GUIDANCE NOTES
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China Classification Society

Guidelines for Ships Using Alternative Fuels

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Beijing

Introduction

With the increasingly strict emission control standards of air pollutants from international and domestic vessels, various clean alternative fuels gradually run on ships. Under the circumstances, China Classification Society (CCS) formulated the 'Guidelines for Ships Using Alternative Fuels' (hereinafter referred to as Guidlines) to provide technical standards for methyl/ethyl alcohol fuel, fuel cells and biodiesel fuel application on ships.

Guidances include 3 parts. Part 1 is Methyl/ethyl Alcohol Fuel, Part 2 is Fuel Cells and Part 3 is Biodiesel Fuel. Other alternative fuels such as dimethyl ether will be considered to comply with Guidelines depending on actual circumstances in the future.

Content

PART 1 Guidelines for Ships Using Methyl/Ethyl Alcohol as Fuel

CONTENT

Chapter 1 General

1.1 Application

1.1.1 Part 1 Guidelines for ships using methyl/ethyl alcohol as fuel (hereinafter referred to as this Part) apply to steel ships of not less than 20m in length and using methyl/ethly alcohol as fuel, including methyl/ethly alcohol carriers unsing their own cargo as fuel, other than passenger ships and other dangerous chemical carriers.

1.1.2 In addition to this Part, methyl/ethyl alcohol fuelled ships are to comply with the applicable requirements of China Classification Society (hereinafter referred to as CCS) Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, Rules for the Classification of Steel Sea-going Ships or Rules for the Construction of Domestic Sea-going Ships or Rules for the Construction of Steel Inland Waterway Ships (hereinafter referred to as *CCS Relevant Rules*) correspondingly. Such ships are to comply with the applicable requirements (if any) of the flag State Administration.

1.1.3 The retrofit of existing ships' diesel engine(s) to methyl/ethyl alcohol fuel engine(s) is to be considered as major conversion, and to comply with the relevant requirements of the flag Administration or the requirements in this Part.

1.2 Definitions

1.2.1 Unless otherwise stated below, definitions are as defined in this part.

(1) *Methyl alcohol* means CH_3OH, either in liquid or vapour state.

(2) *Ethyl alcohol* means C2H5OH, either in liquid or vapour state.

(3) *Fuel* means methyl/ethyl alcohol.

(4) *Fuel tank* is the arrangement for the storage of fuel including tank connections and if necessary the support structures. Fuel tank may be of independent type or integral type.

(5) *Fuel storage hold space* is the space enclosed by the ship´s structure in which an independent fuel tank is situated. If the connections are located within the fuel storage hold space, it is also regarded as the fuel connections storage hold space.

(6) *Fuel connections storage hold space* is the space enclosed by all connections and valves of the fuel tank.

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

(8) *Fuel valve unit (FVU) space* is a space or a box containing valves for controlling and regulatingfuel supply before the Methyl/ethyl alcohol fuel engines.

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

(10) *Independent tank* means a fuel-containment envelope, which is not contiguous with, or part of, the hull structure. An independent tank is built and installed so as to eliminate whenever possible (or in any event to minimize) its stressing as a result of stressing or motion of the adjacent hull structure. An independent tank is not essential to the structural

completeness of the ship's hull.

(11) *Portable tank* means an independent tank being able to be:

–easily connected and disconnected from ship systems; and

–easily removed from ship and installed on board ship.

(12) *Dual fuel engines* means engines that employ methyl/ethyl alcohol as fuel (diesel ignition) or only use fuel oil.

(13) *Single fuel engines* means engines capable of operating on methyl/ethyl alcohol only, and not able to switch over to operation on any other type of fuel.

(14) *Methyl/ethyl alcohol fu*el e*ngines* means dual fuel engines or single fuel engines.

(15) *High pressure fuel piping systems* is the fuel piping systems in which the maximum working pressure is higher than 10MPa.

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

(17) *Fuel release sources* means the parts or locations which may release liquid fuel or fuel vapor, such as valves in fuel pipes, detachable pipe connections, pipe gaskets or pump seal devices.

1.3 Goal and functional requirements

1.3.1 The goal of this Part is to provide the standards for arrangement, construction and installation of the machineries, equipment and systems onboard ships using methyl/ethyl alcohol as fuel, so that the risk to the safety of the ship, crew and environment arising from using methyl/ethyl alcohol as fuel be reduced to a minimum.

1.3.2 Methyl/ethyl alcohol fuelled ships are to be designed and constructed in accordance with the following functional requirements:

(1)The safety, reliability and dependability of the systems shall be equivalent to that achieved with new and comparable conventional oil-fuelled main and auxiliary machinery.

(2)The probability and consequences of fuel-related hazards shall be limited to aminimum through arrangement and system design, such as ventilation, detection and safety actions. In the event of fuel leakage of or failure of the risk reducing measures, necessary safety actions shall be initiated.

(3)The design philosophy shall ensure that risk reducing measures and safety actions for the methyl/ethyl alcohol fuel installation do not lead to an unacceptable loss of power.

(4)Hazardous areas shall be restricted, as far as practicable, to minimize the potential risks that might affect the safety of the ship, persons on board and equipment.

(5)Equipment installed in hazardous areas shall be minimized to that required for operational purposes and shall be suitably and appropriately certified.

(6)Unintended accumulation of explosive, flammable or toxic vapourconcentrations shall be prevented.

(7)System components shall be protected against external damages.

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

(9)Safe and suitable, fuel supply, storage and bunkering arrangements shall be provided, capable of receiving and containing the fuel in the required state without leakage.

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

(11)Machinery, systems and components shall be designed, constructed, installed, operated,

maintained and protected to ensure safe and reliable operation.

(12)Fuel tanks and/or fuel storage hold spaces and machinery spaces containing sources that might release liquid or vapour into the space shall fully consider the riskes of fire or explosion caused by the leakage of fuel, in case an unacceptable loss of power or out of operation of equipment in other compartmens when it comes to danger.

(13)Suitable control, alarm, monitoring and shutdown systems shall be provided to ensure safe and reliable operation.

(14)Fixed fuel vapour and leakage detection suitable for all spaces and areas concerned shall be arranged.

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

(16)Appropriate protective equipment shall be installed onboard the ship to protect the crew engaged in fuel operation.

(17) Commissioning, trials and maintenance of fuel systems and methyl/ethyl alcohol fuel utilization machinery shall satisfy the goal in terms of safety, availability and reliability.

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

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

1.4 Additional notation

1.4.1 Ships applyingfor classification and satisfying the requirements in this Part will be given the following additional notation:

Methyl/Ethyl Alcohol Fuel

1.5 Equivalents or alternatives

1.5.1 Where this Part requires that a particular fitting, material, appliance, apparatus, item of equipment or type thereof should be fitted or carried in a ship, or that any particular provision should be made, or any procedure or arrangement should be complied with, CCS may allow any other fitting, material, appliance, apparatus, item of equipment or type thereof to be fitted or carried, or any other provision, procedure or arrangement to be made in that ship, if it is satisfied by trial thereof or otherwise that such fitting, material, appliance, apparatus, item of equipment or type thereof or that any particular provision, procedure or arrangement is at least as effective as that required by this Part.

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

1.6 Plans and documents

1.6.1 In addition to those specified in *CCS Relevant Rules*, the following plans and documents for ships using methyl/ethyl alcohol as fuel are to be submitted in triple for approval:

(1) Ship arrangement

① arrangement of machinery spaces and boiler rooms, accommodation spaces, service spaces and control stations;

② arrangement of fuel tanks and/or fuel storage hold spaces;

③ arrangement of fuel preparation rooms, if any;

④ arrangement of fuel bunkering systems, including the bunkering connections;

⑤ arrangement of accesses, vent pipes and other openings of fuel storage hold spaces, tank connection spaces;

⑥ arrangement of ventilation pipes, doors and openings within hazardous areas;

⑦ arrangement of entrances and air inlets leading of accommodation spaces, service spaces and control stations;

⑧ location and structure of air locks, if any;

⑨ penetrations in bulkheads, if any;

⑩ discription of coams, drip trays and other protective measures; and

⑪ hazardous areaclassification.

(2) Piping

① details or instruction of fuel piping, including pressure relief valves and vent pipes;

② technical documents for branches, return pipes, elbows, expansion joints, bellows and similar devices;

③ drawing and instruction of flanges, valves and other similar devices infuel piping systems;

④ technical documents for the material, welding, post-weld heat treatment and non-destructive testing of fuel pipes;

⑤ technical documents for pressure tests (strength and tightness tests) of fuel pipes;

⑥ functional test guidelines for all piping, including valves, fittings and equipment relating to fuel (liquid or vapour) operation;

⑦ technical documents for electrical ground system of pipes;

⑧ technical documents for the measures to remove the fuel from the fuel bunkering pipes before shutoff the bunkering connections;

⑨ cooling water systems or hot water systems relating to gas fuel systems, if any;

⑩ arrangement and instruction of gas freeing and inert gas purging systems;

⑪ arrangement of bilge and drainage systems for gas pump rooms, compressor rooms and gas tank connection spaces, if any; and

⑫ calculation for the discharge volume of pressure relief valves of pipes.

(3) ventilation systems

① arrangement and instruction of mechanical ventilation systems in hazardous areas, including the capacity and arrangement of fans and their motors, structures and material of the moving parts and covers of fans; and

② arrangement of double wall pipes (ducts).

(4) Fire-fighting appliances and systems

① arrangement and instruction (capacity calculation, etc.) of water spray systems, including pipes, valves, nozzles and fittings;

② arrangement of fire detection systems;

③ structural fire protection arrangement of fuel tanks and/or fuel storage hold spaces and their vent pipes, bunkering stations (if applicable); and

④ arrangement of dry powder fire-extinguishing arrangements.

(5) Electrical systems

① arrangement of all electrical equipment within thehazardous areas;

② single line diagram of intrinsically safe circuits; and

③ list of certified explosion-proof equipment.

(6) Control and monitoring systems

① arrangement and instruction of fuel vapour detection and alarm systems, including probes, alarm arrangements and alarm set points;

② arrangement and instruction of fuel tanks' monitoring and control systems, including sensors, alarm set points;

③ arrangement and instruction of fuel pumps' monitoring and control systems, if any; and

④ arrangement and instruction of fuel engines' monitoring and control systems.

(7) Test or procedure document

① dock and sea trials procedure relating to methyl/ethyl alcohol fuel, e.g. functional tests for all fuel piping and their valves, fittings and relevant equipment.

1.6.2 In addition to those specified in *CCS Relevant Rules*, the relevant risk analysis reports (if any) shall be submitted to CCS for reference.

1.6.3 In addition to those specified in *CCS Relevant Rules*, at least the following documents are to be kept on board:

(1) an operation manual of fuel tanks;

(2) an operation manual of fuel supply systems;

(3) an operation procedure and maintenance manual of methyl/ethyel fuel engines.

1.7 Surveys of products

1.7.1 All surveys of products are to comply with the requirements of *CCS Relevant Rules.*

1.7.2 Important products related to methyl/ethyl alcohol fuel supply system, such as independent fuel tanks, methyl/ethyl alcohol fuel engines, heat exchanger (if any), fuel pumps, etc. shall hold CCS marine product certificates.

1.7.3 Independent fuel tanks shall meet the following requirements:

(1) The following drawings shall be submitted in triplicate to CCS for approval:

①detailed drawings of fuel tanks, including interal structure, heat insulation (if any), piping, valves and connections, etc.

②detailed drawings of fuel tanks supporting;

③Material introduction for fuel tanks and connecting pipes;

④technical documents for design load and structural analysis of fuel tanks;

⑤complete pressure analysis of fuel tanks;

⑥calculation of discharge volume of pressure relif valve of fuel tanks;

⑦information on nondestructive testing, strength and tightness test of fuel tanks welding;

⑧information for welding process of fuel tanks.

(2) In addition to the requirements of CCS Relevant Rules, provisions required in chapter 2 shall be complied with.

1.7.4 Methyl/ethyl alcohol fuel engines shall comply with the following requirements:

(1) The following drawings shall be submitted in triplicate to CCS for approval:

①drawings of diesel engines required by *CCS Relevant Rules*.

②fuel injection valves and drive, sealing system

③explosive protection and introduction of crankcase

④explosive protection and calculation of exhaust system

⑤schematic diagram of engine control system related to methyl/ethyl alcohol fuel (including monitoring, alarm and safety protection devices)

⑥engine test procedures and test reports related to methyl/ethyl alcohol fuel.

⑦other drawings and materials as necessary required by CCS.

(2) Methyl/ethyl alcohol fuel engines risk analysis (eg FMEA) report shall be submitted to CCS for reference.

(3) In addition to the requirements of disel engines in CCS Relevant Rules, provisions required in chapter 7 shall be complied with.

1.8 Surveys of ships

1.8.1 General requirements

(1)All survey programmes, survey methodss, survey types, survey intervals, survey conditions, and preparation of surveys, survey and test requirements and the preservation of the plans, documents, certificates, records and reports are to comply with the requirements of *Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk*, *Rules for the Classification of Steel Sea-going Ships* or *Rules for the Classification of Domestic Sea-going Ships* for sea-going ships, and inland vessles shall comply with the requirements of *Rules for the Classification of inland Waterway Ships.*

1.8.2 Surveys during construction

(1)In addition to the applicable survey items required in *CCS Relevant Rules*, the following items are to be carried out:

① methyl/ethyl alcohol fuel engines shall be verified and tested to ensure that they arecorrectly installed;

② fuel tanksshall be verified and tested to ensure that they are correctly installed;

③ fuel bunkering systemsshall be verified and tested to ensure that they are correctly installed;

④ fuel supply systemsshall be verified and tested to ensure that they are correctly installed;

⑤ the ventilation systems in machinery spaces containing methyl/ethyl alcohol fuel engines, double wall pipes and fuel preparation rooms (if any)shall be verified and tested to ensure that they are correctly installed;

⑥ the remote closing equipment of methyl/ethyl alcohol fuel enginesshall be verified and tested to ensure that they are correctly installed;

⑦ check the location and quantity of fuel vapordetectors and test the detection and alarm systems;

⑧ for equipment for which safety in hazardous areas depends upon correct operation of protective devices(for example overload protection relays) and / or operation of an alarm (for example loss of pressurisation foran Ex(p) control panel) it shall be verified that the devices have correct settings and / or correct operation ofalarms.

⑨ for spaces protected by pressurisation it shall be examined and tested that purging can be fullyaccomplished. Purge time at minimum flow rate shall be documented. Required shutdowns and / or alarmsupon ventilation overpressure falling below prescribed values shall be tested.

⑩ for other spaces where area classification depends on mechanical ventilation it shall be tested that ventilationflow rate is sufficient, and that required ventilation failure alarm operates correctly.

⑪ intrinsically safe circuits shall be verified to ensure that the equipment and wiring are correctly installed.

⑫ fire detection and fire-extinguishing arrangementshall be verified and tested to ensure that they are correctly installed;

⑬ check the operation manual of fuel supply system.

1.8.3 Surveys after construction

(1) Annual surveys: in addition to the applicable survey items required in *CCS Relevant Rules*, the following items are to be carried out:

① For independent fuel tanks (if any)

a.verify the clarity, security and integrity of tank nameplates;

b.verify that the liquid level indicators of fuel tanks and high level alarm system and high level automatic shutdown system are under normal condition;

c. calibration of the MARVS;

d. verify that the indication of pressure and temperature (if any) and associated alarm device are under normal condition;

e. check if there any denudation, erosion or cut, depression, deformation, welding flaws, frosting, sweating, etc. on tank shells;

f. visual inspection of the weld cracks (if any)on tank connections; and

g. confirm the tank operation procedure is on board.

② Integrated fuel tanks test shall comply with the applicable requirements of Integrated liquid cargo holds annual surveys required in *CCS Relevant Rules*.

③ verify that the sealing devices for fuel storage hold spaces and fuel preparation rooms are under normal condition;

④ verify that doors, sidescuttles and windows of superstructures or deckhouses facing hazardous area are under satified condition;

⑤ examining that the means of closure and other equipment (if any) in any special enclosed space, which is used for protecting the crew in the case of the leakage of fuel, are under normal condition;

⑥ examining that the portable ventilation equipment fitted in the spaces, where people do notenter frequently, are under normal condition;

⑦ examining that the drip tray (if any) are under normal condition;

⑧ examining that the ventilation system and air lock (if any) of working spaces and the ventilation closing equipment of accommodation spaces are under normal condition;

⑨ examining that the manual emergency closing system and compressor automatic closing equipment are under normal condition;

⑩ examination of gas fuel vent piping, including the vent masts and protective screens.

⑪ verity the electrical equipment inhazardous areas are under satisfied condition, and check the the maintenance and repairing records;

⑫ verifyand test the fuel detection system to confirm that it is under normal condition;

⑬ examining the fire detection and fire-extinguishing equipment, and test to start one main fire pump;

⑭ verify the water spray system isunder normal condition;

⑮ checkthe safe operational manual of methyl/ethyl alcohol fuel engines.

(2)Intermediate surveys: in addition to the applicable survey items required in *CCS Relevant Rules* and abovementioned in 1.7.3(1), the following items are to be carried out:

① confirm the electrical ground between the pipes and gas tanks and the hull;

② confirm the spares of mechanical fans used in hazardous spaces are onboard;

③ visual examination of the indications of pressure, temperature and liquid level of fuel systems, and a comparative test is to be carried out by change the pressure, temperature and liquid level. A simulation test may be accepted for the sensors being inaccessible, including alarm and safety function tests;

④ electrical equipment: functional testing of ground protection (checking of earthing contact), integrity of flame-proof enclosure, damage of cable jackets, atmospheres-pressurized apparatuses and relevant alarm devices for the electrical equipment in hazardous areas as far as possible, testing of shut off the power supply for non-certificated explosion-proof electrical equipment in the spaces protected by air locks, and measurement of insulation resistance.

(3)Special surveys: in addition to the applicable survey items required in *CCS Relevant Rules* and above mentioned in 1.7.3(2), the following items are to be carried out:

① For independent fuel tanks

a. a gas tightness test is to be carried out to fuel tanks and their pipes (inlcluding fuel piples, air piples, etc.), and the test medium is to be dry and clean nitrogen or air. Before the test, air is not to be used as the test medium unless the gas composition in the tank is examined to be qualified;

b. a hydraulic test is to be carried out to fuel tanks and their pipes (inlcluding fuel piples, air piples, etc.);

c. all valves and cocks connecting directly to fuel tanks are to be opened up for examination, and internal inspection is to be carried out for the connective pipes, if practicable;

d. pressure/vacuum relief valves are to be opened up for examination and if applicable, the set value of the relief valve is to be checked.

② Integrated fuel tanks test shall comply with the applicable requirements of Integrated liquid cargo holds annual surveys required in *CCS Relevant Rules*

③ verify the set value of pressure relief valves (if any) onfuel pipes;

④ the valves may be detached and adjusted by air or other applicable gas for the purpose of checking and adjusting;

⑤ overhauling and function testing of heat exchangers (if any);

⑥ examination of inert gas generators to confirm the generated inert gas comply with the technical specification and the normal running of the equipment;

⑦ general inspection of distribution valves and pipes of inert gas, external inspection of pressure vessels storing inert gas, and special inspection of securing equipment to confirm that the pressure relief valves are in a good working condition;

⑧ removing the shaft seal on the gastight bulkhead and examining the sealing device;

⑨ examination of the pipes covered with insulation material by removing sufficient insulation material to confirm the situation of the pipes. Special inspections is to be

paid to the sealing condition; and

⑩ for methyl/ethyl alcohol fuel engines, in addition to the applicable survey items specified in *CCS relevant Rules*, the following items are to be carried out: general inspection of the ducts or cover enclosure of fuel pipes, inspection of discharge or inerting equipment for pipes, and operating testing of methyl/ethyl alcohol fuel engines at work.

Chapter 2 Ship arrangement and system design

2.1 General requirements

2.1.1 Fuel tanks shall be located in such a way that the probability for the tanks to be damaged following a collision or grounding is reduced to a minimum.

2.1.2 Fuel tanks, fuel piping and other fuel release sources shall be so located and arranged that released fuel gas is led to safe locations in the open air.

2.1.3 The access or other openings to spaces containing fuel sources of release shall be so arranged that flammable, asphyxiating or toxic gas cannot escape to spaces that are not designed for the presence of such gases.

2.1.4 The probability of a gas fire or explosion in a machinery space due to fuel release shall be minimized.

2.1.5 Fuel piping shall be protected against mechanical damage.

2.1.6 The propulsion and fuel supply system shall be so designed that safety actions after any fuel leakage do not lead to an unacceptable loss of power.

2.1.7 The fuel tanks shall not be located in accommodation and machinery spaces.

2.1.8 Spaces forward of the collision bulkhead (forepeak)and/or, aft of the aftermost bulkhead (aft peak) shall not bearranged as fuel storage tanks and cofferdams.

2.1.9 Fuel tanks on open decks shall be protected against mechanical damage.

2.1.10 Fuel tanks on open decks shall be surrounded by coamings.

2.2 Materials

2.2.1 For the materials of the fuel tank(s) and fuel piping, consideration shall be given to the corrosive and swelling of fuel. The material is to have a design temperature corresponding to the temperature of the fuel. In addition to the requirements specified in this Part, the materials are to comply with the applicable requirements of CCS *Rules for Materials and Welding andRules for Construction and Equipmentof Ships Carrying Dangerous Chemicalsin Bulk.*

2.2.2 Metal materials for fuel tanks and piping are included but not limited to the following materials:

(1) austenitic stainless steel;

(2) duplex stainless steel;

(3) clad steel plate, etc.

2.2.3 Non-metalic materials for fuel tanks and piping are included but not limited to the following materials:

(1)viton

(2)neoprene

(3)ethylene propylene rubber, etc.

2.3 Pipe design

2.3.1 General requirements

(1)The fuel piping is to be color marked uniformly according to the standards accepted by CCS.

(2)Where independent tanks or piping are separated from the ship's structure by thermal isolation, provision shall be made for electrically bonding to the ship's structure both the piping and the tanks. All pipe joints and fittings are to be electrically earthed. Electrical resistance between piping and the hull shall be maximum 1×10^6 Ohm.

(3)Piping other than fuel supply piping and cabling may be arranged in the double wall piping or duct provided that they do not create a source of ignition or compromise the integrity of the double pipe or duct. The double wall piping or duct shall only contain piping or cabling necessary for operational purposes.

(4)Filling piping of fuel tanks shall be arranged to minimize the possibility for static electricity, e.g by reducing the free fall into the fuel tank to a minimum.

(5)Fuel piping design shall prevent the production of gas resistance.

2.3.2 The wall thickness of pipes

(1)The wall thickness of pipes shall not be less than:

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

Where, t_0 ---theoretical thickness, in mm, $t_0 = \frac{P \cdot D}{2.0 \cdot K \cdot e + P}$;

Where, *P*---design pressure, in MPa, See 2.3.3;

D---outside diameter of pipes, in mm;

K--- allowable stress N/mm^2. See 2.3.4

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

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

$$b = \frac{Dt_0}{2.5r}$$

where, r---mean radius of the bend, in mm.

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

a---negative manufacturing tolerance for thickness (%).

2.3.3 Design pressure

(1)The design pressure shall not be less than 1 MPa, except for open-ended pipes where it shall not be less than 0.5 MPa.The design pressure P in the formula for t_0 in 2.3.1(1) is the maximum gauge pressure to which the system may be subjected in service, taking into account

the highest set pressure on any relief valve on the system.

2.3.4 Allowable stress

(1)For pipes the allowable stress K to be considered in the formula for t_0 in 2.3.2 is the lower of the following values:

$$\frac{R_m}{A} \text{ or } \frac{R_e}{\mathrm{B}}$$

Where, R_m--- specified minimum tensile strength at ambient temperature (N/mm2).

Re ---specified minimum yield stress at ambient temperature (N/mm2). If stress-strain curve does not show a defined yield stress, the 0.2% proof stress applies.

A and B have values of at least A = 2.7 and B = 1.8

(2)Where necessary for mechanical strength to prevent damage, collapse, excessive sag or buckling of pipes due to superimposed loads, the wall thickness shall be increased over that required by 2.3.2 or, if this is impracticable or would cause excessive local stresses, these loads shall be reduced, protected against or eliminated by other design methods. Such superimposed loads may be due to: supports, ship deflections, liquid pressure surge during transfer operations, the weight of suspended valves, reaction to loading arm connections, or otherwise.

(3)For pipes made of materials other than steel, the allowable stress shall be considered by CCS.

(4)High pressure fuel piping systems shall have sufficient constructive strength. This shall be confirmed by carrying out stress analysis and taking into account:

① stresses due to the weight of the piping system;

② acceleration loads when significant; and

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

2.3.5 Flexibility of piping

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

2.3.6 Piping fabrication and joining details

(1)Piping for fuel shall be joined by welding except:

① for approved connections to shutoff valve and expansion joints, if fitted; and

② for other exceptional cases specifically approved by CCS.

(2)The following direct connections of pipe length without flanges may be considered:

① Butt-welded joints with complete penetrations at the root;

② Slip-on welded joints with sleeves and related welding having dimensions in accordance with recognized standards shall only be used in pipes having an external diameter of 50 mm or less. The possibility for corrosion to be considered;

③ Screwed connections, in accordance with recognized standards, shall only be used for a piping with an external diameter of 25 mm or less.

(3)Flanges in flange connections shall be of the welded neck, slip-on or socket welded type. However, socket-welded-type flanges shall not be used in nominal sizes above 50 mm.

(4)Welding, post-weld heat treatment and non-destructive testing shall be performed in accordance with recognized standards.

(5)All valves and expansion joints used in high pressure fuel piping systems shall be approved according to a standard acceptable to CCS.

(6)Expansion of piping shall normally be allowed for by the provision of expansion loops or bends in the fuel piping system, however slip joints shall not be used.

(7)For methyl/ethyl alcohol carriers, if double-wall pipes are used for gas fuel supply piping outside of the cargo area, the inner pipe shall have full penetration butt-welded joints and shall be subjected to full radiographic inspection. Flange connections can be used for gas fuel supply piping in fuel connections storage hold spaces, fuel preparation room or other similar space.

(8)Other connections

Piping connections shall be joined in accordance with 2.3.6（2）,but for other exceptional cases,CCS may consider alternative arrangements.

2.4 Loction and separation of spaces

2.4.1 Integrated fuel tanks

(1)The horizontal distance between any part of fuel tanks and the hull plate shall not be less than 800mm. For inland navigation vessels, the area where fuel tanks are located shall have a double bottom, and its height shall not be less than 760mm in any case.

(2)The separation shall be provided around the integrated fuel tanks, unless the surface of fuel tanks is next to the bottom shell plating of hull or fuel preparation room.

2.4.2 Independent fuel tank

(1)Fuel tank can be located in enclosed space or on open deck.

(2)Fuel tank shall be fixed on hull structure. The support or fixing structure shall be designed by considering maximum static and dynamic tilt of ship and acceleration of ship motion.

(3)Any portion of the fuel tank shall not be located less than 800 mm from the ship's side. For inland vessels, the distance between any part of fuel tank and the bottom of ship shall not be less than 760mm.

2.4.3 Portable fuel tanks

(1)The design of portable fuel tank shall comply with 2.4.2. The tank support (container frame or truck chassis) shall be designed for the intended purpose.

(2)Consideration shall be given to the safety of portable fuel tank during connecting fuel piping system. The support or fixing structure of portable fuel tank shall be designed by considering maximum static and dynamic tilt of ship and acceleration of ship motion.

(3)Consideration shall be given to the strength and the effect of the portable fuel tanks on the ship's stability.

(4)Connections to the ship's fuel piping systems shall be made by means of approved flexible hoses or other suitable means designed to provide sufficient flexibility.

(5)Arrangements shall be provided to limit the quantity of fuel spilled in case of inadvertent disconnection or rupture of the non-permanent connections.

(6)The pressure relief system of portable tanks shall be connected to a fixed venting system.

(7)Control and monitoring systems for portable fuel tanks shall be integrated in the ship's control and monitoring system. Safety system for portable fuel tanks shall be integrated in the ship's safety system.

(8)Safe access to tank connections for the purpose of inspection and maintenance shall be ensured.

(9)After connection to the ship's fuel piping system,

① each portable tank shall be capable of being isolated at any time; and

② isolation of one tank shall not impair the availability of the remaining portable tanks.

2.4.4 Machinery space

(1)A single failure within the fuel system shall not lead to a release of fuel into the machinery space.

(2)All fuel piping within machinery space boundaries shall comply with 2.6.3.

2.4.5 Fuel preparation room

(1)Fuel preparation rooms, if such exist, shall be located outside the machinery spaces of category A or other rooms with high fire risks.

2.4.6 Bilge systems

(1)The bilge system in the area where fuel leakage may occur shall be independent of the bilge system of other hold spaces.

(2)One or more holding tanks for collecting drainage and any possible leakage of fuel from fuel pumps, valves or from double walled inner pipes, located in enclosed spaces shall be provided. The holding tanks shall meet the layout requirements of fuel tanks. Measures shall be provided for safely transferring contaminated liquids to onshore reception facilities.

(3)The bilge system serving the fuel preparation room shall be operable from outside the fuel preparation-room.

2.4.7 2.4.7 Drip trays and coamings

(1)Drip trays shall be fitted where leakage and spill may occur, in particular in way of single wall pipe connections.

(2)Each drip tray and continuous coamings shall have a sufficient capacity to ensure that the maximum amount of spill according to the risk assessment can be handled, the height of coamings of a drip tray shall not less than 100mm.

(3)Each drip tray shall be provided with one piping system to safely drain spills or transfer spills to a dedicated holding tank, at least one check valve shall be provided in the piping system.

(4)The dedicated holding tank as described in 2.4.7(3) is to be provided with both a level indicator and an alarm device which are to comply with the applicable requirements of 2.4 and 2.5 of this Part regarding fuel tanks.

(5)A drain valve shall be provided so as to the rain water (if any) will be discharged outside of ship’s side.

2.5 Fuel storage

2.5.1 General requirements

(1)The fuel tank arrangement shall be so designed that safety actions after any gas leakage do not lead to an unacceptable loss of power.

(2)Unless fuel tanks are located on the open deck, all fuel tank connections, accessories, flanges and valves shall be enclosed in the airtight and watertight fuel connection storage hold spaces.

(3)The design of portable fuel tanks shall be equivalent to fixed fuel tanks.

(4)Fuel tanks, inerting system and off gas system shall be designed to prevent the formation of flammable atmosphere within fuel tanks and surrounding cofferdams.

(5)For single fuel power system, fuel shall be stored in at least two fuel tanks. If one of fuel tanks is unavailable, other fuel tanks shall be able to provide enough fuel to make the ship sailing within the intended area. Fuel tanks shall be installed in separated fire protection structures.

2.5.2 Fuel tanks venting and gas-freeing system

(1)Fuel tank venting system shall be independent of the air pipes and venting systems of

accommodation, service and control spaces, or other non-hazardous area.

(2)A piping system shall be arranged to enable each fuel storage tank to be safely gas freed, and to be safely filled with fuel from a gas-free condition. The system shall be arranged to minimize the possibility of pockets of gas or air remaining after changing the atmosphere.

(3)The fuel tanks shall be designed with an internal structure such, that the possibilities for gas pockets after ventilation/gas-freeing are minimized. The ventilation pipes shall be positioned accordingly.

(4)The fuel tank shall have a minimum of two fixed pipes extended to open air for inert gas purging and gas freeing purposes. The pipes to be self-draining.

(5)Pressure vacuum relief valves shall be fitted to each fuel tank to limit the pressure or vacuum in the fuel tank. The tank venting system may consist of individual vents from each fuel tank or the vents from each individual fuel tank may be connected to a common header. Design and arrangement should prevent flame propagation into the fuel tank system. High velocity vent valve shall be fitted. The valve shall have an exit velocity of at least 30 m/s.

(6)Shut off valves shall not be arranged either upstream or downstream of the pressure/vacuum relieve valves. By-pass valves may be provided.

(7)Pressure/vacuum valves shall vent to a safe location on open deck and shall be of a type which allows the functioning of the valve to be easily checked.

(8)Vapour outlets and intake openings of pressure/vacuum relief valves shall be located at least 2.0 m above openweather deck, and shall be protected against the sea. Due attention shall be paid to blockage from icing in cold weather operation.

(9)The fuel tank controlled venting system shall be designed with redundancy for the relief of full flow overpressure and/or vacuum. Pressure sensors fitted in each fuel tank, and connected to an alarm system, may be accepted in lieu of the secondary redundancy requirement for pressure relief. The opening pressure of the vacuum relief valves should not to be lower than 0.007 MPa below atmospheric pressure.

(10)The fuel tank vent system shall be connected to the highest point of each tank and vent lines shall be self-draining under all normal operating conditions.

(11)The vent outlets of the fuel tank shall meet the following requirements:

① When high speed vent valves are not installed in the vent outlets

a. Fuel tank vent outlets shall be situated normally not less than 6 m above the deck and if located within 4 m from gangways, outlets are to be placed not less than 6 m above such gangways.

b. The vent outlets are to be arranged at a distance of at least 10 m from the nearest air intake or opening to accommodation and service spaces and ignition sources.

c. Ships with length not more than 40 m, the vent outlets shall be arranged not less than 3 m above the fuel tanks deck, and at least 5 m from the nearest air intake or opening to enclosed space with ignition sources and deck machinery and equipment with fire hazard.

d. Ships with length not more than 50 m, the vent outlets shall be arranged not less than 4 m above the fuel tanks deck, and at least 7 m from the nearest air intake or opening to enclosed space with ignition sources and deck machinery and equipment with fire hazard.

e. Ships with length not more than 60 m, the vent outlets shall be arranged not less than 5 m above the fuel tanks deck, and at least 9 m from the nearest air intake or opening to enclosed space with ignition sources and deck machinery and equipment with fire hazard.

② When high speed vent valves are installed in the vent outlets

Vent valves are generally approved, and the vapor discharge/air mixture shall upward free jet at least 30m/s, as mentioned in the above①, the vent outlets can be arranged not less than 3 m above the deck or gangways.

(12)Vapour outlets from fuel tanks shall be provided with devices to prevent the passage of flame into the tank. Due attention shall be paid in the design and position of the P/V valves with respect to blocking and due to ice during adverse weather conditions. Provision for inspection and cleaning shall be arranged.

(13)The arrangements for gas-freeing and ventilation of fuel tanks shall be such as to minimize the hazards due to the dispersal of flammable vapours to the atmosphere. The ventilation system for fuel tanks shall be exclusively for ventilating and gas-freeing purposes. Connection between fuel tank and fuel preparation room ventilation will not be accepted.

(14)Gas-freeing operations shall be carried out such that vapour is initially discharged in one of the following ways:

① through outlets at least 2 m above the deck level with a vertical efflux velocity of at least 30 m/s maintained during the gas-freeing operation; or

② through outlets at least 2m above the deck level with a vertical efflux velocity of at least 20 m/s which are protected by suitable devices to prevent the passage of flame.

2.5.3 Inerting and atmospheric control within the fuel storage system

(1) Inerting of the vapour space of the fuel tank under normal operation shall be provided.

(2)The system shall be designed to eliminate the possibility of a flammable mixture atmosphere existing in the fuel tank during any part of the atmosphere change operation, vapour freeing or inerting by utilizing an inerting medium.

(3)To prevent the return of flammable liquid and vapour to the inert gas system, the inert gas supply line shall be fitted with two shutoff valves in series with a venting valve in between (double block and bleed valves). In addition a closable non-return valve shall be installed between the double block and bleed arrangement and the fuel system. These valves shall be located inside hazardous spaces.

(4)Where the connections to the inert gas piping systems are non-permanent, two non return valves may substitute the valves required in 2.5.3(3).

(5)Each inerting area should be spaced apart. Inerting gas inlet pipe of each fuel tank shall be provided with Isolation device. The isolation device shall be located where the crew is easy to find.

2.6 Fuel supply

2.6.1 General requirments

(1)The fuel piping system shall be separate from all other piping systems. For methyl/ethyl alcohol carriers, the fuel piping system shall be separate from cargo piping system. The pipes shall be fitted with a shut-off valve at connections (if any) of fuel pipes and cargo pipes.

(2)The fuel piping system is to be self-draining to suitable fuel or collecting tanks.

(3)All fuel piping shall be arranged for gas-freeing and inerting. .

(4)Fuel pipes shall not be located less than 800 mm from the ship's side.

(5)For single fuel installations, the fuel supply system shall be arranged with full redundancy and segregation, so that a leakage in one system does not lead to an unacceptable loss of power.

2.6.2 Valves arrangement

(1)There shall be a remotely operated shutdown valve on the fuel tank inlets and outlets ,the

remotely operated shutdown valve shall be as close to the tank as possible.

(2)Under normal operation, such as when fuel is supplied to consumers or during bunkering, valves shall be remotely operated if not easily accessible.

(3)The main fuel supply line to each methyl/ethyl alcohol fuel engine room shall be equipped with a manually-operated shutdown valve and an automatically-operated master fuel valve in series or a combined manually- and automatically-operated valve. The master fuel valve shall be situated in the part of the piping that is outside the machinery space. The master fuel valve shall automatically shut off the supplies when activated by the safety system required in table 6.4(2).

(4)The automatic master fuel valve shall be operable from safe locations on escape routes inside a machinery space, the engine control room(if applicable), outside the machinery space, and from the navigation bridge.

(5)The fuel supply line to each consumer shall be provided with a remote shut-off valve.

(6)There shall be one manually operated shut down valve in the fuel supply line to each consumer to ensure safe isolation during maintenance.

(7)In the event of a failure, valves shall fail to a safe position.

(8)For methyl/ethyl alcohol carriers, the pipes shall be fitted with a shut-off valve at connections (if any) of fuel pipes outside cargo area and fuel pipes inside cargo area.

2.6.3 Fuel supply lines in machinery spaces

(1)All piping shall be double walled, the inner pipe containing fuel, the outer pipe shall be gastight and watertight. The annular space between inner and outer pipe shall have mechanical ventilation of under pressure type with a capacity of minimum 30 air changes per hour and shall be fitted with a means of providing liquid leak detection from the inner pipe. The annular space shall be connected to a drainage tank for collecting and detecting possible spilled fuel.

(2)Inerting of the annular space might be accepted as an alternative to ventilation. The inert gas pressure in the annular space shall be higher than the maximum pressure in the inner pipe. Appropriate means of detecting pressure shall be provided as well as alarm for low inert gas pressure.

(3)The outer pipe in the double walled fuel pipes shall be dimensioned for a design pressure not less than the maximum working pressure of the fuel pipes. Alternatively, the maximum accumulative pressure can be calculated or tested under inner pipe rupture and ventilation failure, but the relevant reports shall be submitted to CCS for approval.

2.6.4 Fuel supply lines outside machinery spaces

(1)Fuel piping shall not be led directly through accommodation spaces, service spaces, electrical equipment rooms or control stations.

(2)Fuel pipes led through ro-ro spaces, special category spaces and on open decks shall be protected against mechanical damage.

(3)All fuel pipes shall be double walled and shall comply with the requirements in 2.5.3 if they led through enclosed spaces other than the spaces as described in 2.6.4(2) . Double wall can be omitted for cofferdams, fuel preparation room or other fuel handling spaces.

(4)For methyl/ethyl alcohol carriers, fuel pipes in cargo area shall comply with the relevant requirements in CCS *Rules for Materials and Welding and Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk*instead of complying with 2.6.4(1) and 2.6.4(3) of this part.

2.6.5 Fuel preparation room

(1)The fuel preparation room shall be gastight and watertight.

(2)The fuel preparation room shall have mechanical ventilation of under pressure type and shall be fitted with vapour detector.

(3)Hydraulically powered pumps that are submerged in fuel tanks shall be arranged with double barriers preventing the hydraulic system serving the pumps from being directly exposed to fuel. The double barrier shall be arranged for detection and drainage of eventual fuel leakage.

(4)All pumps in the fuel system shall be protected against running dry (i.e. protected against operation in the absence of fuel or service fluid). All pumps which are capable of developing a pressure exceeding the design pressure of the system shall be provided with relief valves. Each relief valve shall be in closed circuit, i.e. arranged to discharge back to the piping upstream of the suction side of the pump and to effectively limit the pump discharge pressure to the design pressure of the system.

2.7 Bunkering

2.7.1 General requirments

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

2.7.2 Bunkering station

(1)The bunkering station shall be located on open deck so that sufficient natural ventilation is provided. Closed or semi-enclosed bunkering stations should be subject to risk assessment, and the assessment report shall be approved by CCS.

(2)Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations shall not face the bunkering connection. They should be located on the outside of superstructure or the deck, at least 4% of the ship length distance to the place where the bunkering connections are located, and shall not be less than 3m, but not more than 5m.The window and porthole on the side wall of superstructure and the deck towards the bunkering connections within the above distance shall be fixed (non-open).

(3)Closed or semi-enclosed bunkering stations shall be surrounded by gastight boundaries against enclosed spaces.

(4)Bunkering lines shall not pass through accommodation, control stations or service spaces. Bunkering lines passing through non-hazardous areas shall be double walled or located in gastight ducts.

(5)Arrangements shall be made for safe management of any spilled fuel spills. Coamings and/or spill drip trays shall be provided below the bunkering connections.

(6)The bunkering operation shall be monitored and controlled from a safe location. As a minimum the bunker tank level instrumentation and over fill alarms as well as automatic shutdown shall be readable from this location.

(7)Showers and eye wash stations for emergency usage are to be located in close proximity to areas where the possibility for accidental contact with fuel exists. The emergency showers and eye wash stations to be operable under all ambient conditions.

(8)During bunkering operation, all doors, windows on the corresponding superstructure or deck-house side and other openings and air inlets shall be kept closed.

2.7.3 Bunker hoses

(1)Bunker hoses carried on board are to be suitable for fuel and certified to a minimum

bursting pressure of five times the normal working pressure.

(2)Means shall be provided for draining any fuel from the bunkering hoses upon completion of operation

(3)Where fuel hoses are to be carried on board, arrangements shall be made for safe storage of the hoses. Hoses should be stored on the open deck or in a storage room with an independent mechanical extraction ventilation system, providing a minimum of 6 air changes per hour.

2.7.4 Bunkering manifold

(1)The bunkering manifold shall be designed to withstand the external loads during bunkering. The connections at the bunkering station shall be of dry-disconnect type equipped with additional safety dry break-away coupling/self-sealing quick release. The connections shall be standard type.

2.7.5 Bunkering system

(1)Means shall be provided for draining any fuel from the bunkering pipes upon completion of operation.

(2)Means shall be provided to gas free and inert bunker lines. When not engaged in bunkering, the bunkering pipes shall be free of gas, unless the consequences of not gas-freeing are evaluated and approved by CCS.

(3)The ship shall be fitted with a bunkering Emergency Shutdown (ESD) system operable from both the ship and the bunker supply facility. This shall be arranged to ensure rapid and safe shutdown of the bunker supply system without release of liquid or vapour.

(4)In the bunkering line, as close to the connection point as possible, there shall be a manually operated stop valve and a remotely operated shutdown valve arranged in series. Alternatively, a combined manually operated and remote shutdown valve may be provided. It shall be possible to operate this remotely operated valve from the bunkering control station.

(5)Where bunkering pipes are arranged with a cross-over suitable isolation arrangements shall be provided to ensure that fuel cannot be transferred inadvertently to the ship side not in use for bunkering.

2.7.6 loading limit

(1)Fuel tanks shall not be filled to more than a volume equivalent to 98%.

2.8 Inert gas syatem

2.8.1 Inert gas shall be available permanently on board in order to achieve at least one trip from port to port considering maximum consumption of fuel expected and maximum length of trip expected and to keep tanks inerted during two weeks in harbour with minimum port consumption.

2.8.2 The equipment shall be capable of producing inert gas with oxygen content at no time greater than 5% by volume. A continuous-reading oxygen content meter shall be fitted to the inert gas supply from the equipment and shall be fitted with an alarm set at a maximum of 5% oxygen content by volume. The system shall be designed to ensure that if the oxygen content exceeds 5% by volume, the inert gas shall be automatically vented to atmosphere.

2.8.3 The system shall be able to maintain an atmosphere with an oxygen content not exceeding 8% by volume in any part of any fuel tank.

2.8.4 An inert gas system shall have pressure controls and monitoring arrangements appropriate to the fuel tank system.

2.8.5 Where a nitrogen generator or nitrogen storage facilities are installed in a separate compartment outside of the engine-room, the separate compartment shall be fitted with an

independent mechanical extraction ventilation system, providing a minimum of 6 air changes per hour. If the oxygen content is below 19.5% in the separate compartment an alarm should be given.

2.8.6 Nitrogen pipes shall be arranged as far as possible on the open deck, or through well ventilated spaces. Nitrogen pipes in enclosed spaces shall:

(1)be fully welded;

(2)have only a minimum of flange connections as needed for fitting of valves and be fully welded otherwise; and

(3)be as short as possible.

2.8.7 Inert gas utilized for gas freeing of tanks may be provided externally to the ship.

2.9 Arrangement of entrances and other openings

2.9.1 Direct access shall not be permitted from a non-hazardous area to a hazardous area. Where such openings are necessary for operational reasons, an air lock which complies with the requirements of 2.10 shall be provided.

2.9.2 Each fuel preparation room shall have an independent access direct from open deck, where practicable. Where a separate access from open deck is not practicable, an air lock complying with chapter 2.10 shall be provided.

2.9.3 Fuel tanks and surrounding cofferdams shall have suitable access from the open deck, where practicable, for gas-freeing, cleaning, maintenance and inspection.

2.9.4 For fuel tanks or surrounding cofferdams without direct access from open deck, the entry space shall comply with the following:

(1)The entry space shall be fitted with an independent mechanical extraction ventilation system, providing a minimum of 6 air changes per hour. A low oxygen alarm shall be fitted.

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

(3)Direct entry from accommodation spaces, service spaces, control stations and machinery spaces is not permitted.

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

2.10 Air locks

2.10.1 An air lock is a space enclosed by gastight bulkheads with two gastight doors spaced at least 1.5 m and not more than 2.5 m apart. Unless subject to the requirements of the International Convention on Load Line or the relevant regulations from authorities, the door sill shall not be less than 300 mm in height. The doors shall be self-closing without any holding back arrangements.

2.10.2 Air locks shall be mechanically ventilated at an overpressure relative to the adjacent hazardous area or space.

2.10.3 Air locks shall have a simple geometrical form. They shall provide free and easy passage, and shall have a deck area not less than 1.5 m^2. Air locks shall not be used for other purposes, for instance as store rooms.

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

2.10.5 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 shall be given at a manned location to indicate both loss of pressure and opening of the airlock doors when pressure is lost.

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

2.10.7 Electrical equipment which is not of the certified type for propulsion, power generation, manoeuvring, anchoring and mooring equipment as well as the emergency fire pumps shall not be located in spaces to be protected by air-locks.

Chapter 3 Ventilation

3.1 General requirements

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

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

3.1.3 Design of ventilation fans serving spaces containing where vapours from fuels may be present shall fulfil the following：

(1) ventilation fans shall not produce a source of vapour ignition in either the ventilated space or the ventilation system associated with the space. Ventilation fans and fan ducts, in way of fans only, shall be of non-sparkling construction defined as:

① impellers or housings of non-metallic material, due regard being paid to the elimination of static electricity;

② impellers and housings of non-ferrous metals;

③ impellers and housings of austenitic stainless steel;

④ impellers of aluminium alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of non-ferrous materials is fitted in way of the impeller, due regard being paid to static electricity and corrosion between ring and housing.

(2)any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm tip design clearance。

(3)in no case shall the radial air gap between the impeller and the casing be less than 0.1 of the diameter of the impeller shaft in way of the bearing but not less than 2 mm. The gap need not be more than 13 mm.

(4)any combination of an aluminium or magnesium alloy fixed or rotating component and a ferrous fixed or rotating component, regardless of tip clearance, is considered a sparking hazard and shall not be used in these places.

3.1.4 Ventilation systems required to avoid any vapour accumulation shall consist of independent fans, each of sufficient capacity, unless otherwise specified in this Part. The ventilation system shall be of a mechanical exhaust type.

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

3.1.6 Air outlets from non-hazardous spaces shall be located outside hazardous areas.

3.1.7 Air outlets from hazardous enclosed spaces shall be located in an open area that, in the absence of the considered outlet, would be of the same or lesser hazard than the ventilated space.

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

complicated form.

3.1.9 Non-hazardous spaces with entry openings to a hazardous area shall be arranged with an air-lock and be maintained at overpressure relative to the external hazardous area. The overpressure ventilation shall be arranged according to the following:

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

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

② pressurize the space.

(2)operation of the overpressure ventilation shall be monitored and in the event of failure of the overpressure ventilation:

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

② ifoverpressure cannot be immediately restored, automatic or programmed, disconnection of electrical installations according to a recognized standard9[①] shall be required.

3.1.10 Non-hazardous spaces with entry openings to a hazardous enclosed space shall be arranged with an air-lock and the hazardous space shall be maintained at underpressure relative to the non-hazardous space. Operation of the extraction ventilation in the hazardous space shall be monitored and in the event of failure of the extraction ventilation:

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

(2)if underpressure cannot be immediately restored, automatic or programmed, disconnection of electrical installations according to a recognized standard[②]in the non-hazardous space shall be required.

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

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

3.1.13 Mobile ventilation plants are to be provided in hazardous spaces where no man enter always, such as empty places or similar places. Ventilation is to be provided before entrance into such places with the notice board of ventilation. The explosion-proof degree of a mobile ventilation plant is to be matched with the level of the gas hazardous area and hold a marine products certificate.

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

3.1.15 The shell of the fan is to be earthed.

3.1.16 A protective fence, of which the length of single square grid side is not more than 13 mm, is to be provided in way of the external opening of ventilation ducts of hazardous spaces.

3.1.17 Any loss of the required ventilating capacity is to be given an audible and visual alarm at a permanently manned location.

3.1.18 Suitable precaution measures shall be taken to ensure that, in case of a fan or a set of fans failure, no ventilation circulation will be formed between these vent ducts in which the failed fans locate and other vent ducts .

3.1.19 For the mechanical induced draught systems of hazardous spaces, inlets of each air

[①]IEC 60092-502:1999 Electrical Installations in Ships – Tankers – Special Features, table 5 (ch.8.4.5)
[②]IEC 60092-502:1999 Electrical Installations in Ships – Tankers – Special Features, table 5 (ch.8.4.5)

duct are to be carried out according to the area where combustible gas may be accumulated.

3.2 Fuel preparation rooms

3.2.1 General requirements

(1) Fuel preparation rooms shall be provided with an effective mechanical forced ventilation system of extraction type. The ventilation shall be of a capacity of at least 30 air changes per hour.

(2)The number and power of the ventilation fans shall 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.

(3)Ventilation systems for fuel preparation rooms and other fuel handling spaces shall be in operation when pumps or other fuel treatment equipment are working.

(4)Pump and other fuel treatment equipment are to be activated at least 10mins after the start of ventilation system.

3.3 Bunkering station

3.3.1 General requirements

(1)Bunkering stations that are not located on open deck shall be suitably ventilated to ensure that any vapour being released during bunkering operations will be removed outside. If the natural ventilation is not sufficient, the bunkering stations should be subject to special consideration with respect to requirements for mechanical ventilation. CCS may require special risk assessment.

3.4 Double wall pipes

3.4.1 General requirements

(1)Double wall pipes containing fuel piping shall be fitted with effective mechanical ventilation system of the extraction type, providing a ventilation capacity of at least 30 air changes per hour.

(2)The ventilation system for double wall piping shall be independent of all other ventilation systems.

(3)The ventilation inlet for the double wall piping shall always be located in a non-hazardous area, away from ignition sources. The inlet opening shall be fitted with a suitable wire mesh guard and protected from ingress of water.

(4)The number and power of the ventilation fans shall 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.

3.5 Fuelvalveunit spaces

3.5.1 General requirements

(1)Ventilation systems in fuel valve unit spaces are to meet the requirements of 3.4 of this CHAPTER.

3.6 Fuel connections storage hold space

3.6.1 General requirements

(1)Ventilation systems in fuel storage hold spaces are to meet the requirements of 3.2 of thisCHAPTER.

Chapter 4 Fire safety

4.1 General requirements

4.1.1 The fuel preparation room is to be regarded as a machinery space of category A for fire protection purposes.

4.2 Fire protection

4.2.1 Fuel preparation room

(1)The fire integrity of the fuel preparation room having boundaries towards accommodation, control station shall not be less than A-60.

(2) If the fuel preparation room is adjacent to a machinery space of category A or other high fire risk spaces, the class A-60 insulation is to be fitted on the side of the machinery space of category A and high fire risk spaces.

4.2.2 Fuel tank

(1) Any boundary of accommodation spaces, service spaces, control stations, escape routes and machinery spaces, facing fuel tankson open deck, shall be shielded by A-60 class divisions. The A-60 class divisions shall extend up to the underside of the deck of the navigation bridge, or height of bulkhead. In addition, fuel tanks on open deck shall comly with the stowage and segregation requirements of the International Maritime Dangerous Goods (IMDG) Code on class 3 package.

(2) The fuel tanks directly above the top of the machinery spaces of category A / essential machinery space or other rooms with high fire risks, shall be separated by means of a cofferdam with insulation of A-60 class.The separation shall be done by a cofferdam of at least 900 mm (for inland waterway ship, if the arrangement is difficult, after approbal by CCS, the distance can be less than 900mm, but not less than 500mm) with insulation of A-60 class, and the class A-60 insulation is to be fitted on the side of the machinery space of category A and high fire risk space

(3) The fuel tanks or fuel tanks space under open deck shall be separated from the machinery spaces of category A / essential machinery space or other rooms with high fire risks. The separation shall be done by a cofferdam of at least 900 mm (for independent fuel tanks, if the fuel tank shell is not less than 900mm from bulkhead, the fuel tank space can be regarded as a cofferdam), and the class A-60 insulation is to be fitted on the side of the machinery space of category A and high fire risk space. When determining the insulation of the fuel tanks or fuel tanks space under open deck from other spaces with lower fire risks, the fuel tanks or fuel tanks space shall be considered as a machinery space of category A.

4.2.3 Bunkering stations

(1) The bunkering stations shall be separated by A-60 class divisions towards machinery spaces of category A, accommodation, control stations and high fire risk spaces, except for spaces such as tanks, voids, auxiliary machinery spaces of little or no fire risk, sanitary and similar spaces where the insulation standard may be reduced to class A-0.

(2) For domestic navigation ships, if the bunkering stations are on open deck, and distance between the bunkering connector and the bulkhead of the space of space mentioned in 4.2.7, the insulation standard may be reduced to class A-0. While a bunkering

connector is locating in a hollow part of the superstructure or deckhouse, the bunkering connector is to be regarded as being on open deck provided that the hollow depth does not exceed 1m.

4.3 Fire extinction

4.3.1 Fire main

(1) Where the fuel tank is located on open deck that the fire main passes through, isolating valves are to be fitted in the fire main in order to isolate damaged sections of the main. The isolated section of fire main is not to deprive the fire line ahead of the isolated section from the supply of water.

(2) At least two power pumps are to be provided, and the capacity and pressure of each pump are to be sufficient to ensure the simultaneous use of two water jets with a throw of 12 m at least.

(3) The water spray system required in 4.3.2 of this Chapter may be part of the fire main system provided that capacity and pressure of the required fire pump capacity and pressure are sufficient for the operation of both the required numbers of hydrants and the water spray system simultaneously.

(4) All fire hose nozzles are to be dual-purpose (water/water spray type) with switches.

4.3.2 Water spray systems

(1) A water spray system shall be installed for cooling and fire prevention to cover exposed parts of fuel tank(s) located on open deck. The water spray system shall also provide coverage for boundaries of the superstructures, compressor rooms, pump-rooms, cargo control rooms, bunkering control stations, bunkering stations and any other normally occupied deck houses that face the storage tank on open decks unless the tank is located 10m or more from the boundaries.

(2) The system shall be designed to cover all areas as specified above with an application rate of 10 l/min/m^2 for the largest horizontal projected surfaces and 4 l/min/m^2 for vertical surfaces.

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

(4) The capacity of the water spray pump shall be sufficient to deliver the required amount of water to the hydraulically most demanding area as specified above in the areas protected.

(5) For the water spray system, a connection to the ship's fire main through a stop valve shall be provided.

(6) Remote start of pumps supplying the water spray system and remote operation of any normally closed valves to the system shall be located in a readily accessible position which is not likely to be inaccessible in case of fire in the areas protected.

(7) The nozzles shall be of an approved full bore type and they shall be arranged to ensure an effective distribution of water throughout the space being protected.

4.3.3 Fixed fire-extinguishing systems

(1) Where fuel tanks are located on open deck, there shall be a fixed firefighting system of alcohol resistant foam type complying with Fire Safety System Code. The system shall be operable from a safe position.

(2) The foam firefighting shall cover the area below the fuel tank where a large spill of fuel can be expected to spread.

(3)Fixed fire-extinguishing systems that suitable for extinguishing methyl / ethyl alcohol fire shall be arranged for machinery space containing methyl/ethyl alcohol fuel engines and the fuel preparation room.

(4)An approved alcohol resistant foam system covering the tank top and bilge area under the floor plates shall be arranged formachinery space category A containingmethyl/ethyl alcohol fuel engines and the fuel preparation room.

(5) At least two portable dry chemical powder fire extinguisher with a capacity of not less than 5 kg is to be provided near fuel tanks on open deck.

(6) Thebunker station on open deck shall have a fixed fire-extinguishing system of alcohol resistant foam and 2 portable dry chemicalpowder fire extinguisher with a capacity of not less than 5 kg. The fire-extinguishing system shall cover all fire hazards.

(7) At least one portable dry chemical powder fire extinguisher with a capacity of not less than 5 kg is to be provided near the bunkering station in enclosed/semi-enclosed spaces.

(8) At least one portable powder fire extinguisher with a capacity of not less than 5 kg is to be provided near the methyl / ethyl alcohol fuelled engines, as well as the entrance to the machinery space containing the engine.

4.4 Fire detection and fire alarm systems

4.4.1 Fire detection

(1) A fixed fire detection and fire alarm system complying with the Fire Safety Systems Code (FSS Code) shall be provided for the fuel storage hold spaces and the ventilation trunk for fuel containment system below deck, and for all other rooms of the fuel gas system where fire cannot be excluded.

(2) Smoke detectors alone shall not be considered sufficient for rapid detection of a fire.

(3) Where the fire detection system does not include means of remotely identifying each detector individually, the detectors are to be arranged on separate loops.

4.4.2 Alarms and safety actions

(1) When fire is detected in the above spaces, safety actions are given in Table 6.4.2 of Chapter 6 are to be provided.

Chapter 5 Electrical system

5.1 General requirements

5.1.1 The probability of explosions shall be reduced to a minimum by:

(1)reducing the number of sources of ignition; and

(2)reducing the probability of formation of ignitable mixtures.

5.1.2 Hazardous areas on open deck and other spaces not addressed in this chapter shall be analysed and classified based on a recognized standard. The electrical equipment fitted within hazardous areas shall be according to the same standard.

5.1.3 Electrical equipment and wiring shall in general not be installed in hazardous areas unless essential for operational purposes and based on a recognized standard.

5.1.4 All hazardous areas shall be inaccessible to passengers and unauthorized crew at all times.

5.2 Area classification

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

5.2.2 In order to facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are divided into zones 0, 1 and 2. See 5.3 below.

5.2.3 Ventilation ducts shall have the same area classification as the ventilated space.

5.3 Hazardous area zones

5.3.1 Hazardous area zone 0

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

5.3.2 Hazardous area zone 1

This zone includes, but is not limited to:

(1)Cofferdams and other protective spaces surrounding the fuel tanks;

(2) Fuel preparation rooms;

(3)Areas on open deck, or semi-enclosed spaces on deck, within 3 m of any fuel tank outlet, gas or vapour outlet, bunker manifold valve, other fuel valve, fuel pipe flange, fuel preparation room ventilation outlets;

(4)Areas on open deck or semi-enclosed spaces on deck in the vicinity of the fuel tank P/V outlets, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet and within a hemisphere of 6 m radius below the outlet;

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

(6)Areas on the open deck within spillage coamings surrounding methyl/ethyl fuel bunker manifold valves and 3 m beyond these, up to a height of 2.4 m above the deck;

(7)Enclosed or semi-enclosed spaces in which pipes containing methyl/ethyl alcohol fuel are

located, e.g. ducts around methyl/ethyl alcohol fuel pipes, semi-enclosed bunkering stations;

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

(9)An area within 2.4 m of the outer surface of a fuel containment system where such surface is exposed to the weather.

5.3.3 Hazardous area zone 2

This zone includes, but is not limited to:

(1)Areas 4 m beyond the cylinder and 4 m beyond the sphere defined in5.3.2;

(2)Areas within 1.5 m surrounding other open or semi-enclosed spaces of zone 1 defined in 5.3.2(4); and

(3)Air locks.

5.4 Electrical installations

5.4.1 Electrical installations shall be in compliance with a standard at least equivalent to those acceptable to CCS.

5.4.2 Where electrical equipment is installed in hazardous areas , it shall be selected, installed and maintained in accordance with standards at least equivalent to those acceptable to CCS. The following equipment groups and temperature class can be used for potential ship fuels:

For Methyl alcohol: ⅡA,T2

Ethyl alcohol: ⅡB,T2

5.4.3 Equipment for hazardous areas shall be evaluated and certified or listed by an accredited testing authority or notified body recognized by CCS.

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

5.4.5 Bunkering hoses shall be electrically connected with the bunkering manifold.

5.4.6 Arrangements shall be made to alarm in low-liquid level and automatically shutdown the motors in the event of low-liquid level. The automatic shutdown may be accomplished by sensing low pump discharge pressure, low motor current, or low-liquid level. This shutdown shall give an audible and visual alarm on the navigation bridge, continuously manned central control station or onboard safety centre.

Chapter 6 Control,Monitoring and Safety Systems

6.1 General requirements

6.1.1 The control, monitoring and safety systems of the methyl and/or ethyl alcohol installations shall be so arranged that there is not an unacceptable loss of power in the event of a single failure.

6.1.2 A fuel safety system should be arranged to close down the fuel supply system automatically, upon failure in systems as described in table 6.4(1),6.4(2)and upon other fault conditions which may develop too fast for manual intervention.

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

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

6.1.5 Where two fuel supply systems are required to meet the regulations, each system shall be fitted with its own set of independent fuel control and safety systems.

6.1.6 Suitable instrumentation devices shall be fitted to allow a local and a remote reading of essential parameters to ensure a safe management of the whole methyl/ethyl alcohol fuel equipment including bunkering.

6.1.7 Liquid leakage detection shall be installed in the protective cofferdams surrounding the fuel tanks, in all double wall pipes, in fuel preparation rooms, and in other enclosed spaces containing single walled fuel piping or other fuel equipment.

6.1.8 For tanks not permanently installed in the vessel a monitoring systemequivalent to that providedfor permanent installed tanks isrequired.

6.2 Monitoring and Control

6.2.1 Fuel tanks

(1)Level indicators

① Each fuel tank shall be fitted with restricted level gauging device(s), arranged to ensure a level reading is always obtainable whenever the fuel tank is operational.

② Unless necessary maintenance can be carried out while the fuel tank is in service, two devices shall be installed.

(2)Overflow control

① Each fuel tank shall be fitted with a visual and audible high level alarm. This shall be able to be function tested from the outside of the tank.This shall be independent of the high-high level alarm.

② An additional sensor operating independently of the high liquid level alarm shall automatically actuate a shutoff valve to avoid excessive liquid pressure in the bunkering line and prevent the tank from becoming liquid full. The sensor shall be activated with a high, high level alarm.

③ When the fuel 95% liquid level and 98% liquid level of the fuel tank achieved, an audible and visible alarm is to be given at the bridge or continuously manned locations.

6.2.2 Bunkering

(1)Bunkering control is to be from a safe remote location. At this safe remote location:

① Tank pressure and tank level shall be capable of being monitored.

② The remote control valves required shall be capable of being operated from this location.

③ Overfill alarms and automatic shutdown shall also be indicated at this location.

(2)In case of ventilation loss in the annular spaces of the double walled bunkering lines, an audible and visual alarm shall be activated at the bunkering control location.

(3)If fuel leakage is detected in the annular spaces of the double walled bunkering lines an audible and visual alarm shall be activated at the bunkering control location and emergency shutdown shall automatically be activated.

6.2.3 Fuel pumps

(1)Fuel pumps shall be fitted with audible and visual alarms both on the navigation bridge 、in the engine control room and in the fuel preparation room. As a minimum the alarms shall include low fuel output pressure and fuel pump operation.

6.2.4 Engine

(1) In addition to the applicable requirements for mornitoring a diesel engine as provided in SOLAS chapter II-1, part C（for Convention ships）or CCS Relevant Rules (for domestic ships), indicators shall be fitted at the navigation bridge, the engine control room and the manoeuvring platform to indicate the:

① operation of the engine in case of methyl/ethyl alcohol fuel only engines; or

② operation and mode of operation of the engine in the case of dual fuel engines.

6.3 Gas detection,fire detection and ventilationmonitoring

6.3.1 Gas detection

(1)Permanently installed gas detectors shall be fitted in:

① in all ventilated annular spaces of the double walled fuel pipes;

② in fuel preparation rooms;

③ in fuel connection storage hold spaces

④ in cofferdams surrounding fuel tanks

⑤ other enclosed spaces containing fuel piping without ducting;;

⑥ other enclosed spaces containing fuel equipment (except for machine spaces including methyl/ethyl alcohol fuel engines);

⑦ air locks;

⑧ other enclosed or semi-enclosed spaces where fuel vapours may accumulate;

⑨ at ventilation inlets to accommodation and machinery spaces if required based on the risk assessment.

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

(3)The detection equipment shall be located where vapour may accumulate and/or in the ventilation outlets.

(4)Fuel vapour detection equipment shall be designed, installed and tested in accordance

with a recognized standard[3].

(5)An audible and visible alarm shall be activated at a gas fuel vapour concentration of 20% of the lower explosion limit (LEL). The safety system shall be activated at 40% of LEL at two detectors.

(6)Audible and visible alarms from the fuel vapour detection equipment shall be located on the navigation bridge or, in the continuously manned central control station.

(7)Fuel vapour detection required by this section shall be in operation at all time continuous without delay.

6.3.2 Fire detection

(1)Fire detection in machinery space containing methyl or ethyl alcohol engines and rooms containing independent tanks for methyl or ethyl alcohol and fuel preparation rooms shall give audible and visual alarms.

6.3.3 Ventilation monitoring

(2)Any loss of the required ventilating capacity shall give an audible and visual alarm on the navigation bridge or and in a continuously manned control station.

6.4 Safety systems

6.4.1 General requirements

(1)In the event of failure as described in table 6.4(1) and 6.4(2), connecting actions are to be taken in accordance with a recognized standard. The alarm as described in table 6.4(1) is to be located at the bridge and bunking control station, while the alarm in table6.4(2) is to be located at the bridge and continuously manned control station.

(2)Where the fuel supply is shut off due to activation of an automatic stop valve, the fuel supply is not to be opened until the reason for the disconnection is ascertained and the necessary precautions are taken. A readily visible warning notice giving instruction to this effect is to be placed at the operating station for the shut-off valves in the fuel supply pipes.

(3)If a fuel leak leading to a fuel supply shutdown occurs, the fuel supply shall not be operated until the leak has been found and dealt with. Instructions to this effect shall be placed in a prominent position of the machinery space and fuel supply control.

(4)Any operation implying danger of damage to the fuel pipes is not to be undertaken when the methyl/ethyl alcohol fuel engines are running. A readily visible warning notice giving instruction to this effect is to be placed in the machinery space containing methyl/ethyl alcohol fuel engines.

(5)Pumps and fuel supply shall be arranged for manual remote emergency stop from the following locations as applicable:

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

(6)For a direct propulsion system, in case of loss of ventilation or depressurization of inert gas, the single methyl/ethyl alcohol fuel system is to automatically close the master fuel and double block and bleed valves in the supply line provided the other fuel supply unit is ready to deliver; For

[3]IEC 60079-29-1 – Explosive atmospheres – Gas detectors – Performance requirements of detectors for flammable detectors

a electric propulsion system, when the second engine is connected to bus-bar, the first engine is to be shutdown automatically.

Fuel bunkering safety systems Tab.6.4(1)

Parameter	Alarm	Automatic shutdown of the manifold emergency shutdown valve	Comment
Liquid methyl/ethyl alcohol detectionin ducting aroundfuel bunkering lines	×	×	
Loss of ventilation in ducting around fuel bunkering lines	×	×	
Vapourdetection in ducting around fuel bunkering lines exceed 20% LEL	×		
Vapour detection on two detectors[1)] in ducting around fuel bunkering lines exceed 40% LEL	×	×	
High level in tank（95%）	×		
High-high level in tank（98%）	×	×	
Manual shutdownof ESD system		×	
Loss of emergency shutdown valve motive power	×		
[1)] Two independent vapour detectors located close to each other are required for redundancy reasons. If the vapour detector is of self-monitoring type the installation of a single vapour detector can be permitted.			

Fuel supply safety systems Tab. 6.4(2)

Parameter	Alarm	Automatic shut down of tank valve	Automatic shutdown of master fuel valve and DBB valves,Automatic open of vent valves open	Comment
Fuel tanks and dedicated holding tanks				
Low level in tank	×			
High level in dedicated holding tank	×			See 2.4.7.4
Fuel storage hold spaces and cofferdams surrounding fuel tanks				

Vapour detection in cofferdams surrounding fuel tanksexceed 20% LEL	×			
Vapour detection on two detectors[1] in cofferdams surrounding fuel tanks exceed 40% LEL	×	×		
Liquid leakage detection in cofferdams surrounding fuel tanks	×	×		
Vapour detection in fuel storage hold spaces exceed 20% LEL	×			
Vapour detection on two detectors[1] in fuel storage hold spaces exceed 40% LEL	×	×		
Liquid leakage detection in the fuel connections storage hold spaces	×	×[8]		
Ventilation failure in the fuel connections storage hold spaces	×	×[8]		
Fire detection in fuel storage hold spaces	×	×[8]		
Fuel preparation rooms				
Vapour detection exceed 20% LEL	×			
Vapour detection on two detectors[1] exceed 40% LEL	×	×[2]		
Loss of ventilation	×	×[2]		
Liquid leakage detection	×	×[2]		
Fire detection	×	×[2]		
Fuel supply systems between tank and engine room				
Vapour detection in ducting around fuel pipes exceed 20% LEL	×			
Vapour detection on two detectors[1] in ducting around fuel pipes exceed 40% LEL	×	×[2]		
Liquid leakage detection in ducting around fuel pipes	×	×[2]		
Loss of ventilation in ducting around fuel pipes[5]	×		×[2]	
Fuel valve unit spaces				
Vapour detection exceed 20% LEL	×			
Vapour detection on two detectors[1] exceed 40% LEL	×		×[3]	

Liquid leakage detection	×		×[3)]	
Loss of ventilation [5)]	×		×[3) 6)]	
Machinery spaces containing methyl/ethyl alcohol fuel engines				
Fire detection in machinery space	×			
Liquid leakage detection in ducting around fuel pipes	×		×[7)]	
Vapour detection in ducting around fuel pipes exceed 30% LEL	×			
Vapour detection on two detectors[1)] in ducting around fuel pipes exceed 60% LEL	×		×[3)]	
Other requirements				
Abnormal fuel pressure in fuel supply pipe	×			
Failure of valve control actuating medium	×		×[4)]	Time delayed as found necessary
Automatic shutdown of engine (engine failure)	×		×[4)]	
Manually activated emergency shutdown of engine	×		×	

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

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

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

4）Only double block and bleed valves to close.。

5）If the duct is protected by inert gas then loss of inert gas overpressure is to lead to the same actions as given in this tables（see 2.6.3(2)）

6）Only apply to dual fuel engines。

7）May utilize a dedicated valve in case of pipe rupture.

8）If ship will loss power due to the automatical colse of tank master valve, the valve shall not be automatically closed.

Chapter 7 Methyl/ethyl alcohol fuel engines

7.1 General requirements

7.1.1 This Chapter applies to methyl/ethyl alcohol fuel engines for propulsion and for driving generators or other important auxiliary equipment.

7.1.2 In addtion to the applicable requirements in *CCS Relevant Rules*, the design, manufacture, installation and test of methyl/ethyl alcohol fuel engines shall comply with the provisions of this Chapter and Chapter6, methyl/ethyl alcohol fuel engines shall be certified by CCS and hold marine product certificates.

7.1.3 Unless designed with the strength to withstand the worst case over pressure due to ignited fuel leaks, engine components or systems containing or likely to contain an ignitablemixture shall be fitted with suitable pressure relief systems. The explosion venting shall be led away from where personnel may normally be present.

7.1.4 Each cylinder of the engine shall have an independent fuel injection device, and fuel shall be injected directly into the cylinder or into intlet pipes.

7.1.5 All engine parts containing methyl/ethyl alcohol fuel shall be effectively sealed to prevent fuel from leaking into the engine room.

7.1.6 The exhaust system shall be designed to avoid the accumulation of fuel vapour and the exhaust pipes are not to be connected to the exhaust pipes of other engines or systems.

7.1.7 Risk analysis is to be conducted against all possible faults affecting operation safety of methyl/ethyl alcohol fuel engines. Required engine monitoring items are to be determined based on the risk analysis results. The risk analysis shall be documented to CCS.

7.2 Safety protection

7.2.1 Where air intakes are located inside the engine room, they are to be situated as far apart as practicable from the fuel supply pipe such that the risk of the leakage gas entering the intake is minimized. Air intakes located outside the engine room are to be led from a non-hazardous area at least 1.5m from the boundaries of any hazardous area.

7.2.2 The installation of explosion relief valve of methyl/ethyl alcohol fuel engines crankcase shall comply with the following requirements:

(1)In case of methyl/ethyl alcohol fuel directly inject to inlet pipes, the crankcase is to be provided with an explosion relief valve of sufficient relief area unless documentation demonstrating that the system has sufficient strength to contain the worst-case explosion. At least 1 explosion relief valve shall be installed in case of the diameter of cylinder less than 200mm. At least one explosion relief valve shall be installed near the ends of the crankcase in case of diameter of cylinder is 200 mm or above; however, another explosion relief valve shall be installed near the central crankcase in case of crank more than 8. Each crankcase shall be equipped with at least one explosion relief valve in case of the diameter of cylinder above 250 mm. An explosion relief valve shall also be installed for the crankcase separating space with a total volume exceeding 0.6m^3 (such as the gear room, chain box or other similar space)

(2)In case of methyl/ethyl alcohol fuel directly inject to the cylinder, the installation of explosion relief valve shall comply with the applicable requirements in *CCS Relevant Rules*.

7.2.3 For barrel type engines, vent devices shall be installed in the crankcase such that the gas leakage is led to a safe location outside the engine room through a flame arrester. Fuel through vent devices shall be stored in the appropriate collection tank. Maintenance a connection (or other means) is to be provided for crankcase inerting.

7.2.4 For barrel type engines, an oil mist detector or equivalent equipment in the crankcase shall be installed as follows:

(1)In case of methyl/ethyl alcohol fuel injected into inlet pipes, the crankcase shall be fitted with an oil mist detector or equivalent equipment (such as bearing temperature detector) to monitor the hot spots inside the crankcase.

(2)In case of methyl/ethyl alcohol fuel directly inject to the cylinder, the installment of oil mist detector or equivalent equipment shall comply with the applicable requirements in *CCS Relevant Rules*. The electrical equipment and instruments in the crankcase shall be approved safety typle.

7.2.5 The exhaust manifold of a methyl/ethyl alcohol fuel engine is to be equipped with an explosion relief valvesufficiently dimensioned to prevent serious damage in the event of explosion arose from the unburned gas mixture accumulated in the exhaust manifold, except documentation demonstrating that the system has sufficient strength to contain the worst-case explosion.

7.2.6 The exhaust pipes are to be purged by inert gas before restart in the event a methyl/ethyl alcohol fuel engine fails to start or a sudden fire during operation.

7.2.7 Where fuel can enter directly into the auxiliary system medium (lubricating oil, cooling water), suitable means shall be taken to collect the fuel vapour after the outlets of these medium such that the possible vapour leakage is led to a safe location outside the engine room or in appropriate collection tanks.

7.2.8 The combustion of methyl/ethyl alcohol fuel engines to be monitored in order to avoid poor combustion or misfire. In the event that a poor combustion or misfire is detected, the engine may continue operation and only shut down the fuel supplyto the concerned cylinder, but the torsion vibration effect under one cylinder misfire shall be sufficiently considered.

7.3 Fuctional requirements

7.3.1 Dual fuel engines

(1)In case of shutoff of the fuel supply, the engines shall be capable of continuous operation by oil fuel only without interruption.

(2)An automatic system shall be fitted to change over from methyl/ethyl alcohol mode to oil fuel-only mode and vice versa with minimum fluctuation of the engine power. Acceptable reliability shall be demonstrated through testing. In the case of unstable operation on engines when methyl/ethyl alcohol firing, the engine shall automatically change to oil fuel mode. There shall also be possibility for manual change over.

(3)Fuel vapor - air mixture in the cylinder shall be ignited by fuel injection in form of compression ignition. Pilot fuel shall be sufficient to ensure a reliable ignition of the mixture.

(4)In case of a normal stop or an emergency stop, the methyl/ethyl alcohol fuel shall be automatically shut off not later than the pilot oil fuel shutoff. In case of shutoff the pilot oil fuel supply, fuel supply for each cylinder or the engine shall be shut off in advance or at the same time.

7.3.2 Single fuel engines

(1)The starting sequence must be such that fuel gas is not admitted to the cylinders until ignition is activated and the engine has reached a minimum rotational speed.

(2)If ignition has not been detected by the engine monitoring system within expected time after activationof fuel admission or injection valve the fuel supply shall be automatically shut off and the unburnt combustible mixture in the exhaust systemshall be purged.

(3) Unburnt combustible mixture in the exhaust pipes is to be purged after a failed start. Restarting is not to be possible before the exhausts pipes has been completely purged.

(4)In case of an emergency stop or a normal stop the methyl/ethyl alcohol fuel shall be automatically shut off not later than the pilot oil fuel. It shall not be possible to shut off the pilot oil fuel without first or simultaneously closing the fuel supply to each cylinder or to the complete engine.