measures as described in Sections 17.12.2 to 17.12.7 of the IGC Code shall be taken as appropriate;

(3) To minimize the risk of stress corrosion cracking caused by ammonia, measures shall be taken to keep the dissolved oxygen content in ammonia fuel below 2.5 ppm w/w;

(4) Gaskets and seals shall be made of metal, rubber, polymer and other materials compatible with ammonia, such as spiral wound gasket and PTFE;

(5) The design pressure of the liquid ammonia fuel piping system shall be at least 18 bar (corresponding to the vapor pressure of ammonia at 45°C) to prevent ammonia venting during idle states. The design pressure of the gaseous ammonia fuel piping system shall be at least 10 bar. For liquid ammonia fuel piping systems equipped with closed pressure relief installation that return to the ammonia fuel tank, the design pressure shall be at least 10 bar;

(6) Expansion joints and bellows shall not be used in ammonia fuel piping systems. The expansion bellows installed on the engine are acceptable based on the assessment, as reflected in the safety concept of the engine.

2.3.3.17 The inert gas system shall meet the requirements of Section 5, Chapter 4 of the Ammonia Guidelines.

(1) To prevent the backflow of toxic and flammable gases into any non-hazardous spaces, the inert gas supply pipeline shall be provided with two globe valves in series, with a vent valve installed between them (forming a double block-and-bleed valve). In addition, a closable non-return valve shall be provided between the double block-and-bleed valve and the fuel system. These valves shall be located outside non-hazardous spaces;

(2) When the inert gas system is a non-fixed connection, two non-return valves may be used instead of the double block-and-bleed valve and closable non-return valve specified in 4.5.1.4 of Chapter 4 of the Ammonia Guidelines;

(3) Each inerted area shall be separately arranged. An isolation installation shall be provided for the inerting gas inlet pipeline of each ammonia fuel tank. The isolation installation shall be located in a position that is easily visible to personnel entering the ammonia fuel tank;

(4) If there is no inert gas generating installation on board, the inert gas stored on board shall be sufficient to meet at least 30 days of normal consumption;

(5) Inert gases containing carbon dioxide shall not be used to avoid contamination of ammonia due to the formation of carbamates through chemical reactions;

(6) The inert gas generating installation shall be capable of producing inert gas with an oxygen content not exceeding 5% by volume at any time. An oxygen content meter with continuous reading and an alarm installation that activates when the oxygen content exceeds 5% by volume shall be installed on the inert gas supply pipeline;

(7) When the inert gas generating installation is installed in a separate compartment outside the engine room, the compartment shall be equipped with an independent negative pressure mechanical ventilation installation capable of providing at least 6 air changes per hour. A low-oxygen alarm installation shall be installed.

2.3.3.18 The bilge water system and drainage installation shall meet the requirements of 2.2.1.4 of Section 2, and 2.3.3 and 2.3.4 of Section 3 of Chapter 2 of the Ammonia Guidelines, and Section 5.8, 5.9, Chapter 5 of the Ammonia Circular.

(1) The ammonia fuel tank located on the open deck shall be equipped with coamings, water spray systems and independent ammonia-water drainage systems. Aqueous solutions containing liquid ammonia or dissolved ammonia shall not be discharged directly overboard;

(2) The bilge water systems in areas where fuel leakage may occur shall be independent of the bilge water systems in other spaces;

(3) One or more dedicated slop storage tanks/cabinets shall be provided for collecting drainage and fuel that may leak from fuel pumps, valves, and the inner pipes of double-walled pipes. The dedicated slop storage tank/cabinet shall meet the relevant arrangement requirements for ammonia fuel tanks. Measures shall be provided to safely transfer contaminated liquid fuel to onshore receiving installations;

(4) The bilge water system in the fuel preparation room shall be operable from outside the fuel preparation room;

(5) Bilge water from spaces containing potential ammonia release sources shall be retained on board in dedicated slop storage tanks/cabinets for subsequent discharge to receiving facilities;

(6) Bilge water tanks and dedicated slop storage tanks/cabinets that may contain dissolved ammonia shall be located outside the machinery space and shall be provided with exhaust pipelines leading to the ammonia vapor treatment system or mast riser, as well as liquid level indicators, and ammonia vapor concentration detection installations;

(7) Bilge water tanks and dedicated slop storage tanks/cabinets that may contain dissolved ammonia shall be provided with protective isolation cabins, but isolation cabins are not required between them and the ammonia fuel tank and the fuel preparation room;

(8) Drip trays shall be installed in areas where leakage or spillage may occur;

(9) The drip trays or coamings shall be equipped with a pipeline to transfer leaked fuel to a dedicated slop storage tank/cabinet. A non-return valve and a globe valve should be installed on the pipeline;

(10) If the drip pan and coaming are affected by rainwater, a drain valve should be provided to discharge rainwater overboard;

(11) The maximum possible leakage (including leaking fuel and spray water) should be determined through risk analysis in order to design the capacity of the drip pan or coaming;

(12) When fuel is stored in a fuel tank that requires secondary barriers, appropriate relief measures through adjacent hull structures should be provided to deal with any leakage into the ammonia fuel tank space or insulation layer. Bilge water systems should not lead to pumps in spaces where there is no ammonia risk. Such leak detection measures should be in place;

(13) A suitable drainage system should be provided in the ammonia fuel tank space or inter-barrier space of the type A independent ammonia fuel tank to handle liquid fuel in the event of leakage or rupture of the ammonia fuel tank.

2.3.3.19 The schematic diagram of the ammonia treatment system shall meet the requirements of Chapter 2, Section 4, 2.4.2 of the Ammonia Guidelines and Chapter 9, 9.4.8, 9.4.11 of the Ammonia Circular.

(1) Ammonia absorption tanks and ammonia scrubbing systems should take measures to prevent the water in the absorption tanks and storage tanks from freezing;

(2) Ammonia absorption tanks and storage tanks of ammonia scrubbing systems should be equipped with thermometers, liquid level indicators and low and high liquid level alarms;

(3) The air inlet pipe of the ammonia absorption tank should be located below the low liquid level at the bottom of the tank;

(4) Ammonia absorption tanks and ammonia scrubbing systems should be equipped with devices for discharging to land-based receiving facilities;

(5) When neutralizing acid is used to reduce the concentration of ammonia in ammonia absorption tanks and storage tanks of ammonia scrubbing systems, appropriate measures should be taken to prevent possible harm to personnel, corrosive effects on contacting materials and the generation of combustible gases;

(6) The materials of the ammonia absorption tank and ammonia scrubbing system shall comply with the provisions of Chapter 3, Section 3 of the Ammonia Guidelines;

(7) The release mitigation system shall be capable of reducing the ammonia concentration to less than 110 ppm. The discharge of the release mitigation system shall be arranged in accordance with 6.7.2.7 of the Ammonia Circular;

(8) When the activation of the safety system required in 15.2.2 of the Ammonia Circular causes the main fuel valve to close automatically, the entire fuel supply branch downstream of the double block-and-bleed valve shall be automatically purged by an ammonia release mitigation system.

2.3.3.20 Ventilation shall meet the requirements of Chapter 8 of the Ammonia Guidelines and Chapter 13 of the Ammonia Circular (referring to Chapter 13 of the IGF Code).

(1) The area where the air inlet of hazardous spaces is located shall be a non-hazardous area if no such air inlet is provided. The air inlet of non-hazardous enclosed spaces should be at least 1.5 m away from the boundary of any hazardous area. When the air inlet pipe passes through a more dangerous space, the pipe should be airtight and maintained at a pressure higher than that of the space it passes through;

(2) The air outlet of non-hazardous spaces should be located outside the hazardous area;

(3) The air outlet of hazardous spaces shall be located in an open-air area. If there is no such air outlet, the danger of this area shall be equal to or less than that of ventilated spaces;

(4) For non-hazardous places with entrances and exits to hazardous areas, air locks should be installed and maintained at a positive pressure relative to the external hazardous area;

(5) Non-hazardous places with entrances and exits to hazardous places should be equipped with air locks, and the hazardous place should maintain a negative pressure relative to the non-hazardous place;

(6) Ventilation ducts in hazardous spaces shall not pass through accommodation space, service space or other similar spaces;

(7) Ventilation of machinery spaces containing fuel equipment shall be independent of other ventilation systems;

(8) Emergency ventilation capacity shall be provided for machinery spaces containing fuel equipment, with a minimum of 15 air changes per hour. If gas is detected in the machinery space, the ventilation system can be switched from normal mode to emergency mode;

(9) The fuel preparation room should be equipped with an effective negative pressure mechanical ventilation system, and its ventilation capacity should be at least 30 air changes per hour;

(10) When the bunkering station is arranged in enclosed and semi-enclosed spaces, it should be properly ventilated to ensure that any vapor leaked during the bunkering operation can be removed outside the bunkering station;

(11) Ventilation ducts or double-walled pipes containing fuel piping should be equipped with an effective negative pressure mechanical ventilation system, and its ventilation capacity should be at least 30 air changes per hour;

(12) The ventilation system of double-walled pipes or ducts should be independent of all other ventilation systems;

(13) Ventilation inlets for double-walled pipes or ducts shall be located in non-hazardous areas away from ignition sources. The ventilation inlet should be equipped with a suitable metal wire mesh to prevent water ingress;

(14) The ventilation system of the fuel valve unit space shall meet the requirements for double-walled pipe ventilation systems in Chapter 8, 8.1.7 of the Ammonia Guidelines;

(15) An effective suction mechanical ventilation system should be installed at the joints of the ammonia fuel tank. The ventilation capacity should be at least 30 air changes per hour. If other suitable explosion-proof installations are installed, the air change rate can be reduced. The equivalence of the alternative installation should be demonstrated by risk assessment;

(16) An approved fail-safe automatic fire damper shall be provided in the ventilation trunk at the joint of the ammonia fuel tank.

2.3.3.20 The fixed fire extinguishing system shall meet the requirements of Chapter 9, 9.3.1 of the Ammonia Guidelines.

(1) The fuel preparation room, gas compressor room and air pump room (if any) shall meet the fire extinguishing requirements for cargo compressor rooms and cargo pump rooms in ISC's "Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk".

(2) Enclosed spaces containing fuel preparation equipment (such as pumps, compressors or other potential ignition sources) should be equipped with fixed fire extinguishing systems that meet the requirements of SOLAS II-2/10.4.1.1 and the International Code for Fire Safety Systems (FSS Code), taking into account the concentration or release rate required to extinguish gas fires.

2.3.3.21 The water-based fire extinguishing system shall meet the requirements of Chapter 9, 9.3.2 of the Ammonia Guidelines and Chapter 11 of the Ammonia Circular (referring to Chapter 11, 11.4 of the IGF Code).

(1) When the fire main arranged on the open deck passes through the ammonia fuel tank area on the open deck, the fire main should be equipped with an isolation valve to isolate the damaged area in the pipe. The isolation of the damaged part of the fire main should not affect the water supply to the fire pipeline upstream of the isolated pipe section;

(2) At least two fire pumps should be installed, and the displacement and pressure of each fire pump should ensure that at least 2 water jets (sprayed from different fire hydrants) are maintained at any fire hydrant, and the range of each water jet should not be less than 12m;

(3) If the displacement and pressure of the fire pump are sufficient to operate the required number of fire hydrants and the water spray system described in 9.3.3 of the ammonia Guidelines at the same time, the pipeline of the water spray system can be connected to the fire main and supplied with water through the fire pump;

(4) All fire hoses should be dual-purpose (water jet/water spray type) with switches.

2.3.3.22 The water spray system shall meet the requirements of Chapter 9, 9.3.3 of the

Ammonia Guidelines and Chapter 11 of the Ammonia Circular (referring to Chapter 11, 11.5 of the IGF Code).

(1) A water spray system should be installed for cooling, fire protection and crew protection. In addition to covering the exposed part of the ammonia fuel tank located above the deck, the water spray system should also cover the boundaries of the superstructure, fuel preparation room, cargo control room, bunkering control stations, bunkering stations, and other normally manned deckhouses for the ammonia fuel tank. However, coverage may be omitted where the distance between such boundaries and the ammonia fuel tank is 10 m or greater.

(2) The water spray system should be designed to cover all the above areas, and its water spray rate is 10 L/min·m^2 for horizontal protective surfaces and 4L/min·m2 for vertical protective surfaces;

(3) To isolate the damaged pipe section, a globe valve should be installed on the water spray system main pipe at intervals not exceeding 40m. Alternatively, the system may be divided into two or more sections, allowing each section to be operated independently; however, the necessary control installations shall be grouped together in one readily accessible location, which shall remain accessible in the event of a fire in the protected area.

(4) The displacement of the water spray system supply pump should be sufficient to deliver the required amount of water to all protected areas;

(5) The water spray system should be connected to the ship's fire main through a globe valve, which should be set in a safe position outside the engine room;

(6) The starting position of the water spray system supply pump and the operating position of the main control valve of the water spray system should be located in one readily accessible location, which will not be blocked by a fire in the protected area;

(7) Approved water spray nozzles should be equipped and arranged to ensure that the water spray is evenly and effectively distributed in the protected area.

2.3.3.23 The chemical dry powder fire extinguishing system shall meet the requirements of Chapter 9, 9.3.4 of the Ammonia Guidelines and Chapter 11 of the Ammonia Circular (referring to Chapter 11, 11.6 of the IGF Code).

(1) When the ammonia fuel tank is located on an open deck, at least 2 portable dry powder fire extinguishers with a capacity of not less than 5 kg should be installed near the ammonia fuel tank;

(2) When the ammonia fuel tank is located in an enclosed or semi-enclosed space, at least 1 portable dry powder fire extinguisher with a capacity of not less than 5 kg should be installed at the entrance of the ammonia fuel tank;

(3) The bunkering station should be equipped with a fixed dry powder fire extinguishing system, which should cover all areas where fuel leakage may occur. Its fire extinguishing capacity should ensure that it can be released at a rate of not less than 3.5kg/s for at least 45 seconds. Fixed dry powder fire extinguishing systems should be arranged to be manually released at a safe location outside the protected area;

(4) In addition to the portable fire extinguishers that may be required by the competent authority, at least 1 portable dry powder fire extinguisher with a capacity of not less than 5 kg should be installed near the bunkering station and in the fuel preparation room;

(5) At least 1 portable dry powder fire extinguisher with a capacity of not less than 5 kg should be installed near the ammonia engine and at the entrance to the machinery space where it is

located.

2.3.3.24 Ammonia engine safety protection shall meet the requirements of Chapter 7, Section 1, 7.1.4 of the Ammonia Guidelines and Chapter 10 of the Ammonia Circular (pointing to IGF Chapter 10, 10.3).

(1) If the engine air inlet is located outside the cabin, it should be at least 1.5 meters away from the boundary of any hazardous area;

(2) For engines where the lower space of the piston is directly connected to the crankcase, the crankcase should be equipped with a suitable breather, its outlet should lead to a safe position in an open area, and a flame arrester should be installed at its end; the fuel collected after passing through the breather should be stored in a suitable collection tank. The crankcase shall be provided with a connection (or other means) for inerting to facilitate maintenance;

(3) If the engine is shut down in an emergency in ammonia fuel mode, or suddenly stalls during operation in ammonia fuel mode, measures shall be taken to purge the exhaust pipe before the engine is restarted. The purge gas shall be properly treated (such as by an ammonia treatment system).

(4) If the fuel may leak directly into the engine auxiliary system medium (such as lubricating oil and cooling water), appropriate monitoring and alarm installations shall be installed in the above auxiliary systems, and appropriate measures shall be taken behind the outlets of these media to collect fuel vapor to avoid diffusion. Fuel collected from auxiliary system media shall be stored in suitable collection tanks.

(5) The ammonia concentration at the exhaust pipe outlet shall be monitored. If the ammonia concentration exceeds the allowable exposure limit, appropriate measures shall be taken (such as using an ammonia treatment system).

2.3.3.25 general requirements for Ammonia electrical installations

(1) The electrical installation shall meet the requirements of Article 14 of the Ammonia Circular.

(2) The power generation, power distribution and related control systems should be designed in such a way that a single failure will not result in the loss of the ability to maintain the pressure and temperature of the ammonia fuel tank within the normal limits.

(3) For single-fuel power systems, a single failure in the ship's electrical, control, and monitoring systems shall not result in an unacceptable loss of ship power due to its impact on the ammonia fuel supply system from the fuel storage tanks to the engines.

(4) The convention of alternative fuels is not permitted to replace the specific attachments, materials, instruments, equipment components or their types as specified in the ammonia guidelines through operational methods or procedures.;

(5) Any loss of the ventilating capacity required by this section shall activate an audible and visual alarm on the navigation bridge or in a continuously manned central control station or safety centre.

(6) Fuel pipelines should not be arranged in the electrical equipment room or control station.

2.3.3.26 Ammonia electrical installations shall comply with the following requirements:

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

(2) A leakage in the tank connection space should not render necessary safety functions (if any) out of order due to low temperatures caused by the evaporation of leaking fuel.

(3) Where fuel is carried in a fuel containment system requiring a secondary barrier, suitable drainage arrangements for dealing with any leakage into the hold or insulation spaces through the adjacent ship structure should be provided. The bilge system should not lead to pumps in spaces having no risks of ammonia. Means of detecting such leakage should be provided.

(4) 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.

(5) 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.

(6) 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.

(7) The small leak protection system shall be provided in accordance with the relevant requirements of Chapter 4, Section 2 of the ISC Rules for Ships Using Natural Gas Fuels.

(8) Where heating of hull structural materials is applied to ensure that the material temperature does not fall below the specified minimum allowable level, the heating system shall be considered as an essential auxiliary. For heating systems applied to any transverse hull structure, all electrical components of at least one such system shall be supplied from the emergency source of electrical power.

(9) 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.

(10) Valve control for fuel supply lines to each engine and vapour return lines (if fitted) shall comply with the requirements of clause 6.2.1.6 of the ISC Guidelines for Ships Using Ammonia Fuel.

(11) 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.

(12) The number and power of the ventilation fans for the fuel preparation room 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.

(13) The number and power of the ventilation fans for double pipes 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.

(14) The number and power of the ventilation fans for tank connection spaces 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.

(15) Where a mechanical extraction ventilation system is adopted for the annular space of double pipes, suitable gas and liquid leakage detection equipment shall be installed.

(16) Where inerting is adopted as an alternative to mechanical ventilation in the annular space of double pipes, suitable gas and liquid leakage detection equipment shall be fitted. Suitable alarms are to

be provided to indicate a loss of inert gas pressure in the annular space.

2.3.3.27 Electrical installations for airlocks shall comply with the following requirements.

(1) Airlocks are not to be used for other purposes, for instance as electric equipment room.

(2) An audible and visual alarm system to give a warning on both sides of the airlock is to be provided.

(3) 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.

(4) Airlocks must also meet the requirements stipulated in Clauses 2.3.6, 8.1.3.9 and 8.1.3.10 of the Ammonia guidelines.

(5) 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. 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 accepted by ISC is to be required.

(6) 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 accepted by ISC is to be required.

2.3.3.28 Electrical requirements for ammonia fire-fighting:

(1) Control, alarm and protection of sprinkler systems shall comply with the requirements of clauses 2.4.3.3, 2.4.3.4 and 2.4.3.5 of the ISC Guidelines for Ships Using Ammonia Fuel.

(2) 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.

(3) Smoke detectors alone are not to be considered sufficient for a fixed fire detection and fire alarm system. If individual detector cannot be identified, each detector is to be set up to be a single loop.

2.3.3.29 The demarcation of explosion-proof and toxic areas shall meet the requirements of Chapter 10 of the Ammonia Guidelines and Article 12 of the Ammonia Circular.

(1) The electrical equipment and wiring shall not normally be installed in hazardous areas unless it is necessary for essential operations and complies with IEC60092-502 "Electrical Installations in Ships - Tankers - Special Characteristics of Tankers" and IEC60079-10-1 "Explosive Atmospheres-Classification of Areas-Explosive Gas Atmosphere";

(2) The classification of hazardous areas shall meet the requirements of Section 2 of Chapter 10 of the Ammonia Guidelines. The hazardous areas on open decks and other spaces not specified therein shall be determined based on Part 4.4 of IEC60092-502 Tankers Carrying Combustible

Liquefied Gases (if applicable), and the electrical equipment installed in hazardous areas shall comply with the same standard;

(3) The explosion-proof category and temperature group of explosion-proof equipment used in explosive gas environments where the ammonia vapor may appear shall not be lower than IIA/T1 respectively;

(4) The equipment used in hazardous areas shall be evaluated, certified and registered by ISC authorized institution;

(5) The installation of electrical equipment on the ship shall ensure its own safe connection with the hull;

(6) The submersible pump shall be equipped with a installation to sound an alarm when the liquid level is low and automatically shut down the motor when the liquid level is low. The automatic shutdown can be achieved by detecting low pump discharge pressure, low motor current or low liquid level. The shutdown shall also initiate audible and visual alarms on the bridge, in the continuously manned centralized control station or at the ship safety center.

(7) The fuel submersible pump motor and its power supply cable can be installed in the fuel tank. The fuel pump motor shall be able to be disconnected from its power supply during degassing operation or when not submerged, so that it will not be energized in an explosive gas environment.

(8) 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.

(9) 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.

(10) The shell of the fan is to be earthed.

2.3.3.30 The control, monitoring and safety systems shall meet the requirements of Chapter 11 of the Ammonia Guidelines and Article 15 of the Ammonia Circular.

(1) The functional requirements of the control, monitoring and safety systems shall meet the requirements of Clause 11.1.2 of Chapter 11 of the Ammonia Guidelines;

(2) For a single-fuel power system, the impact of a single failure in the control, monitoring and safety systems of the fuel-using equipment on the ammonia fuel supply system from the ammonia fuel tank to the engine will not result in an unacceptable loss of ship power;

(3) Appropriate instrumentation shall be set up to read important parameters locally and remotely to ensure the safe management of all fuel equipment and bunkering;

(4) The installations for detecting liquid fuel leakage shall be installed between the inner and outer tubes of double-walled pipes, in fuel preparation rooms, at the joints of ammonia fuel tanks, and other enclosed spaces containing fuel piping or fuel equipment without double-walled pipes;

(5) The sewage well in each ammonia fuel tank connection space of the independent ammonia fuel tank shall be equipped with a liquid level indicator and temperature sensor. An alarm shall be sounded when the sewage well has a high liquid level, and the low temperature indication shall trigger the safety system;

(6) The liquid level measurement, overflow control, pressure monitoring and temperature measurement of the ammonia fuel tank shall meet the requirements of Article 11.2.1.1 of Chapter 11 of the Ammonia Guidelines;

(7) The overflow alarm of the ammonia fuel tank shall be distinguishable from the overflow alarm (audible and visual) of the cargo system;

(8) The control and alarm of fuel bunkering shall meet the requirements of Article 11.2.1.2 of Chapter 11 of the Ammonia Guidelines;

(9) The monitoring, alarm and protection of gas compressors, fuel pumps, heat exchangers and engines shall meet the requirements of clauses 11.2.1.3 to 11.2.1.6 of Chapter 11 of the Ammonia Guidelines;

(10) For ammonia fuel tank connection spaces, fuel preparation rooms and double-walled pipes (ventilation ducts), the safety system shall be triggered during internal ventilation failures;

(11) The gas detection shall meet the requirements of Article 11.3.1 of Chapter 11 of the Ammonia Guidelines;

(12) The safety system shall meet the requirements of Clause 11.4.1 of Chapter 11 of the Ammonia Guidelines.

Chapter 3 Conversion Survey and Certification

Section 1 Methanol/Ethanol Fuel Conversion for Ships

3.1.1 General requirements

3.1.1.1 The application of methanol/ethanol fuel in ships shall comply with the requirements of ISC Methanol/Ethanol Guidelines and Methanol/Ethanol Circulars.

3.1.1.2 The Section 3.1.2 applies to the conversion of integral methanol/ethanol fuel tanks.

3.1.1.3 The ships using methanol/ethanol fuel shall apply to the competent authority for alternative design approval in accordance with Article 2.3 of the IGF Code.

3.1.1.4 The purpose of the Section is to provide standards for the layout, installation, control and monitoring of machinery, equipment and systems using methanol/ethanol as fuel on ships and to minimize the risks to ships, personnel and the environment. The design and conversion of methanol/ethanol fuel ships shall meet the following functional requirements in order to achieve the above purpose:

(1) The safety, availability and reliability of the system shall be comparable to new similar main engine and auxiliary engine using conventional fuel;

(2) The probability and impact of hazards associated with methanol/ethanol fuels shall be limited to the lowest level through layout and system design (such as ventilation, detection and safety measures); when fuel leaks or risk reduction measures have failure, necessary safety measures shall be activated;

(3) It shall be ensured that risk reduction measures and safety measures for methanol/ethanol fuel installations do not result in unacceptable power losses;

(4) The dangerous areas shall be limited as much as possible to minimize their potential risks that may affect the safety of ships, personnel and equipment on board;

(5) Only equipment necessary for operation shall be installed in hazardous areas, and the performance of such equipment shall be adapted to its working environment and approved by ISC;

(6) It shall be able to prevent the accidental accumulation of explosive, flammable or toxic vapors;

(7) The components of the system shall be properly protected from external damage;

(8) The ignition sources in hazardous areas shall be minimized to reduce the probability of combustion or explosion;

(9) The safe and suitable methanol/ethanol fuel supply, storage and bunkering installations shall be provided which are capable of receiving and containing the fuel in the required condition without leakage;

(10) The piping, storage and overpressure relief installations of appropriate design, manufacture and installation of suitable materials shall be provided to achieve their intended purpose;

(11) The design, manufacture, installation, operation, maintenance and protection of machines, systems and components shall ensure their safe and reliable operation;

(12) Appropriate control, alarm, detection and cut-off systems shall be set up to ensure the safe and reliable operation of the fuel system;

(13) A fixed gas and/or leak detection system suitable for all relevant premises and areas shall

be set up;

(14) The fire prevention, fire detection and fire extinguishing measures shall be set up for potential fire risks;

(15) It shall be ensured that the commissioning, testing and maintenance of methanol/ethanol fuel systems and fuel-using equipment meet the purpose requirements in terms of safety, availability, maintainability and reliability;

(16) A single failure of a technical system or component shall not result in an unsafe or unreliable condition;

(17) Appropriate personnel protection equipment shall be installed on board in order to protect crew members engaged in fuel operations;

(18) An explosion occurring in any premises containing a potential source of release and a potential source of ignition shall not:

① Damage or interfere the normal operation of equipment/systems located in any place other than where the accident occurred;

② Damage the ship resulting in flooding below the main deck or any continuous flooding;

③ Damage the work area or residence, causing casualties;

④ Disrupt the normal operation of the control station and the distribution room required for power distribution;

⑤ Damage the life-saving appliances or related landing installations;

⑥ Disrupt the normal operation of fire-fighting equipment located outside the place damaged by the explosion;

⑦ Affect other areas of the ship, resulting in possible chain reactions, especially those of goods, fuel vapor and fuel;

⑧ Hinder people from using life-saving appliances (LSA) or obstruct the escape routes.

3.1.1.5 The methanol/ethanol fuel conversion ships shall meet the following layout requirements:

(1) The methanol/ethanol fuel tank shall be arranged to minimize the probability of damage after a collision or grounding of the ship;

(2) The methanol/ethanol fuel tank, fuel piping and other fuel release sources shall be arranged so that the released fuel vapor is directed to a safe location in the open air;

(3) The access to or other openings in spaces containing sources of fuel release shall be arranged so that the flammable vapours, asphyxiating gases or toxic gases will not escape into spaces where the presence of such gases was not taken into account in their design;

(4) The probability of fire or explosion caused by fuel leakage in the machinery space shall be minimized;

(5) The fuel pipe system shall be protected to prevent mechanical damage;

(6) The propulsion system and fuel supply system shall be designed so that any safe action after a fuel leak will not result in an unacceptable loss of power;

(7) The methanol/ethanol fuel tanks shall not be located in accommodation spaces and machinery spaces;

(8) The methanol/ethanol fuel tank and its cofferdam shall be located behind the anti-collision bulkhead and before the aft peak bulkhead;

(9) The methanol/ethanol fuel tank located on the open deck shall be protected from mechanical damage;

(10) The methanol/ethanol fuel tank located on the open deck shall be equipped with coamings.

3.1.1.6 Pipeline requirements:

(1) The fuel pipeline and all other pipelines shall be color-coded in accordance with the standards accepted by ISC (such as GB3033 or ISO14726);

(2) All the fuel pipelines and independent methanol/ethanol fuel tanks shall be electrically grounded to the ship structure. All the connectors and accessories must also be electrically connected. The resistance between the pipeline and the hull shall not be greater than 1 MΩ;

(3) The pipes and cables other than fuel supply pipes may be arranged in double-walled pipes or pipelines, but they must not generate ignition sources or damage the integrity of double-walled pipes or pipelines. The double-walled pipes or pipelines shall only contain pipes and cables necessary for operation;

(4) The layout of the methanol/ethanol fuel tank bunkering pipeline shall minimize the possibility of static electricity generation. For example, the injection pipe shall extend into the methanol/ethanol fuel tank and be as close to the bilge as possible;

(5) Considering the maximum set pressure of the system safety valve, the design pressure of the fuel pipeline system shall be the maximum gauge pressure that the system may withstand during use;

(6) Any fuel pipe system shall not be less than 800mm from the ship side;

(7) The fuel piping shall not pass directly through accommodation spaces, service spaces, electrical equipment rooms or control stations;

(8) The fuel pipeline system passing through the ro-ro space, special space and weather deck shall be mechanically protected;

(9) The fuel piping system passing through the enclosed space shall be set as a double-walled pipe. Double-walled pipes may not be installed in the cofferdam, fuel preparation room or methanol/ethanol fuel tank space around the methanol/ethanol fuel tank;

(10) When the ship is normally tilted, all fuel piping system discharges shall be directed to appropriate methanol/ethanol fuel tanks or collection tanks. If there is an alternative design, it shall be approved by the ISC.

3.1.1.7 Requirements for electrical installations:

(1) The standards that electrical equipment complies with shall be at least equivalent to the standards accepted by the ISC (such as IEC60092);

(2) Electrical equipment and lines shall not normally be installed in hazardous areas unless required for essential operations;

(3) When electrical equipment is installed in hazardous areas, the standards for its selection, installation and maintenance shall be at least equivalent to those accepted by the ISC (such as IEC60092);

(4) The lighting system in the hazardous area shall have at least 2 branches. All switches and protection devices shall be able to disconnect all poles or phases and shall be located in non-hazardous areas;

(5) The installation of electrical equipment on the ship shall ensure the safe connection between itself and the hull;

(6) Electrical equipment used for propulsion, power generation, maneuvering, anchoring, mooring and emergency fire pumps, if located in a space protected by an airlock, shall be qualified

explosion-proof equipment;

(7) It shall be able to sound an alarm when the liquid level of the methanol/ethanol fuel tank is low and automatically shut down the motor when the liquid level is low. Automatic shutdown can be achieved by detecting low pump discharge pressure, low motor current, or low liquid level. When shutting down, audible and visual alarms shall also be given on the bridge, in the continuously manned centralized control station or ship safety center;

(8) The electronic control system, fuel control system and fuel safety system of the methanol/ethanol engine shall be powered by two power supplies, one for the main power supply and the other for the battery power supply or UPS (except backup UPS). When the main power supply fails, it shall be able to automatically switch to battery or UPS power supply, and alarm shall be displayed locally and on the bridge. The power supply time of the battery shall not be less than 30 min. When the ship only uses batteries as the main power supply, the above system shall be powered by two main power supplies.

3.1.1.8 In addition to surveys according to the applicable requirements of relevant ISC Rules, the following items shall be added for ship conversion survey:

(1) Installation and testing of methanol/ethanol engines;

(2) Installation and testing of methanol/ethanol fuel tanks;

(3) Installation and testing of the fuel bunkering system;

(4) Installation and testing of fuel supply systems;

(5) Installation and testing of methanol/ethanol engine machinery space, methanol/ethanol fuel tank connection space, double-walled pipes, fuel preparation room (if any), and ventilation system;

(6) Installation and testing of remote shutdown devices for methanol/ethanol engines;

(7) The installation location and number of fuel vapor probes, and the test of detection and alarm systems;

(8) Confirmation and safety inspection of explosion-proof equipment or anti-ignition equipment;

(9) For spaces where the hazard level depends on mechanical ventilation, the ventilation device shall be tested for effectiveness, the ventilation volume shall be sufficient, and the alarm of ventilation system failure shall be correct;

(10) Confirmation for the correctness of equipment and cable installation for intrinsically safe circuits;

(11) Confirmation and safety inspection of spaces protected by positive pressure ventilation;

(12) Installation and testing of fire detection and extinguishing devices;

(13) Check the fuel supply system operation manual.

3.1.2 Methanol/ethanol fuel tank

3.1.2.1 Steel plate material

(1) Unless otherwise specified, the steel plate materials used for methanol/ethanol fuel tanks shall comply with the relevant requirements of Part 1 "Metallic Materials" of "Rules for Materials and Welding" of the ISC.

3.1.2.2 Welding

(1) Unless otherwise specified, the welding of methanol/ethanol fuel tanks, as well as the welding consumables and welding processes used shall comply with the relevant requirements of Part 3 "Welding" of "Rules for Materials and Welding" of the ISC;

(2) If high-strength thick plates are used, the welding consumables and welding processes used shall comply with the relevant requirements of "Guidelines for Application of High-strength Thick Steel Plates for Ships" of the ISC.

3.1.2.3 Tightness test and structural test

(14) The tightness test and structural test of the methanol/ethanol fuel tank shall comply with provisions in the Section 3, Chapter 4, Part 1 of the "Rules for Classification of Sea-Going Steel Ships" of the ISC and IACS UR S14, as well as special requirements of flag states.

3.1.2.4 NDT

(1) The quantity and location of NDT for methanol/ethanol fuel tank shall meet the requirements in 5.3.2.8, Part 3 of "Rules for Materials and Welding" of the ISC;

(2) Except for the methanol/ethanol fuel tank, the quantity and location of NDT for other modified structures shall comply with the requirements of Section 3, Chapter 5, Part 3 of "Rules for Materials and Welding" of the ISC;

(3) The test methods and acceptance criteria for NDT shall comply with the requirements of Appendix 1 and Appendix 2 of "Rules for Materials and Welding" of the ISC, Chapter 7 of "Guidelines for Inspection of Hull Welds" of the ISC or recognized test methods and acceptance criteria.

3.1.2.5 Conversion engineering control

(1) Conversion process control

① The shipyard shall formulate reasonable construction process plans such as the disassembly and assembly sequence and welding sequence arrangement for structural conversion construction;

② The possible dangerous conditions during the ship conversion process shall be evaluated. The evaluation generally includes structural strength, stability and ship stability (if necessary), and necessary safety measures shall be taken to avoid structural instability and irreversible major deformation during the construction process;

③ The shipyard shall measure and monitor the structures that are prone to deformation during the conversion process so as to promptly detect abnormal deformation and structural instability, and take necessary corrective and remedial measures. The construction process plan shall include the measurement range and monitoring measures;

④ The conversion process formulated shall fully consider measures to reduce the original internal stress of the ship's modified structure caused by the following factors, so as to avoid damage to the ship's structure due to excessive stress during operation:

a. Internal stress caused by inconsistent force on the new and old structures due to a large number of structural installation and welding works carried out under force conditions;

b. Welding residual stress caused by structural welding, especially greater residual stress resulting from components with larger welding constraints;

c. Residual stress caused by local shrinkage due to hot working of the structure;

d. Internal stress caused by forced assembly of the structure.

⑤ Except for special circumstances, the following works shall be carried out in a dry dock or floating dock and shall be clearly stated in the construction process plan:

a. Welding works related to underwater outer plates;

b. Works that have a greater impact on the original internal stress of the structure;

c. Works that require docking for correction and remediation when abnormal conditions

occur in the structure.

(2) During the conversion of the methanol/ethanol fuel tank, the following structural details shall be noted:

① Pay attention to accuracy control when dismantling old components. The deformation of the original hull structure shall be considered to avoid cutting and dismantling the old structure according to theoretical data, which will cause too large assembly gap between the methanol/ethanol fuel tank and the old structure after hoisting and positioning;

② The new and old structures shall maintain good continuity to avoid forced assembly and structural misalignment;

③ Through-welding holes shall be avoided as much as possible for components in high stress areas. If temporary through-welding holes are required for process or other reasons, they shall be sealed after welding is completed;

④ For high-stress areas where the welding volume is relatively concentrated, appropriate measures shall be taken to reduce welding residual stress, such as:

a. Use a welding method with lower heat;

b. Adopt a reasonable welding sequence;

c. Adopt an assembly fixation method with a lower degree of restraint and a smaller assembly gap;

d. Reduce the amount of welding after the sections are loaded on board;

e. Other methods deemed appropriate.

⑤ When welding, measures to release residual stress are adopted. According to the amount of welding and the density of welding, one or more of the following measures can be considered:

a. Knock and vibrate the weld metal before the weld bead is completely cooled;

b. Preheating before welding (120°C~180°C);

c. PWHT;

d. Weld grinding;

e. Ultrasonic impact weld;

f. TIG welding remelting, etc.

⑥ High-strength steel structures shall generally avoid using distortion correction by flame. If the distortion correction by flame is adopted, it is required to strictly control the heating temperature according to the requirements of IACS Rec.47;

⑦ The layout of the pipeline bracket shall comply with the accepted standard. The setting of the bracket shall avoid any impact on the hull structure. In particular, pipe brackets shall not be welded on the hull structure holes and the free edges of the plates.

(3) Node control in high-stress areas

① The assembly accuracy between components that transmit stress to each other shall take into account the need for high stress levels. When components in two directions intersect, the interrupted component shall be strictly aligned on both sides of the continuous component as required by IACS Rec.47.

② The connection of components subjected to high stress shall avoid overlapping.

③ The free edges of components subjected to high stress shall be smooth and ground if necessary.

④ Special consideration shall be given to the shape of openings in components subjected to high stress. The edges of openings shall be ground.

⑤ Special attention shall be paid to the formation of welds in high-stress areas to avoid poor weld shapes. Grinding methods can be used to make the welds smooth.

3.1.3 Methanol/ethanol dual-fuel main engine

3.1.3.1 In addition to meeting the requirements of the "Rules for Classification of Sea-Going Steel Ships" and the methanol/ethanol guidelines, surveys and tests shall also be carried out in accordance with the requirements of 3.1.3.2 to 3.1.3.6 of this section.

3.1.3.2 Confirm that the modification plan and modification checklist have been approved by the ISC;

3.1.3.3 Confirm the addition and replacement of parts during the modification process, and verify the part certificates according to certificate list and approval documents of the ISC;

3.1.3.4 According to the approval documents, refer to the list of replaced and newly added parts during the main engine modification process to check the installation of relevant parts;

3.1.3.5 On-site conversion survey:

(1) Cylinder head: Confirm that the product has been surveyed by the ISC and certified, undergo pressure tests (if applicable), and verify the emission number;

(2) Pump, valve and pipe fittings: Pressure test (high-pressure sealing oil pipes, low-pressure sealing oil pipes, double-walled pipes, control oil pipes, FVT, etc.);

(3) Ventilation effect test of double-walled pipe;

(4) Electronic control system: Power supply and ground fault test;

(5) Security and function test of valve group unit (FVU/FVT);

(6) Security and functional test of the methanol/ethanol supply system (LFSS);

(7) Functional verification of purging pipeline (including liquid return pipeline);

(8) Check the security signals from external engine systems (especially alarm points that cause engine shutdown);

(9) Others: Engine control software update, verification of various sensor signals on the engine, cleaning of the entire machine systems, emission-related parts and parameters verification, etc.

3.1.3.6 Requirements for mooring adjustment test and voyage test:

(1) Before the test, the cleaning of the entire machine systems shall be confirmed: Fuel, lubricating oil, hydraulic oil, cooling water and air systems are clean and reliable;

(2) Main engine security test:

① Security test of methanol/ethanol drive system and methanol/ethanol injection system;

② Joint commissioning: Communication and failure alarm (ECS, PCS); temperature and pressure alarm of methanol/ethanol supply system; FVU temperature and pressure alarm;

③ Peripheral security test (methanol/ethanol detection sensors for machinery spaces and ventilation systems).

(3) Functional verification test of the electronic control system:

① Functional test on the methanol/ethanol injector;

② Validation of methanol/ethanol injection system;

③ Purging function;

④ Waste liquid blending function (only applicable to WinGD X-DF-M);

⑤ Supply pressure closed-loop control function;

⑥ Automatic mode switching function.

(4) Running-in and performance test verification:

① Fuel mode verification;

② Methanol/ethanol mode verification;

③ Fuel-methanol/ethanol mode switching test;

④ Methanol/ethanol main engine matching LP-SCR test (if applicable).

(5) Emission test (if necessary).

3.1.4 Methanol/ethanol dual-fuel generator prime mover

3.1.4.1 The survey and test requirements for the conversion of the methanol/ethanol dual-fuel generator prime mover refer to the applicable parts of 3.1.3 of this section.

3.1.5 Methanol/ethanol dual-fuel boiler

3.1.5.1 The design of the burner shall ensure stable combustion under all ignition conditions.

3.1.5.2 The main/propulsion boiler shall be capable of automatically switching from methanol/ethanol mode to fuel mode without interrupting combustion.

3.1.5.3 Facilities shall be provided for inerting or purging the methanol/ethanol fuel piping system.

3.1.5.4 Fire detectors suitable for the ignition characteristics of alcohol shall be added at locations where methanol/ethanol leaks may occur.

3.1.5.5 It shall be possible to manually start the boiler purging procedure.

3.1.5.6 Measures shall be taken to ensure that the fuel flow to the burner can be automatically cut off unless a stable ignition has been established and maintained in the burner.

3.1.5.7 A manually operated globe valve shall be installed on the fuel supply pipeline of each methanol/ethanol burner.

3.1.5.8 When the burner is turned off in methanol/ethanol mode, measures shall be taken to automatically purge the burner air supply pipeline using inert gas.

3.1.5.9 The fuel conversion system shall be equipped with a monitoring and alarm system to ensure its continuous availability.

3.1.5.10 When all working burners are turned off, measures shall be taken to ensure that the boiler burners are automatically purged before re-ignition.

3.1.5.11 After conversion, the modified pipeline and its accessories shall be tested for tightness in accordance with the "Rules for Classification of Sea-Going Steel Ships".

3.1.5.12 The corrosiveness and swelling of the fuel shall be considered for equipment and piping materials used in direct or indirect contact with methanol/ethanol.

3.1.6 Methanol/ethanol fuel supply system

3.1.6.1 The design and layout of the methanol/ethanol fuel supply system pipelines shall meet the requirements of the methanol/ethanol guidelines.

3.1.6.2 During the ship conversion survey phase, the layout of the fuel preparation room and supply piping system shall be checked to confirm that it meets the requirements of the approved drawings.

3.1.6.3 Perform effect tests on the monitoring, control and safety systems of the supply system to confirm that they meet the requirements of the approved drawings.

3.1.6.4 Any fuel piping system shall not be less than 800 mm from the ship's side. The fuel supply piping system shall be independent of other piping systems on board. A single failure in the fuel supply system shall not cause fuel to leak into the machinery space.

3.1.6.5 The propulsion units, generating sets and fuel supply systems shall be arranged so that a single failure of the fuel supply will not result in an unacceptable loss of power.

3.1.6.6 The outer pipe or ventilation duct of the fuel pipeline shall be airtight and liquid-tight.

3.1.6.7 The annular space between the inner and outer pipes of the fuel pipeline shall be ventilated by negative pressure mechanical draft, and the air outlet shall lead to an open-air area with a ventilation capacity of at least 30 air changes per hour. Appropriate gas and liquid leakage detection measures shall be arranged in the annular space. Double-walled pipes shall be connected to suitable collection tanks to collect and detect any leaks that may occur.

3.1.6.8 Inerting is acceptable as an alternative for mechanical ventilation of the annular space between the inner and outer pipes. Appropriate gas and liquid leakage detection measures shall be arranged in the annular space. When the inert gas pressure in the annular space decreases, an appropriate alarm signal shall be issued.

3.1.6.9 The design pressure of the outer tube of a double-walled pipe shall not be less than the maximum working pressure of the inner tube; alternatively, the maximum cumulative pressure calculated in the case of an inner tube rupture may be used.

3.1.6.10 All the fuel lines shall be provided with degassing and inerting measures.

3.1.6.11 The valves on the inlet and outlet of the methanol/ethanol fuel tank shall be as close to the methanol/ethanol fuel tank as possible. The valves that need to be operated under normal operating conditions (such as when fuel is normally supplied to the equipment or refueled) but are not easily accessible shall be able to be remotely operated.

3.1.6.12 One automatically operated main fuel valve shall be provided on the main fuel supply line to each unit or group of equipment using fuel. The main fuel valve shall be arranged on the pipeline outside the machinery space containing equipment using methanol/ethanol fuel. The main fuel valve shall be able to automatically cut off the fuel supply according to the situations specified in Table 11.4.1 of the Methanol/Ethanol Guidelines.

3.1.6.13 The manual emergency cut-off measures for equipment fuel supply shall be arranged at all escape routes of machinery spaces containing equipment using fuel, outside the machinery spaces containing equipment using fuel, outside the fuel preparation room and on the bridge. The cut-off activation installation shall be set as a physical button, appropriately marked and protected to prevent accidental operation, and can be operated under emergency lighting.

3.1.6.14 One remote control globe valve shall be set on the fuel supply pipeline of each equipment.

3.1.6.15 One manual globe valve shall be installed on the fuel supply pipeline of each equipment to ensure safe isolation during equipment maintenance.

3.1.6.16 The valves shall be fail-safe.

3.1.6.17 If the pipeline penetrates the bulkhead below the top of the methanol/ethanol fuel tank, 1 globe valve shall be installed on the methanol/ethanol fuel tank bulkhead. If the methanol/ethanol fuel tank is adjacent to the fuel preparation room, the valve can be installed on the bulkhead on one side inside the fuel preparation room.

3.1.6.18 No fuel preparation room shall be located inside Category A machinery spaces (sea-going ships)/important machinery spaces (inland ships). The fuel preparation room shall be airtight and liquid-tight relative to adjacent spaces and ventilated to open areas.

3.1.6.19 The fuel preparation room shall be equipped with fuel leakage detection equipment and negative pressure mechanical exhaust.

3.1.6.20 The hydraulic part of the hydraulically driven pump immersed in the methanol/ethanol fuel tank shall be provided with a double barrier to prevent the hydraulic system

serving the pump from being directly exposed to the methanol/ethanol. The double-layer barrier shall be equipped with liquid leakage detection equipment and can discharge accidental fuel leakage.

3.1.6.21 Measures shall be taken to prevent idling (such as avoiding operation without fuel or lack of servo fluid) for all the fuel pumps. All the fuel pumps that may exceed the system design pressure shall be equipped with a release valve. Each release valve shall be arranged in a closed loop, such as upstream of the pipeline that discharges the released fuel back to the suction end of the pump, so as to effectively limit the pressure at the pump outlet to below the system design pressure.

3.1.6.22 The valves and joints on the fuel pipeline in the machinery space that are not equipped with double-layer barriers shall be arranged in the fuel valve unit.

3.1.6.23 The fuel valve unit shall be airtight and liquid-tight.

3.1.6.24 The negative pressure mechanical exhaust shall be carried out in the fuel valve unit, and the air outlet shall lead to an open area with a ventilation capacity of at least 30 air changes per hour.

3.1.6.25 In the fuel valve unit, gas and liquid leakage detectors shall be installed to detect any possible leakage. The unit shall be connected to a collection tank to collect the leaked gas and liquid.

3.1.6.26 Security and function test of methanol/ethanol low flash point fuel supply system (LFSS) and fuel valve block unit (FVT/FVU).

3.1.7 Methanol/ethanol fuel bunkering system

3.1.7.1 The design and layout of the methanol/ethanol fuel bunkering system pipeline shall meet the requirements of the Methanol/Ethanol Guidelines.

3.1.7.2 During the ship conversion survey stage, the layout of the bunkering station and the bunkering pipe system shall be checked to confirm that it meets the requirements of the approved drawings. Any fuel pipe system shall not be less than 800mm from the ship's side.

3.1.7.3 Before bunkering, the monitoring and control of the bunkering system and the utility test of the safety system shall be completed to confirm that they meet the requirements of the approved drawings.

3.1.7.4 The bunkering station shall be located on an open deck to allow for adequate natural ventilation. The risk assessment shall be carried out for enclosed or semi-enclosed bunkering stations, and the assessment report shall be approved by ISC. When the natural ventilation is insufficient, the mechanical ventilation installations shall be set up according to risk assessment. The special considerations in the risk assessment shall include, but are not limited to, the following design features:

(1) Isolation from other areas on board;

(2) Arrangement of dangerous areas on board;

(3) Requirements for forced ventilation;

(4) Leakage monitoring requirements;

(5) Safety actions related to leakage monitoring;

(6) Entering the bunkering station from a non-hazardous area through an airlock;

(7) Monitoring the bunkering station through direct observation or closed-circuit television (CCTV).

3.1.7.5 The entrances, air inlets and openings to accommodation spaces, service spaces,

machinery spaces and control stations shall not face the bunkering station. They shall be located on the end wall not facing the bunkering station and/or on the outer side wall of the superstructure or deckhouse at least 4% of the ship length (L) but not less than 3m from the end wall of the superstructure or deckhouse facing the bunkering station, but the distance need not exceed 5m. No doors shall be provided within the above restrictions, but those places that do not lead to accommodation spaces, service spaces or control stations such as goods control stations and storage rooms may have doors. If such a door is provided, the insulation of the boundary of the premises shall meet the "A-60" standard.

3.1.7.6 The boundary between the enclosed and semi-enclosed bunkering stations and the surrounding spaces shall be airtight and liquid-tight.

3.1.7.7 The bunkering pipeline shall not pass through accommodation spaces, service spaces or control stations. bunkering piping through enclosed spaces in non-hazardous areas shall be double walled or surrounded by airtight ducts.

3.1.7.8 There shall be an installation for safe disposal of fuel leaks. A coaming and/or a drip pan shall be provided under the bunkering connection to enable safe collection and storage of leaked fuel.

3.1.7.9 The catch tray shall be equipped with a pipeline to transport the leaked fuel to a dedicated collection tank, which shall take into account measures to prevent backflow. If the catch tray is affected by rainwater, a drain valve shall be provided to discharge the rainwater overboard. The special collection tank mentioned above shall be equipped with liquid level indication and alarm installations. When the capacity of the catch tray is less than 10L, it can be emptied manually.

3.1.7.10 The showers and eyewash stations for emergency use shall be arranged in areas close to operations where fuel contact may occur. The showers and eyewash stations shall be operable and usable in all circumstances.

3.1.7.11 The fuel bunkering hose equipped on the ship shall be compatible with the fuel. Each type of bunkering hose, together with its end fittings, shall be prototype tested at normal ambient temperature and 200 pressure cycles at 0 to at least 2 times the maximum working pressure. After the pressure cycle test, the bursting pressure of the prototype test shall be at least 5 times the specified maximum working pressure at the upper and lower extreme operating temperatures. The hose used for prototype test cannot be used for fuel bunkering.

3.1.7.12 Before being put into use, the bunkering hose shall be subjected to a hydrostatic test at ambient temperature with a pressure no less than 1.5 times its specified maximum working pressure but not necessarily exceeding 0.4 times its bursting pressure. The hose shall be marked with the test date by steel stamp or other means. If it is used in occasions other than ambient temperature, its maximum and minimum operating temperatures shall be indicated. The specified maximum working pressure shall not be less than 1MPa.

3.1.7.13 A device shall be provided to drain the fuel from the bunkering hose after the bunkering operation is completed.

3.1.7.14 If the ship is equipped with a fuel bunkering hose, a safe storage location shall be arranged on board and possible leakage from the hose connectors shall be considered. The hoses shall be stored on an open deck or in a storage room with an independent mechanical ventilation system capable of at least 6 air changes per hour.

3.1.7.15 The fuel bunkering main pipe shall be designed to withstand external loads during

bunkering. The connection of the bunkering station shall be dry disconnect type and equipped with an additional safety dry breakaway valve/self-sealing quick release installation. The joints shall be of standard type.

3.1.7.16 The loading limit of the methanol/ethanol fuel tank shall be no greater than 98% under any circumstances.

3.1.7.17 A device shall be provided to drain any fuel from the bunkering pipe after bunkering is completed.

3.1.7.18 The bunkering pipeline shall be capable of inerting and degassing. The bunkering pipeline shall be in a degassed state when it is not being bunkered, unless the impact of non-degassing has been evaluated and approved by ISC.

3.1.7.19 The Ship/Shore Link (SSL) or equivalent means of automatic and manual emergency disconnection (ESD) communication with the fuel supply source shall be provided on board. The system shall be operable both on the bunkered ship and at the bunkering side. The ESD system shall be able to quickly and safely cut off the fuel supply without causing any fuel leakage.

3.1.7.20 Each bunkering pipeline shall be installed in series with 1 manual operation globe valve and 1 remote control shut-off valve, or 1 manual operation and remote control combination valve as close to the shore connection as possible. It shall be possible to operate the remote control valve at the bunkering operation control position and/or other safe positions.

3.1.7.21 If there is a cross-arrangement of the bunkering pipelines, appropriate isolation installations shall be set up to ensure that no fuel can be accidentally delivered to the side of the ship not used for bunkering operations.

3.1.8 Auxiliary system

3.1.8.1 Survey of ventilation and degassing systems

(1) The methanol/ethanol fuel tank shall be equipped with a controlled ventilation system. The ventilation system shall be independent of the air pipes and ventilation systems in accommodation spaces, service space, control stations or other non-hazardous spaces;

(2) A fixed piping system shall be set up to enable each methanol/ethanol fuel tank to be safely purged and degassed, and safely refueled in the purged state;

(3) A pressure/vacuum relief valve shall be provided on each methanol/ethanol fuel tank to limit the pressure and vacuum that may occur within the methanol/ethanol fuel tank. The ventilation system of the methanol/ethanol fuel tank can be composed of separate ventilation pipes for each methanol/ethanol fuel tank, or these separate ventilation pipes can be combined into a ventilation main pipe. The ventilation system shall be designed and set up to prevent flames from entering the methanol/ethanol fuel tank. If the high velocity pressure relief valves (PRVs) are installed at the end of the vent pipe, they shall be certified for fire resistance in accordance with standards accepted by ISC (such as MSC/Circ.677); if the PRVs are installed on the vent pipe, a flame arrester with fire resistance meeting the certification requirements of standards accepted by ISC (such as MSC/Circ.677) shall be installed at the vent outlet;

(4) The front and rear ends of the pressure/vacuum relief valve shall not be equipped with globe valves, but the bypass valves can be installed. If a second set of independent over/under pressure protection is provided for all methanol/ethanol fuel tanks in accordance with 4.2.1.7 of the Methanol/Ethanol Guidelines, a globe valve may be provided on the vent main for temporary division of the methanol/ethanol fuel tank during maintenance;

(5) The controlled ventilation system of the methanol/ethanol fuel tank shall have sufficient

redundancy to release possible overpressure and vacuum. Each methanol/ethanol fuel tank can be equipped with a pressure sensor and connected to the alarm system, which can serve as an alternative to secondary redundancy. The opening pressure of the vacuum relief valve is usually set at no less than 0.007MPa of atmospheric pressure;

(6) The air outlet of the pressure/vacuum relief valve shall be connected to a safe position on the open deck, and a pressure/vacuum relief valve that is convenient for functional inspection shall be used;

(7) The methanol/ethanol fuel tank ventilation system shall be connected to the highest point of each methanol/ethanol fuel tank. Under all normal operating conditions, the fuel ventilation pipeline shall enable the fuel to drain back into the methanol/ethanol fuel tank by itself;

(8) The height of the vent pipe outlet of the methanol/ethanol fuel tank shall be no less than 3m above the weather deck. If it is located within 4m of the elevated step bridge, it shall usually be no less than 3m above the elevated step bridge. The vent pipe outlet shall also be set at least 10m away from the air inlet or opening of the nearest accommodation spaces, service spaces and ignition sources. The vapor shall be ejected vertically upward without hindrance;

(9) The methanol/ethanol fuel tank ventilation system can only be used for ventilation and degassing. The methanol/ethanol fuel tank and the ventilation system of the fuel preparation room shall not be connected;

(10) The degassing operations shall be carried out so that the gas is discharged in one of the following ways:

① It can maintain an outlet speed of at least 30m/s during degassing operations and spray freely upward through an outlet at least 3m higher than the deck level;

② It passes through exits at least 3m above deck level and is able to maintain an exit velocity of at least 20m/s for free upward spraying, while protecting these exits with appropriate installations to prevent the passage of flames.

3.1.8.2 Survey of inerting system

(1) All methanol/ethanol fuel tanks shall be able to remain inert at all times during use;

(2) To prevent flammable liquids or vapors from entering the inert gas system, two globe valves with one breather valve in the middle shall be installed on the inert gas supply pipeline. In addition, a closable non-return valve shall be provided between the two globe valves + breather valve and the fuel system. These valves shall be located in hazardous areas;

(3) If the connection of the inert gas pipeline system is non-fixed, two non-return valves can be used instead of two globe valves with one breather valve and the closable non-return valve in (2);

(4) Each methanol/ethanol fuel tank inerting inlet line shall be provided with an isolation installation located at a location that is easily visible to the crew entering the methanol/ethanol fuel tank. Isolation shall be provided by means of removable short pipes;

(5) The inert gas generating installation shall be able to produce an inert gas with an oxygen content of no greater than 5% by volume at any time. An oxygen content meter with continuous reading and an alarm installation that activates when the oxygen content exceeds 5% by volume shall be installed on the inert gas supply pipeline; The system design shall ensure that the inert gas release valve to the atmosphere shall open automatically when the oxygen concentration by volume is greater than 5%;

(6) The inert gas system shall be able to maintain a gas environment with an oxygen content

not exceeding 8% by volume in any part of the methanol/ethanol fuel tank;

(7) When the inert gas generating installation or storage installation is installed in a separate compartment outside the engine room, the separate compartment shall be equipped with an independent negative pressure mechanical ventilation installation with a ventilation capacity of at least 6 air changes per hour. If the oxygen content in a separate compartment is less than 19.5%, an alarm shall be sounded. Each compartment shall be equipped with at least two oxygen sensors. The audible and visual alarms shall be provided at each entrance to the inert gas chamber;

(8) The inert gas pipelines shall only pass through the well-ventilated spaces. The inert gas pipelines in enclosed spaces shall be as short as possible and have only the minimum number of full penetration flange joints required for the installation of valves;

(9) Confirm that the pipelines, valves and accessories for degassing, purging and inerting of the methanol/ethanol fuel tank meet the requirements of the approved drawings;

(10) For systems using nitrogen for inerting, a tightness test shall be conducted on the pipelines, valves, and accessories of the nitrogen system. Additionally, a utility test shall be carried out on the safety valves and pressure reducing valves of the system to confirm that they meet the requirements of the approved drawings.

3.1.8.3 Survey of Bilge Water System

(1) The bilge water system in an area where fuel leaks may occur shall be independent of those in other spaces;

(2) One or more dedicated collection tanks shall be provided for collecting drainage and fuel that may leak from fuel pumps, valves, and the inner pipes of double-walled pipes. The dedicated collection tank shall meet the relevant layout requirements of the methanol/ethanol fuel tank. Measures shall be provided to safely transfer contaminated liquid fuel to onshore receiving installations;

(3) The bilge water system in the fuel preparation room shall be operable from outside the fuel preparation room;

(4) A utility test shall be carried out on the water level and temperature (if equipped) alarms of the bilge water system. A suction test shall be performed on the bilge water system.

3.1.8.4 Survey of Fire Protection System

(1) Fire prevention

① From the perspective of fire prevention, the fuel preparation room shall be regarded as a Category A machinery space (sea-going ships). When the fuel preparation room is adjacent to Category A machinery spaces (sea-going ships) or other spaces with a higher risk of fire, accommodation spaces, control stations and cargo areas, at least Class A-60 fire protection division shall be adopted;

② When the methanol/ethanol fuel tank is located on an open deck, the boundary surfaces of the accommodation spaces, service spaces, control stations, escape routes and machinery spaces facing the methanol/ethanol fuel tank shall utilize Class A-60 fire protection division. This insulation shall extend to the bottom of the bridge deck, or the actual height of the bulkhead;

③ A cofferdam of at least 600 mm shall be provided between the methanol/ethanol fuel tank and Category A machinery spaces (sea-going ships) or other places with a higher risk of fire. Moreover, the Class A-60 fire protection division shall be adopted on the side close to the cofferdam in Category A machinery spaces (sea-going ships) or other places with a higher risk of fire;

④ When determining the fire protection division between methanol/ethanol fuel tanks or methanol/ethanol fuel tank spaces and other spaces with a lower risk of fire, the methanol/ethanol fuel tanks or methanol/ethanol fuel tank spaces shall be regarded as Category A machinery spaces (sea-going ships). Class A-60 fire protection division shall be adopted between the spaces of the methanol/ethanol fuel tank;

⑤ Class A-60 fire protection division shall be adopted for the boundary surfaces of Category A machinery spaces (sea-going ships), accommodation spaces, control stations and places with a higher risk of fire facing the bunkering station. This insulation shall extend to the bottom of the bridge deck, or the actual height of the bulkhead. However, such boundaries of liquid tanks, void spaces, auxiliary machinery spaces, toilets, and other similar spaces with a lower risk of fire can be reduced to Class A-0.

(2) Fire detection and fire alarm system

① All compartments equipped with methanol/ethanol fuel systems shall be provided with fixed fire detection and fire alarm systems that comply with the International Code for Fire Safety Systems (FSS Code).

② Appropriate detectors shall be selected based on the ignition characteristics of alcohols. Smoke detectors shall be used in combination with detectors that can detect methanol/ethanol fires more effectively.

③ Means shall be provided to facilitate the detection and identification of methanol/ethanol fires in machinery spaces for fire inspection and extinguishing purposes, such as portable thermal detection equipment.

④ When the function of identifying individual detectors is not available, each detector shall be set as an individual loop.

⑤ After a fire is detected in the above-mentioned spaces, the safety measures listed in Table 11.4.1 of the Methanol/Ethanol Guidelines shall be adopted.

(3) Fire extinguishing

① When the fire main arranged on the open deck passes through the area of the methanol/ethanol fuel tank on the open deck, the fire main should be equipped with an isolation valve to isolate the damaged area of the pipe. The isolation of the damaged part of the fire main should not affect the water supply to the fire pipeline upstream of the isolated pipe section;

② When the methanol/ethanol fuel tank is located on an open deck, a fixed water spray system shall be provided for dilution, cooling and fire prevention;

③ The water spray system shall cover all exposed parts of the methanol/ethanol fuel tank above the deck. Specific requirements are detailed in Section 8.3.2 of Chapter 8 of the Methanol/Ethanol Guidelines;

④ When the methanol/ethanol fuel tank is arranged on an open deck, the ship shall be equipped with a fixed foam fire extinguishing system (AR-AFFF) with alcohol-resistant fire extinguishing agent. The control arrangement of the system shall ensure safe operation in the event of a fire in the protected area. The system shall meet the requirements of Chapter 17 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) and Chapter 14 of the International Code for Fire Safety Systems (FSS Code);

⑤ Machinery spaces and fuel preparation rooms where methanol/ethanol fueled engines or fuel pumps are arranged shall be protected by a fixed fire extinguishing system that meets the requirements of the International Code for Fire Safety Systems (FSS Code). In addition, the

extinguishing agent used shall be suitable for extinguishing methanol/ethanol fires;

⑥ An approved foam system (with an alcohol-resistant fire extinguishing agent) shall be provided for Category A machinery spaces (sea-going ships) and fuel preparation rooms containing methanol/ethanol. It shall cover the inner bottom plating and the bilge area under the plating. If the fire extinguishing system described in this clause meets the requirements of the fixed fire extinguishing system required in clause ④ above, only the fire extinguishing system described in this clause may be provided;

⑦ The bunkering station shall be equipped with a fixed alcohol-resistant foam fire extinguishing system, and portable chemical dry powder fire extinguishers or equivalent fire extinguishers shall be provided at/near the entrance.

⑧ When the methanol/ethanol fuel tank is located on an open deck, at least 2 portable dry powder fire extinguishers with a capacity of not less than 5 kg each shall be provided near the methanol/ethanol fuel tank.

⑨ At least 1 portable dry powder fire extinguisher with a capacity of not less than 5 kg shall be provided near the methanol/ethanol engine and at the entrance of the machinery space where it is located.

3.1.8.5 Survey of ventilation system

(1) If the methanol/ethanol fuel tank or cofferdam does not have direct access to an open deck, its access passage shall be equipped with an independent negative pressure mechanical ventilation system with a ventilation capacity of at least 6 air changes per hour;

(2) When the ventilation capacity of the ventilation system decreases, audible and visual alarms shall be activated on the bridge, central control room with continuous personnel on duty or ship safety center and at the local location;

(3) The survey requirements for mechanical ventilation are specified in Section 1, Chapter 12 of the Methanol/Ethanol Guidelines;

(4) The survey requirements for ventilation of the fuel preparation rooms are specified in Section 2, Chapter 12 of the Methanol/Ethanol Guidelines;

(5) The survey requirements for ventilation of the bunkering stations are specified in Section 3, Chapter 12 of the Methanol/Ethanol Guidelines;

(6) The survey requirements for ventilation of double-walled pipes are specified in Section 4, Chapter 12 of the Methanol/Ethanol Guidelines;

(7) The ventilation system of the fuel valve unit space shall meet the requirements for the double-walled pipe ventilation systems specified in 12.4.1 of Chapter 12 of the Methanol/Ethanol Guidelines;

(8) The ventilation system of the methanol/ethanol fuel tank connection space shall meet the requirements for the double-walled pipe ventilation systems specified in 12.4.1 of Chapter 12 of the Methanol/Ethanol Guidelines.

3.1.9 Certification

3.1.9.1 For ships using methanol/ethanol fuel, upon application by the ship owner or shipyard/design unit, and after ISC
has conducted drawing review and survey to confirm compliance with the relevant provisions of Chapters 1 to 14 of the ISC Guidelines for Ships Using Methanol/Ethanol as Fuel, the class notation "Methanol Fuel" or "Ethanol Fuel" may be granted.

3.1.9.2 For ships that have satisfactorily completed the conversion survey, a new cargo ship

safety construction certificate should be issued to clarify its application of Part G of Chapter II-1 of SOLAS and the applicability of the alternative design. The approval document for the alternative design should be attached to the cargo ship safety construction certificate.

3.1.9.3 After the conversion of methanol/ethanol fuel for the main engine and generator prime mover is completed, the product survey department shall issue the main engine and generator prime mover product certificate and EIAPP certificate based on the prototype machine type approval certificate and emission certificate, and provide corresponding remarks. The date of certificate issuance shall be no later than the date of the ship's IAPP certificate issuance.

3.2.9.4 For ships that have satisfactorily completed the conversion survey in accordance with the Technical Rules for Control of Nitrogen Oxide Emissions from Marine Diesel Engine, the International Air Pollution Prevention Certificate (IAPP Certificate) and related attachments should be re-issued.

3.2.9.5 For ships subject to the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 or/and Regulation (EU) No 1257/2013, the inventory of hazardous materials shall be verified after conversion, and the inventory of hazardous materials shall be updated if necessary.

Section 2 Ship LNG Fuel Conversion

3.2.1 General requirements

3.2.1.1 This section is intended to provide guidance for the needs of ships implementing LNG fuel conversion. It applies to ships with a length of 20m and above engaged in international voyages that have ISC class and/or apply for ISC class.

3.2.1.2 The purpose of this section is to provide standards for the arrangement, conversion and installation of relevant machinery, equipment, and systems involved in the process of ship LNG fuel conversion, and to minimize the risks to the ship, crew and environment. To achieve the above purpose, the conversion of ship LNG fuel shall meet the following functional requirements:

(1) The safety, availability and reliability of the system before conversion shall be equivalent to those of the main engines and auxiliary engines using conventional petroleum fuel before conversion;

(2) The probability and consequences of fuel-related hazards shall be limited to the minimum level through arrangement and system design (such as ventilation, detection, and safety measures). When gas leakage occurs or risk mitigation measures fail, necessary safety measures shall be activated;

(3) It shall be ensured that risk mitigation measures and safety measures for gas fuel installations do not result in unacceptable power loss;

(4) The dangerous areas shall be limited as much as possible to minimize their potential risks that may affect the safety of ships, personnel and equipment on board;

(5) Only equipment necessary for operation shall be installed in hazardous areas, and the performance of such equipment shall be adapted to its working environment and approved by ISC;

(6) It shall be able to prevent the accidental accumulation of explosive, flammable or toxic gas concentrations;

(7) The components of the gas fuel system shall be properly protected from external damage;

(8) The ignition sources in hazardous areas shall be minimized to reduce the probability of explosion;

(9) Safe and suitable fuel supply, storage and bunkering installations shall be provided which are capable of receiving and containing the fuel in the required condition without leakage. Except for discharges necessary for safety reasons, the system shall be designed to prevent the external discharge of natural gas under all normal working conditions (including idle conditions);

(10) Gas piping, containment and overpressure relief installations that are properly designed, constructed and installed shall be provided to achieve their intended purposes;

(11) The design, manufacture, installation, operation, maintenance and protection of machines, systems and components shall ensure their safe and reliable operation;

(12) The arrangement and location of the fuel tank and machinery spaces containing gas release sources shall be such that a fire or explosion in any one of them will not result in unacceptable power loss or inoperability of equipment in other compartments;

(13) Appropriate control, alarm, detection and shutdown systems shall be set up to ensure the safe and reliable operation of the gas fuel system;

(14) A fixed gas detection system suitable for all relevant spaces and areas shall be set up;

(15) Fire prevention, fire detection and fire extinguishing measures suitable for controlling relevant hazards shall be set up;

(16) It shall be ensured that the commissioning, testing and maintenance of fuel systems and gas fuel engines meet the objectives in terms of safety, reliability and availability;

(17) Warning signs and protection measures shall be provided in all areas where cryogenic equipment and piping are located to prevent cryogenic injuries to personnel due to unintentional approach or contact.

(18) The purpose of the onboard testing of gas-consuming equipment is to verify the compatibility between power transmission and driving equipment, control systems, and necessary auxiliary systems under the converted fuel mode, the integration of gas-consuming equipment control system with the ship's control system, and other items not covered during factory acceptance testing.

3.2.1.3 All survey procedures, survey methods, survey types, survey intervals, survey conditions, pre-survey preparations, survey and test requirements, as well as the preservation of ship drawings, data, certificates, records and reports, shall be implemented in accordance with the relevant provisions of the Rules for Classification of Sea-Going Steel Ships. For liquefied gas carriers, the relevant requirements for conversion shall also comply with the requirements of the Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and the Guidelines for Design and Installation of Gas Fuel Engine Systems for Liquefied Gas Carriers; for ships other than liquefied gas carriers, the relevant requirements of the natural gas regulations shall be met. In the process of ship conversion, in addition to conducting surveys in accordance with the requirements for construction surveys specified in the above-mentioned ISC related specifications, the following additional items shall also be surveyed:

(1) Installation and testing of gas fuel engines and boilers (if equipped);

(2) Installation and testing of fuel tanks;

(3) Installation and testing of the fuel bunkering system;

(4) Installation and testing of fuel supply system (including heat exchanger);

(5) Installation and testing of the ventilation systems for machinery spaces of gas fuel engines,

LNG fuel containment system spaces, double-walled pipes, LNG fuel containment system connection spaces (if equipped), and fuel preparation rooms (if equipped);

(6) Installation and testing of remote closing appliance for gas fuel engines;

(7) Inspection of the installation location and quantity of gas probes, and testing of the gas detection and alarm systems;

(8) Installation and testing of the safety functions of fuel bunkering system and fuel supply system;

(9) Confirmation and security inspection of explosion-proof equipment or anti-ignition equipment. If the safety of explosion-proof electrical equipment relies on the action of protective installations (such as overload protection relays) and/or alarm installations (such as pressure loss alarms for positive pressure equipment), the protective installation and alarm installation shall undergo utility tests to verify the correctness of their actions and alarm installation setting values;

(10) Confirmation of the positive pressure ventilation capacity for spaces protected by positive pressure. The purification time under the minimum ventilation flow rate shall be tested and recorded in relevant documents. The action values of safety measures (shutdown and/or alarm) to be taken when the pressure is abnormal shall be verified;

(11) For spaces where the hazard level depends on mechanical ventilation, the ventilation installation shall undergo utility tests, the ventilation volume shall be sufficient, and the alarms for ventilation system failures shall operate correctly;

(12) Confirm the correctness of equipment and cable installation for intrinsically safe circuits;

(13) Installation and testing of fire prevention, fire detection and fire extinguishing installations;

(14) In case of alterations, replacements, or major repairs to the ship's structure, equipment, systems, accessories, arrangements, or materials that affect Part I of the IHM, an additional survey for the International Certificate on the Inventory of Hazardous Materials may be requested.

3.2.1.4 ISC allows the use of other alternative equipment or measures for specific accessories, materials, instruments, components of equipment or their models that should be installed or equipped on board as required by the Guidelines, or special measures and any procedures or arrangements to be taken, but they should be confirmed by tests or other methods to have at least equivalent effectiveness to those required by this specification. ISC does not allow the use of operating methods or procedures to replace specific accessories, materials, instruments, equipment components, or their models specified in this specification.

3.2.2 LNG fuel containment system

3.2.2.1 The function of the LNG fuel containment system is to ensure proper storage of converted gas fuel so that its risks to personnel, vessels, and the environment are comparable to those of conventional oil-burning vessels.

3.2.2.2 Commonly used LNG fuel containment systems are mainly divided into independent LNG fuel containment systems and membrane fuel tanks, among which independent fuel tanks are divided into types A, B, and C. The definition of each LNG containment system type is given in the Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and its amendment notification.

3.2.2.3 The technical requirements during the conversion of the fuel tank shall meet the provisions of Chapter 4 of the Natural Gas Rule.

3.2.2.4 Before conversion, it should be ensured that the structure and layout of the area where the ship is intended to be used as an LNG fuel containment system meet the construction requirements of various types of containment systems. The specific survey items and acceptance criteria shall comply with the requirements for new constructions, with reference to the relevant provisions in Chapter 4 of the Guidelines for the Survey of Liquefied Gas Carriers.

3.2.3 LNG fuel main engine

3.2.3.1 The LNG fuel main engine shall meet the requirements of Chapter 9, Part 3 of the Rules for Classification of Sea-Going Steel Ships and 7.2 of Chapter 7 of the Natural Gas Rules.

3.2.3.2 The technical requirements for the electronic control system of LNG fuel main engine shall meet Appendix 5 Electronic Control System of Natural Gas Specification.

3.2.3.3 For nitrogen oxide emission survey of LNG fuel main engine, if the conversion of marine diesel engine is a substantial change, it shall be carried out in accordance with ISC's Guidelines for Nitrogen Oxide Emission Test and Survey of Marine Engine, and relevant supporting documents shall be provided.

3.2.3.4 The crankcase, oil pan, and cooling system should be equipped with a ventilation system independent of other engines.

3.2.3.5 Special requirements for LNG dual-fuel engines: When the gas fuel supply is interrupted, the engine should be able to operate continuously using only fuel without interruption. A control system shall be provided for automatic switching from gas fuel mode to oil mode and from oil mode to gas fuel mode with minimal engine power fluctuations during fuel switching. The reliability of the fuel mode conversion should be proven to be acceptable through experiments. If the engine gas fuel mode is unstable, it should automatically switch to fuel mode. The gas supply system should always be manually shut down. During normal parking or emergency shutdown, the gas fuel supply should be cut off no later than the ignition source is turned off. The ignition source cannot be turned off before the air supply to each cylinder or the entire engine is cut off in advance or at the same time.

3.2.3.6 Special requirements for LNG single gas fuel engines: During normal shutdown and emergency shutdown, the gas fuel supply should be cut off no later than the ignition source is turned off. The ignition source cannot be turned off before the air supply to each cylinder or the entire engine is cut off in advance or at the same time.

3.2.3.7 The air intake manifold, scavenge box, exhaust system, and crankcase shall be provided with suitable pressure relief systems unless they are designed to withstand the overpressure caused by ignition of leaking gas in the worst case. The pressure relief system should lead to a safe location and away from personnel.

3.2.3.8 The crankcase, oil pan, scavenge box, and cooling system vent pipes should be equipped with gas detection installations. In addition, it should be arranged to alarm before reaching 100% of the minimum flammability limit.

3.2.3.9 Risk analysis should be conducted on all faults that may affect the safe operation of the engine, and the required engine monitoring items should be determined based on the analysis results. The relevant analysis report should be submitted to ISC. The risk analysis shall meet the requirements of Appendix 1 to Chapter 9, Part 3 of the Rules for Classification of Sea-Going Steel Ships.

3.2.3.10 The onboard test shall be carried out in accordance with Appendix 1 to Chapter 9, Part 3 of ISC Rules for Classification of Sea-Going Steel Ships.

3.2.3.11 For dual-fuel gas equipment, shipboard tests should be completed in gas mode and oil mode according to the application situation, and fuel conversion tests should be carried out under different designed loads. The operating parameters of the conversion process will not undergo detrimental changes, and the conversion process should be able to proceed automatically. In any case, the above conversion process should be manually interrupted.

3.2.3.12 For single-fuel gas equipment, the fuel supply system shall be arranged to be sufficiently redundant and segregated from the LNG fuel containment system up to the gas-consuming equipment, such that a leakage in one system will not lead to unacceptable power loss.

3.2.4 LNG fuel generator prime mover

3.2.4.1 The survey and testing requirements for the conversion of LNG dual-fuel generator prime movers shall make reference to the applicable parts of Section 3.2.3.

3.2.5 LNG-fuel boiler

3.2.5.1 The boiler shall meet the requirements of Chapter 6, Part 3 of the Rules for Classification of Sea-Going Steel Ships and 7.3 of Chapter 7 of the Natural Gas Rules.

3.2.5.2 Measures should be taken to ensure that the gas fuel supply to the burner can be automatically cut off when satisfactory ignition cannot be carried out and maintained.

3.2.5.3 One manual globe valve shall be provided on the fuel line of each gas burner.

3.2.5.4 All boilers shall be subject to operability function test and function test of safety protection installations.

3.2.5.5 For dual-fuel gas equipment, shipboard tests should be completed in gas mode and oil mode according to the application situation, and fuel conversion tests should be carried out under different designed loads. The operating parameters of the conversion process will not undergo detrimental changes, and the conversion process should be able to proceed automatically. In any case, the above conversion process should be manually interrupted.

3.2.5.6 For single-fuel gas equipment, the fuel supply system shall be arranged to be sufficiently redundant and segregated from the LNG fuel containment system up to the gas-consuming equipment, such that a leakage in one system will not lead to unacceptable power loss.

3.2.6 LNG fuel supply system

3.2.6.1 The gas supply system for LNG dual-fuel or single-fuel powered ships is mainly composed of a fuel pump or pressure build-up unit (PBU), evaporator, heater, group valve unit (GVU), and gas equipment.

3.2.6.2 The gas fuel supply system shall meet the requirements of Chapter 6 of the Natural Gas Rule.

3.2.6.3 The design and layout of the gas supply system pipeline shall meet the requirements of Chapter 2 and Chapter 3 of the Natural Gas Rule.

3.2.6.4 LNG carriers shall meet the requirements of Chapter 5 and Chapter 16 of the Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

3.2.7 LNG fuel bunkering system

3.2.7.1 The gas fuel bunkering system shall meet the requirements of Chapter 5 of the Natural Gas Rule.

3.2.7.2 If the bunkering pipeline needs to pass through a watertight deck or bulkhead, double-wall vacuum or effective measures should be adopted to ensure that the low temperature of

the bunkering pipeline does not damage the strength of the watertight deck or bulkhead. The end of the sampling port of the LNG fuel containment system shall, to the greatest extent possible, avoid having an upward-facing opening. Or effective measures should be taken to prevent rain, snow, and dew from entering the sampling port.

3.2.7.3 A catch tray should be installed below the bunkering connection of the bunkering station and any possible leakage location. The catch tray and its discharge measures should meet the requirements of 2.3.7 in Chapter 2 of the Natural Gas Rule.

3.2.7.4 The strength test and overall tightness test of the bunkering pipeline should be completed before bunkering.

3.2.7.5 The shut-off test of the cold ESD valve should be carried out.

3.2.7.6 When the LNG fuel containment system is filled for the first time, the manufacturer should have a complete bunkering plan, including but not limited to the drying, inerting, replacement, precooling, bunkering, and other operating procedures of the LNG fuel containment system and the precooling temperature curve provided by the technical party of the LNG fuel containment system.

3.2.8 Auxiliary system

3.2.8.1 Survey of fire protection system:

(1) For the layout of the LNG fuel containment system, pay attention to the fire protection division of the boundary surfaces of the accommodation spaces, service spaces, control stations, escape routes, and machinery spaces facing the LNG fuel containment system, which should meet the requirements of Chapter 8, 8.2.2.1 of the Natural Gas Rule;

(2) The LNG fuel containment system space should be isolated from Category A machinery spaces/important machinery spaces, or other spaces with a greater risk of fire. This isolation should be a cofferdam of at least 900mm in width, having an A-60 fire protection division. The Class A-60 fire protection division should be arranged as close to the side of the cofferdam as possible in Category A machinery spaces/important machinery spaces, or other places with a greater risk of fire;

(3) For the layout of bunkering stations, attention shall be paid to the fact that Class A-60 fire protection division shall be adopted for the boundaries of Category A machinery spaces/important machinery spaces, accommodation spaces, control stations, and spaces with greater fire risk facing the bunkering station. However, such boundaries of liquid tanks, void spaces, auxiliary machinery spaces, toilets, and other similar spaces with less fire risk can be reduced to Class A-0;

(4) If the ESD-protected machinery space is isolated by a single boundary, the boundary should be A-60 grade division;

(5) The water-based fire protection system shall meet the requirements of 8.3.2, Chapter 8 of the Natural Gas Rule. In addition, if the water spray system shares the same fire pump with the water-based fire protection system, it should be verified that the displacement of the fire pump meets the number of fire hydrants and water spray systems required for operation;

(6) The water spray system shall meet the requirements of 8.3.3, Chapter 8 of the Natural Gas Rule. In addition, during installation, attention should be paid to the fact that the installation angle of the nozzle meets the manufacturer's requirements and the water mist spraying effect test satisfies the surveyor;

(7) The chemical dry powder fire extinguishing system shall meet the requirements of 8.3.4, Chapter 8 of the Natural Gas Rule. The fixed dry powder fire extinguishing system set up at the

bunkering station can be a top nozzle, powder fire monitor, or its equivalent type, which should cover all possible leakage points. If there is a fixed pipeline between the dry powder container and the hand-held hose or powder fire monitor, the length of the pipeline should not exceed the length required for it to keep the dry powder flowing during continuous or intermittent use, and the dry powder in the pipeline should be expelled after the system is shut down;

(8) If there are fuel preparation rooms, gas compressor rooms, and air pump rooms, they should meet the fire extinguishing requirements for goods compressor rooms and cargo pump rooms in the Specifications for the Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk;

(9) Enclosed spaces containing fuel preparation equipment (such as pumps, compressors or other potential ignition sources) should be equipped with fixed fire extinguishing systems that meet the requirements of SOLAS II-2/10.4.1.1 and the Code for Fire Safety Systems (FSS Code), taking into account the concentration or release rate required to extinguish gas fires;

(10) For LNG fuel containment system spaces and ventilation trunks for fuel tanks below deck, as well as in all other gas fuel system compartments where fire risks cannot be ruled out, 1 fixed fire detection and fire alarm system complying with the Code for Fire Safety Systems shall be provided. The use of smoke detectors alone shall not be considered as providing adequate rapid fire detection capability;

(11) After a fire is detected in the above spaces, the safety measures listed in Table 12.4.3 of Chapter 12 of the Gas Code shall be taken, and ventilation shall be stopped.

3.2.8.2 Survey of ventilation system:

(1) For LNG dual-fuel or single-fuel powered ships, the mechanical ventilation of each space shall meet the requirements of Chapter 10 of the Natural Gas Rule;

(2) In addition to meeting the requirements of Chapter 10 of the Natural Gas Rule, attention should also be paid to the outlets of oxygen-enriched pipelines for nitrogen generators, seawater electrolysis installations, and other installations to avoid setting the ventilation system inlet in the dangerous area of the oxygen-enriched pipeline outlet.

3.2.8.3 Survey of Inert Gas System:

(1) Inert gas is usually used for the inerting of LNG fuel containment systems and their spaces, as well as purging of fuel pipelines. The main purpose of fuel system inerting and purging is to prevent the formation of combustible gas in, near, or around the fuel system piping, LNG fuel containment system, equipment, and adjacent spaces;

(2) The fuel system inerting and purging procedures should ensure that air is not introduced into the piping system or LNG fuel containment system containing a flammable gas atmosphere, and gas fuel is not introduced into the cofferdams or spaces adjacent to the fuel system;

(3) The equipment for generating inert gas on board should have measures to continuously monitor the dew point and oxygen content, and be equipped with an alarm installation that can alarm when the oxygen content (by volume) is 5%;

(4) Arrangements should be provided to prevent fuel vapor from flowing back into the inert gas system space;

(5) Spaces containing inert gas generating installations shall not have direct access to accommodation space, service space or control station, but the inert gas generating installation may be located in machinery space. Inert gas pipelines shall not pass through accommodation spaces, service spaces, or control stations;

(6) The outlet of the oxygen-enriched pipeline of the inert gas generator should be considered as a dangerous gas outlet;

(7) The crankcase should be equipped with interfaces or other means for inerting, ventilating, and gas concentration measurement during engine maintenance.

3.2.8.4 Survey of combustible gas survey:

(1) The combustible gas detection system shall meet the requirements of Chapter 12, 12.3 of the Natural Gas Rule, and shall be arranged to initiate the safety actions for fire detection as required by Table 12.4.3 of Chapter 12 of the Natural Gas Rule.

3.2.8.5 Survey of bilge water system:

(1) The bilge water system in the area where LNG leakage may occur shall be independent of those in other spaces.

(2) When fuel is stored in a fuel tank that requires secondary barriers, appropriate drainage installations should be provided to handle leakage from adjacent hull structures into the LNG fuel containment system space or insulation space. Bilge water systems should not be directed to pumps in safe spaces. Additionally, an installation that can detect such leakage must be installed.

(3) The LNG fuel containment system space or the inter-barrier space of the type A independent LNG fuel containment system should be equipped with an appropriate drainage system to deal with the liquid fuel leaked when the LNG fuel containment system leaks or ruptures.

3.2.9 Issuance

3.2.9.1 Upon satisfactory completion of all conversion item surveys, for ships that hold and/or are applying for ISC class and are in compliance with the Guidelines and relevant rules, the class certificate may be reissued at the applicant's request. Corresponding class notations, such as DFD (Dual-Fuel Engine Installation) or GF (Single Gas Fuel Engine Power Installation) for bulk liquefied gas carriers, or Natural Gas Fuel for other ships, may be assigned.

3.2.9.2 For non-liquefied gas carriers that have satisfactorily undergone the conversion survey, a new cargo ship safety construction certificate should be issued to clarify its application of Part G of Chapter II-1 of SOLAS and the applicability of the alternative design. The approval document for the alternative design should be attached to the cargo ship safety construction certificate.

3.1.9.3 After the conversion of LNG fuel for the main engine and generator prime mover, the product survey department shall issue the main engine and generator prime mover product certificate and EIAPP certificate based on the prototype machine type approval certificate and emission certificate, and provide corresponding remarks. The date of certificate issuance shall be no later than the date of the ship's IAPP certificate issuance.

3.2.9.4 For ships that have satisfactorily completed the conversion survey in accordance with the Technical Rules for Control of Nitrogen Oxide Emissions from Marine Diesel Engine, the International Air Pollution Prevention Certificate (IAPP Certificate) and related attachments should be re-issued.

3.2.9.5 For ships subject to the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 or/and Regulation (EU) No 1257/2013, the inventory of hazardous materials shall be verified after conversion, and the inventory of hazardous materials shall be updated if necessary.

Section 3 Ship Ammonia Fuel Conversion

3.3.1 General requirements

3.3.1.1 All survey procedures, survey methods, survey conditions, pre-survey preparations, survey and test requirements, as well as the preservation of ship drawings, data, certificates, records and reports shall meet the specifications and requirements of ISC.

3.3.1.2 The product certificates of equipment related to ammonia fuel conversion system shall meet corresponding requirements.

3.3.1.3 The equipment and arrangement of the ammonia fuel converted system shall conform to the approved drawings and relevant regulations of ISC.

3.3.1.4 The functions of the ammonia fuel converted system shall be verified by utility testing.

3.3.1.5 The purposes of this section are to provide standards for the arrangement, conversion and installation of related machinery, equipment and systems involved in the process of converting ships to ammonia fuel and minimize the risks to the ship, crew and environment. To achieve the above purposes, the design and conversion of the ship to ammonia fuel shall meet the following functional requirements:

(1) The safety, availability and reliability of the system before conversion shall be equivalent to those of the main engine, auxiliary engine and boiler fueled by conventional petroleum before conversion;

(2) The probability and consequences of fuel-related hazards shall be limited to the minimum level through arrangement and system design (such as ventilation, detection, and safety measures). When gas leakage occurs or risk mitigation measures fail, necessary safety measures shall be activated;

(3) It shall be ensured that risk mitigation measures and safety measures for gas fuel installations do not result in unacceptable power loss;

(4) The dangerous areas shall be limited as much as possible to minimize their potential risks that may affect the safety of ships, personnel and equipment on board;

(5) Only equipment necessary for operation shall be installed in hazardous areas, and the performance of such equipment shall be adapted to its working environment and approved by ISC;

(6) It shall be able to prevent the accidental accumulation of explosive, flammable or toxic gas concentrations;

(7) The components of the gas fuel system shall be properly protected from external damage;

(8) The ignition sources in hazardous areas shall be minimized to reduce the probability of explosion;

(9) Safe and suitable fuel supply, storage and bunkering installations shall be provided which are capable of receiving and containing the fuel in the required condition without leakage.

(10) Gas piping, containment and overpressure relief installations that are properly designed, constructed and installed shall be provided to achieve their intended purposes;

(11) The design, manufacture, installation, operation, maintenance and protection of machines, systems and components shall ensure their safe and reliable operation;

(12) The arrangement and location of the fuel tank and machinery spaces containing gas release sources shall be such that a fire or explosion in any one of them will not result in

unacceptable power loss or inoperability of equipment in other compartments;

(13) Appropriate control, alarm, detection and shutdown systems shall be set up to ensure the safe and reliable operation of the gas fuel system;

(14) A fixed gas detection system suitable for all relevant spaces and areas shall be set up;

(15) Fire prevention, fire detection and fire extinguishing measures suitable for controlling relevant hazards shall be set up;

(16) It shall be ensured that the commissioning, testing and maintenance of fuel systems and gas fuel engines meet the objectives in terms of safety, reliability and availability;

(17) Warning signs and protection measures shall be provided in all areas where cryogenic equipment and piping are located to prevent cryogenic injuries to personnel due to unintentional approach or contact.

(18) The purpose of the onboard testing of gas-consuming equipment is to verify the compatibility between power transmission and driving equipment, control systems, and necessary auxiliary systems under the converted fuel mode, the integration of gas-consuming equipment control system with the ship's control system, and other items not covered during factory acceptance testing.

3.3.2 Ammonia fuel tank

3.3.2.1 For converted ships, Type-C tanks are generally used. If Type-A or Type-B tanks are used, they shall meet the requirements of Type-A/B tanks in the Ammonia Guidelines. The requirements of this section apply to Type-C tanks.

3.3.2.2 Ammonia fuel storage installation shall meet the requirements of the Ammonia Guidelines and the Ammonia Circular. The liquid ammonia in the ammonia fuel tank shall be maintained at a temperature not exceeding -30°C by means acceptable to the competent authority. The systems and installations used for this purpose may include one or a combination of the following:

(1) Steam re-liquefaction;

(2) Steam thermal oxidation; or

(3) Liquid ammonia fuel cooling.

The selected method shall be able to maintain the fuel temperature under the assumption that it is not used for propulsion or power generation. Fuel discharge to maintain ammonia fuel tank pressure is not acceptable except in emergency situations

3.3.2.3 Ammonia fuel tanks shall not be located in accommodation spaces or Category A machinery spaces.

3.3.2.4 The ammonia fuel tank and its cofferdam shall be located behind the anti-collision bulkhead.

3.3.2.5 If the ammonia fuel tank and pressure vessel for treatment are supplied as a whole product, they shall hold ISC marine product certificate, and the actual products shall be checked.

3.3.2.6 If the ammonia fuel tank and pressure vessel for treatment are built by a shipyard, their plates, pipes (seamless pipes and welded pipes), profiles and forgings shall hold ISC marine product certificates. The ammonia fuel tank and pressure vessel for treatment shall be fabricated with particular attention to the following:

(1) The welding procedure qualification of ammonia fuel tank and pressure vessel for treatment has been approved;

(2) Normal control shall be carried out before and during welding. The low-temperature

resistant stainless steel pipes shall be protected in all aspects during transportation, storage and processing;

(3) The welding consumables shall meet the requirements;

(4) Completed welds shall be visually checked and tested.

(5) The NDT shall prove that they meet the requirements;

(6) The quality assurance/quality control (QA/QC) plan shall meet the requirements;

(7) The inspection and testing during construction shall prove that they meet the requirements. Special attention shall be paid to the different test requirements for different types of ammonia fuel tanks;

(8) The process used for bonding joints (connecting other than welding) shall meet the requirements of the approved drawings.

3.3.2.7 The ammonia fuel tank shall hold ISC marine product certificate, and the tank nameplate shall be clear, firm and reliable with complete content. The model, design temperature, design pressure, test pressure, insulation form (when applicable), effective volume and loading limit shall be consistent with the approved drawings;

3.3.2.8 The accessories of the ammonia fuel tank, such as various main valves, equipment, sensors, pressure/temperature/liquid level indicators, and auxiliary pipelines shall be checked. It is necessary to timely verify the marine product certificates of the accessories of the ammonia fuel tank and confirm that they are suitable for gas fuel on board

. The specific requirements for the functions of pressure/temperature/liquid level indicators and sensors are as follows:

(1) Overflow monitoring:

① Each ammonia fuel tank shall be equipped with a high-level alarm installation independent of other level indicators, which shall give an audible and visual alarm when activated;

② Each ammonia fuel tank shall also be equipped with another sensor, which shall be able to automatically close the ESD valve on the bunkering pipe when the ammonia fuel tank is at a high-high liquid level. The sensor shall be independent of the high liquid level alarm installation;

③ If there is an override overflow control system for the installation, it shall be able to prevent improper operation. In case of override, the system shall be able to give continuous visual indication on the bridge, continuously manned central control station or ship safety center.

(2) Pressure monitoring:

① Each gas phase space of the ammonia fuel tank shall be equipped with one direct reading pressure gauge. In addition, indirect indications shall be provided on the bridge, continuously manned central control room or ship safety center;

② The maximum and minimum allowable pressures in the ammonia fuel tank shall be clearly marked on the pressure gauge of the ammonia fuel tank;

③ The high-pressure alarm and low-pressure alarm (if vacuum protection is required) of the ammonia fuel tank shall be installed on the bridge, the continuously manned central control room or the ship safety center. The alarm shall be triggered before the set pressure of the safety valve is reached.

(3) Temperature monitoring:

① Except for the independent Type-C tanks equipped with a vacuum insulation system and a pressurized fuel discharge installation, each ammonia fuel tank shall be equipped with devices to measure and indicate the fuel temperature at least in three locations: the bottom and middle of the

ammonia fuel tank, and the top of the ammonia fuel tank below the maximum allowable liquid level.

3.3.2.9 The base of the ammonia fuel tank (the hull structure under the ammonia fuel tank) and its welding shall meet the requirements of the approved drawings, and the hull structure shall effectively support the ammonia fuel tank.

3.3.2.10 The ammonia fuel tank shall be installed and fixed according to the approved drawings and installation process requirements.

3.3.2.11 There shall be a reliable electrical connection between the ammonia fuel tank and the hull.

3.3.2.12 The content of the risk identification analysis of the ammonia fuel tank shall be verified and confirmed on site.

3.3.3 Ammonia dual-fuel main engine

3.3.3.1 The conversion of the main engine shall be authorized by the patent owner, and the conversion plan shall be submitted to ISC for review and approval.

3.3.3.2 The conversion and testing of the main diesel engine shall comply with the requirements of Chapter 9, Part III of the *Rules for Classification of Sea-Going Steel Ships* and the guidelines *Diesel Engines and Their Important Parts*.

3.3.3.3 The product certificate and nameplate shall be verified and the warning sign of the main engine shall be checked. The location and content of the warning sign shall be inspected to confirm that warning sign meets the requirements of the specification or the requirements of the main engine manual.

3.3.3.4 The installation process of the main engine shall be approved by the main engine manufacturer and submitted to ISC for review and approval.

3.3.3.5 The conversion survey of the main engine shall be carried out in accordance with the enterprise standards of the manufacturer or the standards and regulations approved by ISC.

3.3.3.6 The production, installation and testing of the main engine ammonia fuel double-wall pipe shall be confirmed.

3.3.3.7 If the engine is shut down in an emergency in ammonia fuel mode, or suddenly stalls during operation in ammonia fuel mode, measures shall be taken to purge the exhaust pipe before the engine is restarted. The purge gas shall be properly treated (such as by an ammonia treatment system).

3.3.3.8 If the fuel may leak directly into the engine auxiliary system medium (such as lubricating oil and cooling water), appropriate monitoring and alarm installations shall be installed in the above auxiliary systems, and appropriate measures shall be taken behind the outlets of these media to collect fuel vapor to avoid diffusion. Fuel collected from auxiliary system media shall be stored in suitable collection tanks.

3.3.3.9 The ammonia concentration at the exhaust pipe outlet shall be monitored. If the ammonia concentration exceeds the allowable exposure limit, appropriate measures shall be taken (such as using an ammonia treatment system).

3.3.3.10 The monitoring, alarm and control systems of the main engine shall be tested for functions. The alarm test items shall meet the relevant requirements in Chapter 9, Part 3 and Appendix 2 and Appendix 11 to Chapter 9 of the *Rules for Classification of Sea-Going Steel Ships*. For automated ships, they shall also meet the relevant requirements in Chapter 3, Part 4 of the *Rules for Classification of Sea-Going Steel Ships*.

3.3.3.11 Navigation test of ammonia-powered ships: The engine shall be equipped with an automatic fuel mode switching system. When the fuel mode is switched (from fuel oil mode to ammonia fuel mode or from ammonia fuel mode to fuel mode), power or speed fluctuation shall be minimized, and the reliability of the fuel mode switching shall be proved through tests. If the engine runs unstably in ammonia mode, it shall automatically switch to fuel oil mode. In any case, it shall be possible to cut off the fuel supply manually.

3.3.3.12 Minimum stable speed test: The minimum stable speed test shall be carried out according to the minimum stable speed and fuel oil substitution rate provided by the main engine manufacturer. The test duration shall be at least 10 minutes to determine whether the engine can run stably. At the same time, the following parameters shall be recorded: speed, power, ammonia fuel inlet temperature and pressure, maximum explosion pressure, average indicated pressure per cylinder, suction temperature and pressure, exhaust gas temperature per cylinder, exhaust temperature before turbocharger, fuel oil substitution rate, turbocharger speed and other parameters that need to be recorded.

3.3.3.13 Endurance test: For ammonia dual-fuel engines, all load tests shall be carried out in different operating modes (such as ammonia fuel mode and fuel mode). The first retrofitting of the corresponding model ammonia dual-fuel engine, when the load test is carried out in ammonia mode, it shall run at rated speed for at least 4 hours, Subsequent retrofitting can consider being operated for at least one hour,and at 1.032 times the rated speed for at least 0.5 hours. The test of other load points in the propulsion characteristics shall generally last for at least 0.5 hours or meet the requirements of the main engine manufacturer. The test load shall be each percentage of the maximum output power in ammonia mode. The parameters to be recorded are as follows: rotational speed, power, intake ammonia fuel temperature and pressure, mean indicated pressure per cylinder, intake air temperature and pressure, exhaust gas temperature per cylinder, exhaust gas temperature before the turbocharger, fuel substitution rate, and turbocharger rotational speed. During load testing, switching tests between diesel and dual-fuel modes shall be conducted. The maximum rotational speed, minimum rotational speed, speed fluctuation rate, and mode switching stabilization time under the corresponding load shall be recorded. All parameters shall meet the relevant requirements.

3.3.3.14 Voyage test of engine room automation ship: For ammonia dual-fuel engines, all engine room automation tests shall be carried out in various operating modes (such as ammonia fuel mode and fuel mode). For main propulsion installation program control, remote control and automated ships or ships with unmanned engine rooms, control tests of the main engine within all operating conditions shall be carried out on the bridge (including the central control room if provided).

3.3.3.15 Ship maneuverability related tests: After the main engine conversion, ship maneuverability tests shall be carried out in diesel modes during the trial voyage phase to ensure that relevant requirements are met.

3.3.3.16 Disassembly survey of the main engine after sea trial: After the sea trial, hot crank difference measurement shall be carried out, covering piston, connecting rod bearing, main bearing, cylinder liner, cylinder head, intake and exhaust valves, cam transmission gear or chain, ammonia injection valve, pilot fuel injection valve/spark plug, and thrust block.

3.3.3.17 NO_X emission test: For the main engine that has not been certified in the early stage, it is necessary to carry out the NO_X test on a real ship after the conversion of the main engine to

ensure that the NO_X emission meets the relevant requirements of Article 13 of Annex VI of MARPOL. The measurement and test program shall meet the requirements of NTC2008 and be approved by ISC. The test program shall cover the principle, accuracy and verification requirements of the test equipment, the selection and weight of operating points, the arrangement of measurement points, the work condition requirements and the measurement time. Measurement tests shall be witnessed by ISC.

3.3.4 Ammonia dual-fuel generator prime mover

3.3.4.1 The product certificate and nameplate of the generator prime mover shall be checked, including the information in the notes.

3.3.4.2 The installation process of diesel generator sets shall have been reviewed and approved by the attending surveyor.

3.3.4.3 The welding condition of the diesel generator set base shall be checked to ensure the welding quality.

3.3.4.4 The gaskets, foot bolts and tight-fitting bolts shall be checked.

3.3.4.5 The prime mover shall be able to use fuel oil or ammonia fuel as the main fuel, and be equipped with pilot fuel for ignition.

3.3.4.6 The production, installation and testing of the double-walled tube of the prime mover of the ammonia dual-fuel generator shall be confirmed.

3.3.4.7 The prime mover shall be equipped with an automatic fuel switching system. The prime mover shall not have large speed fluctuations during fuel switching, and the reliability of the automatic fuel switching system shall be verified through tests, and manual intervention shall be possible under any circumstances. If the engine runs unsteadily in ammonia fuel mode, it shall automatically switch to fuel oil mode. The prime mover ammonia fuel mode shall be able to quickly switch from ammonia fuel mode to fuel oil mode. When switching to either fuel supply, the prime mover shall be able to operate continuously on that fuel without affecting the power supply.

3.3.4.8 The prime mover shall be capable of continuous operation on fuel oil only when the ammonia fuel supply is cut off. After a switch from ammonia fuel mode to fuel oil mode due to a fault, the ammonia fuel mode shall not be used before troubleshooting. If the prime mover stops in an emergency in ammonia fuel mode, or suddenly stalls during operation in ammonia fuel mode, measures shall be taken to purge the exhaust pipe before the prime mover is restarted. The purge gas shall be properly treated (such as by an ammonia treatment system).

3.3.4.9 In the absence of pilot fuel injection or spark plug (if applicable), it shall be ensured that ammonia fuel is not supplied to the combustion chamber.

3.3.4.10 During normal parking and emergency parking, the ammonia fuel supply shall be cut off no later than the ignition source is cut off. When the ignition source is cut off, the ammonia fuel supply to each cylinder or the entire prime mover shall be cut off in advance or simultaneously.

3.3.4.11 After installation on board, the gas pipeline shall be tested for air tightness.

3.3.4.12 The prime mover shall be tested in various operating modes (such as ammonia fuel mode and fuel oil mode), including load tests, as follows:

(1) 100% power (rated electric power of generator): at least 60 min;

(2) 110% power (rated electric power of generator): at least 10 min.

3.3.4.13 The prime mover shall be tested for starting in various operating modes (such as

ammonia fuel mode and fuel oil mode) to verify that the capacity of the starting medium can meet the required number of starts.

3.3.4.14 The generator set shall be tested for steady-state voltage characteristics, dynamic voltage characteristics, load transfer and parallel operation in various operating modes (such as ammonia fuel mode and fuel oil mode).

3.3.4.15 The monitoring, alarm and control systems of the main engine shall be tested for functions. The alarm test items shall meet the relevant requirements in Chapter 9, Part 3 and Appendix 2 and Appendix 11 to Chapter 9 of the *Rules for Classification of Sea-Going Steel Ships*. For automated ships, they shall also meet the relevant requirements in Chapter 3, Part 3 of the *Rules for Classification of Sea-Going Steel Ships*.

3.3.4.16 For the main engine that has not been certified in the early stage, it is necessary to carry out the NO_X test on a real ship after the conversion of the main engine to ensure that the NO_X emission meets the relevant requirements of Article 13 of Annex VI of MARPOL. The measurement and test program shall meet the requirements of NTC2008.

3.3.5 Ammonia dual-fuel boiler

3.3.5.1 The product certificate and nameplate of the ammonia dual-fuel boiler shall be checked, including the information in the notes.

3.3.5.2 The boiler shall be reliably fixed on the ship, and the furnace feet and the upper part of the cylinder shall be so fixed as to adapt to the thermal expansion of the drum and header.
All pipelines and burner components through which ammonia fuel may flow shall be effectively sealed to prevent ammonia fuel leakage into the engine room.

3.3.5.3 The ammonia fuel pipeline shall be installed and arranged with necessary flexibility to adapt to the swing or vibration of the engine room and prevent fatigue damage at the connection between the pipeline and the boiler.

3.3.5.4 The outer surface of the ammonia fuel pipeline shall be properly wrapped with insulation materials.

3.3.5.5 The production, installation and testing of the ammonia fuel supply pipeline of the ammonia dual-fuel boiler shall be confirmed.

3.3.5.6 Hydraulic test and tightness test of liquid ammonia pipeline. Before the converted liquid ammonia fuel pipeline is installed, a hydraulic test shall be carried out in accordance with 6.6.2, Chapter 6, Section 6, Part 3 of the *Rules for Classification of Sea-Going Steel Ships.*

3.3.5.7 After the boiler accessories are installed, a hydraulic test at 1.25 times the design pressure shall be carried out, but the test pressure shall not exceed 90% of the yield force at the test temperature.

3.3.5.8 After all boilers are shipped, they shall be tested for operability and functions of safety protection installations.

3.3.5.9 The functional test of the ammonia fuel boiler can be carried out simultaneously in combination with the system it constitutes. In addition to meeting the applicable requirements for boilers in Chapter 6, Part 3 of the Rules for Classification of Sea-Going Steel Ships, it shall also meet the applicable requirements of boiler manufacturers on the use of ammonia fuel.

3.3.5.10 Safety valve commissioning test. The number of safety valves, the opening and closing pressures of the safety valves shall be checked to confirm that they meet the requirements of the specifications. For double safety valves, each valve shall be checked separately, and then

two shall be checked together. After the test, the safety valves that have passed the inspection shall be sealed with lead.

3.3.5.11 Function tests shall be carried out on the monitoring, alarm and control systems of boilers. The alarm test items shall meet the requirements of the approved drawings.

3.3.5.12 The pressure storage test of the ammonia dual-fuel boiler shall be carried out in various operating modes (such as ammonia fuel mode and fuel oil mode). When the main steam valve of the boiler is closed and the furnace is fully burned, the pressure rise of the boiler shall be checked to confirm that it meets the requirements of the specification.

3.3.5.13 Manual opening installation survey. The manual opening device installed in a safe place in the boiler room or on the bottom floor of the engine room shall be surveyed to confirm that the operating installation is effective and the manual opening handle is flexible.

3.3.5.14 External inspection under steam pressure shall be carried out to ensure that the water level gauge, relief valve, pressure gauge, safety valve, etc. are in good condition.

3.3.6 Ammonia fuel supply system

3.3.6.1 The product certificates of ammonia absorption tanks, buffer tanks, and ammonia/ethylene glycol heat exchangers shall be checked to ensure that the design temperature, design pressure, and materials of the above equipment meet the requirements of actual ships. After the pressure vessel accessories are installed, a hydraulic test at 1.25 times the design pressure shall be carried out, but the test pressure shall not exceed 90% of the yield force at the test temperature.

3.3.6.2 Safety valve survey

(1) The number and opening and closing pressures of the following safety valves shall be verified, such as ammonia fuel storage tanks, liquid ammonia pump outlets, ammonia buffer tanks, and ammonia recovery tanks;

(2) The outlet of the liquid ammonia pump outlet safety valve shall be led to the pump inlet;

(3) The emergency isolation safety installation of the ammonia fuel tank safety valve shall be verified to ensure that only one pressure relief valve is isolated and a physical interlock is set;

(4) The outlet of the pressure relief valve shall be consistent with the approved drawings. According to the requirements of the ammonia circular, except for the pressure relief system of the fuel storage tank, the outlets of other safety valves shall be led to the ammonia recovery system.

3.3.6.3 Fuel valve survey

(1) Use ammonia fuel valves with threaded connections only for secondary and instrument pipelines with an outer diameter of less than or equal to 25 mm;

(2) Check the product certificate of the valve to ensure that the design temperature and design pressure of the valve meet the actual ship use, and the material of the valve meets the relevant requirements of the guidelines;

(3) Confirm the function of valves that require fault closure, put the remote control valve in the open position, manually cut off the driving medium (air, electricity, hydraulic pressure) of the remote control valve, and confirm whether the valve is in the closed state;

(4) Set the proportional valve output opening on the control interface: 0%, 25%, 50%, 75%, 100%, record the actual position and feedback position of the valve. If the difference between the valve set opening and the actual position is not more than 5%, it is qualified;

(5) Switch valve test: Test the pneumatic switch valve through the manual knob of the solenoid valve and check whether the valve position feedback is correct. Test the remote control switch pneumatic switch valve, security system cut-off ESD valve, and check whether the valve

position feedback is correct. Adjust the opening of the control valve through the operation interface, check whether the opening signal is consistent with the feedback signal and the actual action on site; test the quick opening and closing actions, check and record the opening and closing speed. The mechanical action time of a single valve shall be ≤5s, and the comprehensive response of system linkage shall be ≤30s;

(6) Security system ESD valve test: Use an analog signal generator to simulate high-high, high, low and low-low alarm signals respectively to confirm whether the action of the ESD valve meets the requirements when a system failure occurs as described in Table 11.4.1 (1) and Table 11.4.1 (2) of Chapter 11 of the Ammonia Guidelines;

(7) Proportional valve test: Set the proportional valve output opening on the control interface: 0%, 25%, 50%, 75%, 100%.

(8) Record the actual position and feedback position of the valve; if the difference between the valve setting opening and the actual position is no more than 5%, it is qualified.

3.3.6.4 Liquid ammonia pump survey

(1) Start-stop and emergency stop tests of local and remote control positions of liquid ammonia pump;

(2) When the outlet pressure of the liquid ammonia pump is low and the operation fails, an audible and visual alarm shall be sent on the bridge, engine room control room and fuel preparation room. At the same time, the standby pump shall be able to automatically start working. If the standby pump still alarms, the main valve and main fuel valve of the ammonia fuel tank shall be closed to stop the supply of ammonia.

3.3.6.5 Valve bank unit survey

(1) Check the product certificate of the valve bank unit to ensure that the design temperature, design pressure, material and explosion-proof level of the valve bank unit meet the requirements of the actual ship;

(2) Check the welding and conduct NDT on the valve bank units and external pipelines;

(3) Check the operation of the two globe valves + breather valve specified in Table 11.4.1 (2) of Chapter 11 of the Ammonia Guidelines;

(4) Check the ventilation and inerting effectiveness of valve bank units.

3.3.6.6 Control, monitoring and safety systems of the gas supply system

(1) Check the product certificate of the gas supply system;

(2) Verify the two power supplies of the electronic control system;

(3) Verify the emergency stop of the electronic control system;

(4) The safety system of the gas supply system shall be independent of the fuel control system, including power supply, input and output signals;

(5) When multiple fuel supply systems are set up, each system should be equipped with its own independent fuel control and safety system;

(6) Confirm the alarm conditions when the alarms in Table 11.4.1 (1) and Table 11.4.1 (2) of Chapter 11 of the Ammonia Guidelines occur, as well as the opening and closing conditions of the remote control valves related to the entire gas supply system;

(7) The alarms in Table 11.4.1(1) of Chapter 11 of the Ammonia Guidelines shall be arranged on the bridge and bunkering control position; the alarms in Table 11.4.1(2) shall be arranged on the bridge or continuously manned central control room or ship safety center to verify the alarm conditions at the above positions.

3.3.6.7 Fixed gas detectors for ammonia concentration detection shall be installed in the following areas: Between the inner and outer layers of double-walled pipes; in the fuel preparation room; in the connection space of ammonia fuel tank; in a cofferdam adjacent to the ammonia fuel tank; other enclosed spaces containing fuel pipelines but without double-walled pipes; other machinery spaces containing fuel pipelines, equipment or fuel-using equipment; inside the airlock; in the expansion tank of ammonia heating circuit; enclosed/semi-enclosed bunkering stations; in the ventilation pipeline of the ammonia special sewage storage tank/cabinet; in the vent pipes of bilge water tanks containing potential sources of ammonia release; other enclosed/semi-enclosed spaces where fuel vapor accumulation may occur; ventilation inlets in accommodation and machinery spaces where fuel vapor ingress may exist after the required risk analysis. The specific requirements are as follows:

(1) The number of gas detectors in each space should be considered according to the size, layout, and ventilation conditions of the space. They are usually arranged at places where fuel vapor may accumulate and/or ventilation outlets;

(2) The location and number of ammonia concentration probes meet the requirements of the approved drawings;

(3) For probes installed at the vent, a gas dispersion analysis shall be conducted to determine their optimal installation location;

(4) Use 30ppm and 300ppm standard ammonia to conduct alarm utility tests on each probe respectively. When the ammonia concentration is greater than 30ppm, it can issue an audible and visual alarm on the bridge and continuously manned spaces; when the ammonia concentration is greater than 300ppm, it can issue an audible and visual alarm in the bridge and continuously manned spaces, and at the same time execute the safety systems in Tables 11.4.1 and 11.4.2 of Chapter 11 of the Ammonia Guidelines to trigger the ESD system action;

(5) The audible and visual alarms of the gas detection installation should be arranged on the bridge or the control room with continuous on-duty personnel;

(6) A manual liquid ammonia leak alarm transmitter should also be installed outside the engine room/fuel preparation room;

(7) Configure no less than 2 sets of portable gas detectors for crew members to check ammonia vapor in relevant spaces.

3.3.6.8 Survey of compressors and pumps

(1) Check the marine product certificate of the compressor and/or pump, and verify that its installation and layout meet the requirements of the approved drawings;

(2) Check the set pressure of the release valve of the compressor and/or pump;

(3) Perform utility tests on compressors and/or pumps;

(4) For compressors and/or pumps, installations capable of manual remote emergency cut-off should be arranged in accessible locations such as near the exits of the bridge, goods control room, ship's safety center, engine room centralized control room, fire control station, and fuel preparation room (where applicable). For compressors, local manual emergency cut-off should also be arranged;

(5) Audible and visual alarms for gas fuel compressors shall be provided on the bridge and engine room control room. The alarm items should at least include low intake pressure, low exhaust pressure, high exhaust pressure, and compressor operation failure;

(6) Temperature monitoring shall be implemented for the bulkhead shaft stuffing boxes and

bearings, with continuous audible and visual alarms activated on the bridge or the continuously manned centralized control station;

(7) Audible and visual alarms for fuel pumps shall be provided on the bridge, engine room control room, and fuel preparation room. Alarm items should include at least low fuel outlet pressure and fuel pump operation failure.

3.3.7 Ammonia fuel bunkering system

3.3.7.1 During the ship construction survey stage, it should be confirmed that the layout of the bunkering station and the bunkering pipe system meets the requirements of the approved drawings.

3.3.7.2 Before bunkering, the monitoring and control of the bunkering system and the utility test of the safety system shall be completed to confirm that they meet the requirements of the approved drawings.

3.3.7.3 Survey of remote control valve of bunkering pipe system

(1) The valve should be a fail-closed type. Keep the valve open, disconnect the control medium (air, electricity, oil, etc.) of the valve, and confirm that the valve is closed;

(2) Remote control function test of the remote control valve: switch the valve control to manual control and keep it in the open position. Press the ESD close button on the bridge, port and starboard bunkering stations, engine room entrances, fuel preparation rooms, ammonia control rooms, and ship-shore connection systems to confirm that the valve is in the closed state.

3.3.7.4 Survey of ship-shore connection system: In addition to the ESD emergency cut-off function, voice calls between the ship side and the shore side can also be carried out to ensure smooth sound without noise.

3.3.7.5 Survey of sampling valves: The sampling valve should be equipped with two globe valves, a blind flange, or a plugging installation.

3.3.7.6 Drying and inerting: Take samples from the sampling point to ensure that the oxygen content is less than 3% and the dew point is less than -40°C.

3.3.7.7 Survey of Fuel Heating System:

(1) Check the installation and layout of heaters and accessories, expansion tanks, and accessories according to the approved drawings;

(2) Conduct a utility test on the heater and check the temperature monitoring installation at the gas fuel outlet of the heater;

(3) Perform utility tests on the high and low level alarms of the expansion water tank, and check the working status of the liquid level gauge and thermometer;

(4) Confirm that the expansion tank vent pipe should be led to the ammonia treatment system (or an open-air safe location).

3.3.7.8 Survey of fuel preparation room:

(1) Confirm that the fuel preparation room should not be adjacent to accommodation spaces, control stations, service spaces, special spaces and roll-on/roll-off spaces according to the approved arrangement plans. If an independent fuel preparation room is set up, its boundary surface shall be airtight. When the material preparation room cannot be arranged on or accessed from the open deck, an airlock should be installed at the entrance;

(2) Confirm that the threshold height of the fuel preparation room entrance is consistent with the approved drawings;

(3) Confirm that the inlet of the fuel preparation room and its compressors, fuel pumps,

valves and other fuel leakage-prone parts are arranged accordingly;

(4) Water spray nozzles shall be arranged and a utility test of the water spray system shall be carried out. For manually controlled water spray systems, the control position should be located outside the fuel preparation room;

(5) According to the approved drawings, confirm the possible sources of liquid fuel leakage in the fuel preparation room. Drip trays shall be installed beneath detachable pipe connections, pumps, valves, and heat exchangers. The capacity of the drip trays shall comply with the requirements of the approved drawings;

(6) Confirm that the bilge water in the drip tray can be transported to the waste liquid storage tank outside the fuel preparation room, and a globe valve and non-return valve should be installed on the pipeline. The bilge water system should be independent of other bilge water systems on board;

(7) A performance test of the fixed fire detection and alarm system in the fuel preparation room shall be carried out. The alarm system shall not be equipped with smoke detectors only;

(8) Perform utility tests on the ventilation system in the fuel preparation room. Confirm that the fan is in normal working condition, and confirm that the flow meter or wind pressure sensor for measuring ventilation capacity is in normal condition. When ventilation fails, it can trigger the corresponding alarm on the bridge or the continuously manned control room or ship safety center, and close the main valve of the ammonia fuel tank at the same time;

(9) Perform utility tests on the fail-safe automatic fire damper in the ventilation trunk;

(10) The spherical area within a radius of 5m from the ventilation inlet of the fuel preparation room, as well as the open deck and fuel preparation room in the spherical area with a radius of 10m from the ventilation outlet are all toxic areas. Confirm that the openings of accommodation spaces, service spaces and control stations should not be located in this area;

(11) Perform utility tests on the ammonia gas detectors. If the fuel preparation room is a closed space, there should be an on-site display of ammonia concentration at its entrance. When the ammonia vapor concentration reaches 110 ppm and 220ppm, an audible and visual alarm should be issued. The safety system shall be activated when the ammonia vapor concentration reaches 220 ppm;

(12) The open deck and semi-enclosed space areas at the entrance of the fuel preparation room, the spherical area with a radius of 1.5m at the ventilation inlet of the fuel preparation room, and the spherical area with a radius of 3m at the ventilation outlet of the fuel preparation room are Class 1 hazardous areas. Confirm that the explosion-proof category and temperature group of electrical equipment should not be lower than II A/T1 respectively;

(13) Confirm that electrical equipment should be grounded as much as possible (grounding point inspection), and check flameproof enclosure integrity, and cable outer sheath damage;

(14) Confirm that the fuel preparation room is ventilated when the pump or compressor is working.

3.3.8 Ammonia fuel mitigation release system

3.3.8.1 Conduct utility tests on the thermometers, liquid level indicators and low and high liquid level alarms on the ammonia absorption tank and ammonia discharge cabinet.

3.3.8.2 Conduct a utility test on the ammonia catalytic installation, mainly including alarm point tests (for alarms related to inlet/outlet temperature, inlet/outlet pressure, inlet/outlet differential pressure, etc.). The alarm points shall comply with the requirements specified in the

requirements of Table 6.2.4 in Chapter 6 of the Shipboard Application Guidelines for Selective Catalytic Reduction (SCR) Systems.

3.3.8.3 Water spray system test items:

(1) Check the reliability of the low liquid level alarm function of the fresh water tank. The low water level setting value should meet the requirement that the system works for 30 minutes;

(2) Conduct a utility test on the water level control system of the fresh water tank, and the low water level alarm should automatically initiate water replenishment;

(3) Conduct action tests of ammonia detection alarm and automatic spray system in different areas;

(4) Manual release operation of automatic water spray system (the manual release button shall be located outside the protected space);

(5) Check the reliability of the system spray pump's automatic start-up;

(6) Check the effectiveness of the sound and light signals indicating the automatic water spray system;

(7) After the pump is started, check the water mist of each nozzle and whether the distribution in this place is uniform and effective;

(8) Select any nozzle for pressure detection, check the end pressure value, and calculate the water discharge rate;

(9) The system operation time is not less than 15 minutes. During the test, check whether there is abnormal heating, leakage, knocking and other phenomena in the moving parts of the pump and motor;

(10) The test spray system is triggered, and the main valve, main fuel valve and two globe valves of the ammonia fuel tank are closed;

(11) Verify the automatic, remote, and local start-up functions of the water spray system;

(12) The IP level of electrical equipment in the area covered by the water spray system shall be surveyed and shall not be lower than IP44.

3.3.9 Auxiliary system

3.3.9.1 Survey of inerting and environmental control:

(1) When the inert gas generating installation is installed in a separate compartment outside the engine room, the compartment shall be equipped with an independent negative pressure mechanical ventilation installation capable of providing at least 6 air changes per hour. A hypoxic alarm installation should be installed;

(2) The inert gas generating equipment shall be capable of producing inert gas with an oxygen content (by volume) not exceeding 5% at any time. The inert gas supply pipeline leading from the inert gas manufacturing equipment should be equipped with one oxygen content meter that can read continuously and one alarm installation set to alarm when the maximum oxygen content (by volume) is 5%;

(3) Nitrogen pipelines should only pass through well-ventilated spaces. Nitrogen pipelines in enclosed spaces should be fully welded, with only the minimum flange joints required to install valves, and as short as possible;

(4) Confirm that the pipelines, valves and accessories for degassing, purging and inerting of the ammonia fuel tank meet the requirements of the approved drawings;

(5) For systems utilizing nitrogen for inerting, determine that the amount of nitrogen is consistent with the approved calculation sheet;

(6) For nitrogen inerting, the pipelines, valves and accessories of the nitrogen system should be tested for tightness, and the system safety valve and pressure reducing valve are tested for effectiveness to confirm that they meet the requirements of the approved drawings;

(7) Inerting and environmental control shall be carried out in accordance with the operating procedures for degassing, purging and inerting of the ammonia fuel tank.

3.3.9.2 Survey of Fire Protection System:

(1) According to the approved Fire Protection Division Arrangement Plan, confirm that the fire protection division of the ammonia fuel tank, bunkering station, fuel preparation room, and other locations on board meets the relevant requirements in the annotated drawings and Guidelines;

(2) Fixed fire detection and alarm systems shall be installed in the ammonia fuel tank space and its ventilation trunk, as well as in the fuel preparation room. Smoke detectors should not be installed alone. The coverage of the detectors shall be confirmed, and a utility test shall be conducted on the probes to ensure that they can trigger the safety system and close the main valve of the ammonia fuel tank;

(3) Conduct a utility test on the water spraying fire extinguishing system to ensure that its coverage meets the requirements of the approved drawings and the supply pump displacement meets the requirements of the approved drawings;

(4) Verify the layout of the water spray system to ensure that it meets the requirements of the approved drawings;

(5) Confirm that the starting position of the water spray system supply pump and the operating position of the main control valve of the water spray system are easy to reach and located outside the protected area;

(6) The fixed chemical dry powder fire extinguishing system of the bunkering station is tested to ensure that it can cover possible leakage points. The best injection direction and angle are confirmed during the test, and the position is kept unchanged as much as possible in the future. The release rate and time meet the requirements;

(7) Confirm that the number and location of portable dry powder fire extinguishers meet the requirements of the approved drawings and Guidelines.

3.3.9.3 Survey of pressure relief system:

(1) Check the product certificate of the pressure relief valve to confirm that it is suitable for gas fuel on board;

(2) Check that the number and displacement of pressure relief valves meet the requirements of approved drawings;

(3) Check the installation position of the pressure relief valve. The pressure relief valve remains in the gas phase space when the ship is at a heel of 15° and a pitch of 0.015L (L is the length of the ship) under the filling limit (FL);

(4) Test the pressure relief valve of the ammonia fuel tank to confirm that it meets the requirements of the approved drawings. The safety valves on the ammonia fuel tank and related system pipelines shall be sealed by each manufacturer, and the manufacturer must issue a relevant adjustment report and ensure that it is true and effective;

(5) Confirm the safety measures that can urgently isolate a pressure relief valve in the ammonia fuel tank when it has failures. The relevant isolation procedures shall be included in the operation manual. The isolation procedures shall be designed to isolate only one pressure relief

valve. The appropriate physical interlocks shall be set for this purpose. The isolation of the pressure relief valve shall be carried out under the supervision of the captain. This action shall be recorded in the ship's voyage logbook and next to the pressure relief valve;

(6) Check the height of the air vent, which shall be no less than B/3 or 6 m above the weather deck, whichever is greater. It shall be 6 m higher than the working area and walkway. An appropriate protective net with a square mesh size no greater than 13 mm^2 shall be installed to prevent foreign matters from entering at the outlet end of the vent pipe;

(7) The pressure relief valve exhaust pipe outlet B (maximum width) or 25 m is a toxic area. Verify that the air inlet, outlet or opening leading to accommodation spaces, service spaces and control stations or other non-hazardous areas and the exhaust outlet of the machine are not within this area.

3.3.9.4 Survey of ventilation system:

(1) Confirm that the following premises are equipped with suction mechanical ventilation systems, and their power supply, ventilation capacity, number, power, and fan arrangement and installation shall comply with the requirements of the approved drawings and the ventilation chapter of the "Guidelines for Ships Using Ammonia Fuel". The specific locations are as follows: machinery spaces with gas-consuming installations in the ammonia fuel tank and its connection spaces, fuel preparation rooms, bunkering stations, double-walled pipe and gas valve unit spaces, air locks, and inert gas installation compartments;

(2) The fans and ventilation pipes used in hazardous areas shall be non-sparking structures that meet the requirements, and the explosion-proof fans shall hold marine product certificates;

(3) The casing of the fan used in dangerous places shall be grounded;

(4) When the ventilation system has failures, there must be corresponding audible and visual alarms on the bridge or continuously manned central control station or safety center.

(5) Conduct utility tests on fans and ventilation systems to confirm that they are working properly. Confirm that the flow meter or wind pressure sensor for measuring ventilation capacity is in normal condition, and pay attention to the fact that the ventilation system of the ammonia fuel tank connection space and the machinery space with equipment using gas shall continue to operate when the engine is in gas mode.

(6) Check that the installation and layout of ventilation ducts, pipes and accessories related to the gas fuel system meet the requirements of the approved drawings;

(7) Check that the closing appliances and other installations (if any) of any special enclosed spaces for crew protection in case of gas fuel leakage are in normal condition, and carry out utility tests;

(8) Confirm that any ventilation ducts used in hazardous spaces are separated from those used in non-hazardous spaces;

(9) Confirm that the location and layout of air inlets and outlets in hazardous spaces and gas-safe spaces meet the requirements of the approved drawings;

(10) Confirm that ventilation ducts in hazardous spaces shall not pass through accommodation spaces, service spaces or other similar spaces;

(11) Confirm that a protective net with a single square mesh side length of no more than 13mm shall be installed at the external opening of the ventilation pipe in dangerous places;

(12) Confirm that the ventilation system of double-walled pipes for gas supply pipelines and gas valve unit spaces in gas safety machinery spaces and machinery spaces shall be independent

of other ventilation systems;

(13) Confirm that the air duct at the joint of the ammonia fuel tank shall be equipped with an approved fail-safe automatic fire damper;

(14) If the engine air inlet is located outside the engine room, it should be at least 1.5 meters away from the boundary of any hazardous area.

3.3.9.5 Survey of bilge water and catch tray:

(1) The bilge water system shall be independent of the bilge water systems in other places, and confirm that its system layout meets the requirements of the approved drawings;

(2) Confirm that the layout of special sewage storage tanks/cabinets meets the requirements of approved drawings;

(3) Alarm the water level and temperature (if any) of the bilge water system. Perform a suction test on the bilge water system, which can be operated outside the fuel preparation room;

(4) Confirm the exhaust pipes of the bilge water tank for dissolving ammonia and the special sewage storage tank/cabinet, and conduct utility tests on the liquid level indicator and ammonia concentration probe;

(5) Confirm that the layout and volume of the catch tray meet the requirements of the annotated drawings.

3.3.9.6 Survey of personnel protection:

(1) There shall be enough and no less than 3 complete sets of safety equipment. Each set of equipment shall provide sufficient personnel protection to allow entry into the gas-filled space for work, and meet the following requirements:

① A self-contained positive pressure air respirator (including the entire mask) with a capacity of at least 1,200L of free air (without using stored oxygen);

② The airtight protective clothing, boots and gloves that meet the standards accepted by ISC;

③ Steel core rescue rope with belt;

④ Explosion-proof lamp.

(2) The facilities for providing sufficient compressed air are available, consisting of the following equipment:

① Each required respirator shall be equipped with at least 1 spare air bottle filled with air;

② One air compressor that is suitable for supplying high-pressure air of the required purity and has sufficient capacity and can operate continuously;

③ One inflation valve box that can inflate the spare air bottle of the required respirator.

(3) The ship shall provide each person on board with sufficient respiratory gas masks and eye protection equipment for emergency escape, and shall meet the following requirements:

① The filter-type respiratory gas masks shall not be used;

② The self-contained breathing apparatus shall have the ability to work continuously for at least 15min;

③ The emergency escape gas masks shall not be used for fire fighting or other purposes, and this requirement shall be marked.

(4) The ship shall be equipped with medical emergency equipment, including oxygen resuscitation equipment and suitable antidotes, in accordance with standards accepted by ISC;

(5) A stretcher shall be placed in an easily accessible place so that it can be used to lift injured persons from below deck;

(6) One or more appropriately marked decontamination sprinklers and eye wash equipment shall be installed in the engine room, fuel preparation room, near the bunkering station and at appropriate locations on the deck, and they shall be available at all times.

3.3.10 Issuance

3.2.10.1 After satisfactory completion of all conversion project surveys, ships with ISC classification that meet the requirements of the Guidelines and relevant specifications and/or apply for ISC classification may be reissued as required by the applicant, and the Ammonia Fuel class notation may be granted

3.2.10.2 For ships that have satisfactorily completed the conversion survey, a new cargo ship safety construction certificate should be issued to clarify its application of Part G of Chapter II-1 of SOLAS and the applicability of the alternative design. The approval document for the alternative design should be attached to the cargo ship safety construction certificate..

3.1.10.3 After the conversion of ammonia fuel for the main engine and generator prime mover, the product survey department shall issue the main engine and generator prime mover product certificate and EIAPP certificate based on the prototype machine type approval certificate and emission certificate, and provide corresponding remarks. The date of the certificate issuance shall be no later than the date of the ship's IAPP certificate issuance.

3.2.10.4 The "International Air Pollution Prevention Certificate" (IAPP Certificate) and related annexes shall be re-issued for ships that have satisfactorily completed the conversion survey in accordance with the "Technical Rules for Control of Nitrogen Oxide Emissions from Marine Diesel Engine".

3.2.10.5 Check the IHM after conversion for ships subject to the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 or/and Regulation (EU) No. 1257/2013, and update it if necessary.