2020

Guidelines for Ships Using Low-flashpoint Fuels (LPG & Methyl/Ethyl Alcohol)

(2020.06)

GL-0013-E

KR

Introduction

With the implementation of IMO regulations limiting ship-source emissions and air pollutants from international shipping, the switch from fossil oil to environmental friendly fuels is accelerating. The IGF Code (The International Code of Safety for Ships using Gases or other Low-flashpoint Fuels) has focused on LNG first as an alternative fuel. However, provisions for Methyl/Ethyl alcohols, LPG and other low-flashpoint fuels are expected to follow in the near future.

Despite the increased demand for LPG as a marine fuel as a result of its potential environmental and economic benefits, actual applications have been delayed. This is because there are still some concerns about its safety for marine use and current lack of domestic/international regulations or track records.
In order to seize the initiative, KR has conducted a study into the safety of LPG fuel. The characteristics and risk factors of LNG and LPG were compared, the inherent risks of LPG fuel were identified by analysing the characteristics of onshore LPG facility's safety devices, ship structures and systems, and safety regulations were developed to reduce or eliminate these risks.
These guidelines provide additional and alternative requirements for ships using LPG as fuel based on the IGF Code in part 1 and for LPG carriers using their cargo, based on the IGC Code in Part 2 respectively.

Methyl/ethyl alcohol fuels referred to as methanol and ethanol are good alternative fuels for reducing both the emissions and carbon footprint of ship operations. Methanol and ethanol are both colourless, flammable liquids. Methyl alcohol can be produced from both fossil fuels and renewable sources, with the majority produced from natural gas. Ethyl alcohol is also an alcohol and is mainly produced from biomass. Methyl/ethyl alcohol is corrosive and methyl alcohol is toxic compared to conventional fossil fuels. Unlike LPG fuel, there are already ships using methyl/ethyl alcohol fuel for their ship operations in Europe. There is growing interest across the industry and potential for methyl and ethyl alcohol to be developed as alternative marine fuels.

These guidelines are prepared based on the IMO CCC 6's outcome that will come into effect shortly. Based on the fuel characteristics of methyl/ethyl alcohol, there will be specific requirements for the design, arrangement, control and monitoring of engines and related devices so they can be operated in an environmentally-friendly manner to minimize the risk to ships and humans in all operating conditions.
KR issues these guidelines as a result of this research. For ships under the Korean flag, these guidelines cannot be used for the purpose of classification. However, we hope that the guidelines will be used as a reference for the safety requirements and design of these vessels.

KR will continue to monitor maritime technological trends for low-flammable fuels other than LNG and further developments to the IGF Code/IGC Code. KR will also supplement these guidelines by seeking the opinions and feedback of relevant stakeholders.

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PART 1
Ships using LPG as Fuels(IGF Ships)

CHAPTER 1 GENERAL

Section 1 General

101. Application

1. This Part applies to ships using LPG as fuel in accordance with **Ch 1, 101. 1** of the Rules. However, This Part dose not apply to ships subject to Korean Ship Safety Act.
2. LPG fuels in this Part include LPG in gas phase and liquid phase.
3. The requirements of this Part are prescribed in addition to the requirements in the Rules. Except where specially required in this Part, the relevant requirements in the Rules are to be applied. (The terms 'LNG' and 'natural gas' are to be construed as 'LPG liquid' and 'PG' respectively.)

102. Definition

The definitions of terms not specified in the followings are to be as specified in the Rules.

1. **LPG** means liquefied petroleum gas. It is mainly composed of propane, butane or a mixture of propane (C_3H_8) and butane (C_4H_{10}) and contains small amounts of propylene and butylene. In this Part, not only liquid but also gaseous petroleum gas is referred to as LPG. However, when it is necessary to distinguish between the liquid state and the gas state, LPG in the liquid state is referred to as LPG liquid, and LPG in the gaseous state is referred to as LPG gas.
2. **Fuel** in this Part means LPG.
3. **Critical temperature** means the highest temperature at which a gas can be changed into a liquid.
4. **Autoignition temperature** means the lowest temperature at which it spontaneously ignites in normal atmosphere without an external source of ignition, such as a flame or spark.
5. **Gas dispersion analysis** means the analysis of the dispersion behavior of gases using appropriate modeling techniques such as computational fluid dynamics (CFD) analysis.
6. **Ventilation analysis** means the analysis of the ventilation efficiency of a space performed using appropriate modeling techniques such as computational fluid dynamics (CFD) analysis.
7. **Effectiveness of ventilation** mean the effectiveness on controlling the disperse and persistence of an explosive gas atmosphere due to gas leakage. This depends on the degree of dilution, the availability of ventilation and the design of the system. (See IEC 60079-10-1, 6.5.4)
8. **Degree of dilution** means a measure of the ability of ventilation or atmospheric conditions to dilute a release to a safe level. The degree of dilution is defined as high ventilation, medium ventilation, and low ventilation. (See IEC 60079-10-1, 6.5.4)
9. **Leakage** means leaking out of gas or liquid from the tank or equipment to the outside.
10. **Relief** refers to the release of gas into the atmosphere through a pressure relief valve for the purpose of pressure control within the tank or equipment.
11. **Exhaust** means exhausting the leaked gas in the dangerous area to the outside through a forced ventilation system.
12. **Flash gas** means to the vapor generated from the LPG liquid as the LPG liquid is depressurized or heated during the process of bunkering propane and butane respectively in the tank.

103. General

1. LPG has different properties from those of LNG. Considering properties and related risks of LPG, safety for using LPG fuel is to be secured.

2. Typical difference between properties of LPG and LNG referred to in Pare 1 are shown, but not limited to, in Table 1.

Table 1 Properties comparison of LPG and LNG, and related risks of LPG

properties	LNG	LPG	related risks
Vapour SG at 15 ℃ and atmospheric pressure	0.55	1.52(Propane) 2(Butane)	· unfavorable for exhaust/dispersion of leakage gas
Flammable limits in air by volume (%)	5 ~ 15	2.2~9.5(Propane) 1.8~8.4(Butane)	· formation of flammable atmosphere at lower concentrations
Autoignition temperature (℃)	595	459(Propane) 405(Butane)	· hazard of autoignition at relatively lower temperatures than LNG · hazard of ignition of unburned gas
Boiling point at 1 bar absolute (℃)	-161	-42(Propane) -1(Butane)	· unfavorable for visual identification of gas leakage
Vapour pressure at 45 ℃ (bar)	_	15(Propane) 4(Butane)	· liquefaction by pressurizing at atmospheric temperature · various boundaries of the phase change according to the composition ratio.
Critical temperature (℃)	-82.95	96(Propane) 152(Butane)	· stored at atmospheric temperature under pressure
Variety of composition ratio	methane	butane and propane	· change of properties on the basis of composition ratio

3. For LPG properties listed in Table 1, the properties and related risks that are to be specially considered in arrangement and system design are as follows.

(1) Specific gravity of gas

(A) Since LPG gas is heavier than air, in case of leakage and relief on open decks, it may settle down at the bottom and flow through the decks with dangerous concentration. It is therefore necessary to check the floor arrangement and openings of other spaces in the way of the LPG leakage/relief source to prevent gas from accumulation and ingress into other spaces.

(B) In LPG fuelled ships, the leakage or relief sources of LPG are mainly as follows;
- vent mast,
- valve and flange connection of LPG fuel piping,
- equipment constituting LPG fuel supply systems,
- LPG combustion equipment,
- tank connections and valves,
- bunkering manifolds,
- damage of fuel pipe, and
- damage of fuel tank

(C) Since LPG gas differs from LNG gas in its dispersion properties, safety measures(gas detection, ventilation, distance to openings in non-hazardous areas, etc.) are to be subject to special consideration to prevent accumulation of gas.

(D) It is to be ensured that the discharged gas to the open area through the ventilation outlet of the hazardous area is not likely to be recirculated to the ventilation inlet through the floor.

(2) Autoignition temperature

(A) The autoignition temperature is to be specially considered in that the unburned gas can ignite without ignition sources at high temperatures such as the high temperature of the exhaust and surfaces of the machinery.

(B) The autoignition temperatures of propane and butane, as the main components of LPG, are 459 ℃ and 405 ℃ respectively which are relatively low compared to LNG(595 ℃). Therefore,

the possibility of spontaneous combustion of unburned gas in the exhaust system is to be considered.

(3) Critical temperature

(A) Since the LNG has a critical temperature of -83℃ the inside of the tank is to be kept at a cryogenic temperature to store the LNG in a liquid state. However, LPG has a critical temperature of 96 ℃ to 152 ℃ depending on the composition ratio of butane and propane, so it can be stored in a liquid state using a pressurized tank at atmospheric temperature.

(B) The pressure of the tank is to be higher than the vapor pressure of LPG at the working temperature to store LPG only in a pressure type. The working temperature is to be determined in consideration of the heat ingress from the outside into LPG.

(4) Vapor pressure at 45 ° C and variation of composition ratio

(A) LPG has a vapor pressure of 4 bar to 15 bar at 45 ° C, which is the reference temperature of the engine room, and the liquid phase and gas pressure conditions of the fuel are determined according to the composition ratio of propane and butane. Therefore, when the fuel supply pressure is close to the vapor pressure, the possibility of an unintended phase change in the fuel supply system is to be considered.

(B) The requirements for purging and venting systems of the Rules are specified for gaseous fuels, so that those systems for fuel supply systems in liquid state are to be designed and arranged suitably for liquid fuels.

(C) Since LPG has different properties depending on the composition ratio of propane and butane, the composition ratio of fuel LPG is to be suitable for normal operation of the fuel consumption device.

4. For the purposes of **Ch 1, 103.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels,** a risk assessment required in **Ch 3** is to be carried out to demonstrate satisfaction of the goal and the functional requirements of this Part and the equivalent level of safety of LNG fuel. ⚓

CHAPTER 2 GOAL AND FUNCTIONAL REQUIREMENTS

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

201. Functional Requirements

The requirements of this section are prescribed in addition to the requirements in **Ch 2, Sec 2** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**. Except where specially required in this Section, the relevant requirements in the Rules are to be applied.

1. In applying **Ch 2, 201. 2** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, effectiveness of the ventilation and detection for LPG leakage is to be ensured taking into account characteristics of LPG.
2. In applying **Ch 2, 201. 10** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, LPG liquid is not to be released to the atmosphere through vent pipe.
3. In applying **Ch 2, 201. 11** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, Machinery, systems and components are to be suitable for the properties of all possible composition of the LPG. ⚓

CHAPTER 3 GENERAL REQUIREMENTS

Section 1 Goal

101. Goal

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

Section 2 Risk Assessment

201. Risk assessment

1. A risk assessment is to be conducted to ensure that risks arising from use of LPG fuel affecting the person on board, the environment and the ship are addressed. Consideration is to be given to the hazards associated with physical layout, operation and maintenance, following any reasonably foreseeable failure.

2. The risk assessment is to address the possible leakage of the fuel and the consequences thereof. In particular, considering the properties of LPG gas heavier than air, consideration is to be given to the possibility of gas accumulation at the bottom and escape of gas into other space.

3. Risk assessment is to be conducted in accordance with **IACS Rec 146**. However, since Appendix 3 in **IACS Rec 146** deals with the properties and risk of LNG, the properties of LPG and the related risk are to be applied to the risk assessment.

4. In risk assessment, in addition to **Ch 3, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be as a minimum considered, but not limited to:
   (1) Leakage potential of LPG and its consequence
   (2) Dispersion characteristics of leaked LPG in ship
   (3) For the following areas/spaces, but not limited to, the risk assessment is to address the possibility of leakage gas entering the non-hazardous area and its consequence. If necessary, analysis of dispersion and/or ventilation is to be conducted to demonstrate the dispersion characteristics and ventilation characteristics of the leakage gas in the area/space.
      (A) tank connection space
      (B) fuel tank
      (C) fuel preparation room
      (D) bunkering station
      (E) a space where single walled fuel pipes are installed.
      (F) gas valve unit room
      (G) in the way of vent mast
   (4) The risk of LPG in accordance with **Ch 1, 103. 4**
   (5) Leakage detection in the drip tray according to **Ch 5, 305. 1**
   (6) Ignition of unburned gas in the exhaust system according to **Ch 10, 201. 2**
   (7) The gas leakage in the gas turbine space according to **Ch 10, 503. 1**
   (8) Possibility of staying of the LPG fuel in the vent pipe
   (9) The purging and venting of the LPG liquid in the fuel pipe where high pressure liquid fuel is supplied to the engine,
   (10) The pressure rise inside the tank due to the generation of flash gas where propane and butane are filled into the fuel tank respectively.
   (11) Possibility of recirculation of hazardous gas in accordance with **Ch 13, 305. 1**
   (12) The effectiveness of ventilation in hazardous spaces in accordance with **Ch 13, 308. 1**
   (13) Installation of gas detectors according to **Ch 15, 801. 1** (1)
   (14) Hazards for passenger ships according to **Ch 17, 101. 2**

202. Limitation of explosion consequences

An explosion in any space containing any potential sources of release and potential ignition sources is is to limited in accordance with **Ch 3, 301.** of **Rules for the Classification of Ships Using Low-flash-point Fuels.** ⚓

CHAPTER 4 CLASSIFICATION AND SURVEYS

Section 1 General

101. General

1. The classification and surveys of ships intended to be classed with the Society or classed with the Society are to be in accordance with the requirements specified in this Chapter.
2. In the case of items not specified in this Chapter, the requirements specified in **Pt 1** of **Rules for the classification of steel ships** are to be applied.

Section 2 Classification

201. Class notation

Ships satisfying the requirements of this Part may be given a notation LFFS (DF-LPG, SF-LPG) as additional special feature notations.

202. Maintenance of classification

1. Ships classed with the Society are to be subjected to the surveys to maintain the classification and are to be maintained in good condition in accordance with the requirements specified in this Chapter.
2. Plans and particulars of any proposed alterations to the approved scantlings or arrangements of hull, machinery or equipment are to be submitted for approval by the Society before the work is commenced and such alterations are to be Surveyed by the Society.

203. Classification Survey during Construction.

1. General

At the Classification Survey during Construction, the hull, machinery and equipment are to be examined in detail in order to ascertain that they meet the relevant requirements of this Guidelines.

2. Plan and Documents

For a ship in which LPG-fuelled engine installations are installed, plans and documents(triplicate for approval and 1 copy for reference), specified below **3** and **4**, are to be submitted and approved before the work is commenced. And, the Society, where considered necessary, may require further plans and documents other than those specified below.

3. Plan and data for approval

In addition to **Ch 4, 203. 3** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following plans and documents are to be submitted.
(1) detailed drawings of vent mast including head
(2) arrangement of ventilation duct in hazardous area
(3) detailed layout of the gas detector
(4) route of outer pipes and ducts of fuel pipe and location of their ventilation outlets and outlets

4. Plans and documents for reference

In addition to **Ch 4, 203. 4** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following plans and documents are to be submitted.
(1) approval data of the combustion engine
(2) data of ventilation analysis and dispersion analysis performed in accordance with requirements in this Part
(3) design pressure calculation formula for pressurize type of fuel tank where temperature control measures are not provided
(4) risk assessment data according to **Ch 3, 201.**.

Section 3 Periodical Surveys

Ch 4, Sec 3 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied. ⚓

CHAPTER 5 SHIP DESIGN AND ARRANGEMENT

Section 1 General

101. Goal

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

Section 2 Functional Requirements

201. Functional Requirements

In addition to the requirements in **Ch 5, Sec 2** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following apply:

1. In applying **Ch 5, 201. 2** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, locations of the vent mast and the ventilation outlet of the hazardous area are to be determined considering the surrounding arrangement so as to minimize the possibility of accumulation of the gas released on the open space and to facilitate dispersion into the atmosphere;
2. In applying **Ch 5, 201. 3** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, openings are to be arranged so that gas can not escape to the openings of non-hazardous spaces, taking into account the specific gravity and dispersion characteristics of LPG gas.

Section 3 Arrangement of Fuel Tanks

Ch 5, Sec 3 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 4 Arrangement of machinery space

401. Gas safe machinery space

1. A single failure of fuel systems is not to lead to a gas release in the machinery space. I.e, gas safe machinery space concept may be accepted.
2. Gas safe machinery space concept is to be in accordance with **Ch 5, 401. 1** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**

Section 5 Gas Safe Machinery Space

Ch 5, Sec 5 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 6 ESD-Protected Machinery Spaces

ESD protected machinery space concept is not be permitted.

Section 7 Location and protection of fuel piping

701. Location and protection of fuel piping

In addition to the requirements in **Ch 5, Sec 7** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following apply:

1. Double barrier around fuel piping systems shall be continuous and not have openings in machinery spaces. Where a gas valve unit is located in a gas safety machinery space, the means of access to the gas valve unit room/enclosure is permissible only through a bolted hatch which can withstand the maximum leakage pressure.

Section 8 Fuel Preparation Room

Ch 5, Sec 8 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 9 Bilge Systems

901. Bilge systems

In addition to the requirements in **Ch 5, Sec 9** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following apply:

1. The bilge systems in the hazardous area are to be arranged separately for each space and discharged overboard or to an enclosed tank fitted with a gas detector. Where bilge piping of two or more hazardous area is connected, means are to be provided to prevent the gas in one area from entering through bilge pipes the connected bilge pipes into other areas.

Section 10 Drip Trays

1001. Drip tray

In addition to the requirements in **Ch 5, Sec 10** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following apply:

1. Drip trays containing fuel spill are to be equipped with means to detect leakage and shut off the fuel if required by the risk assessment.
2. Drip trays which may be exposed to low temperature due to fuel leakage are to be made of materials suitable for low temperatures.

Section 11 Arrangement of Entrances and Other Openings in Enclosed Spaces

Ch 5, Sec 11 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 12 Airlocks

Ch 5, Sec 12 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 13 Outlets of vent pipe and pressure relieving systems

1301. Outlet of vent pipe and pressure relieving systems

1. LPG gas line from the followings is to be led to a vent mast.
   (1) the pressure relief valve of the tank, and
   (2) vent lines and bleed lines for gas fuel systems
2. LPG liquid line from the followings is to be led to a fuel tank. Special consideration is to be given to the fuel tank of refrigerated type other than a fully pressurized type. Where it is not practicable, the line may be led to a vent mast provided that LPG liquid is not released to the atmosphere.
   (1) the pressure relief valve of the liquid fuel supply pipe,
   (2) vent line and bleed line of liquid fuel supply piping, and
   (3) pressure relief valve in bunkering line ⚓

CHAPTER 6 FUEL CONTAINMENT SYSTEM

Section 1 General

101. Goal

The goal of this chapter is to provide that gas storage is adequate so as to minimize the risk to personnel, the ship and the environment to a level that is equivalent to a conventional oil fuelled ship.

Section 2 Functional Requirements

201. Functional requirements

In addition to the requirements in **Ch 6, Sec 2** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following apply:

1. The fuel containment arrangement shall be designed considering for various characteristics for all possible composition of the LPG.
2. The maximum vapour pressure in the fuel tank shall correspond to the maximum temperature in the fuel tank that may reach to due to solar radiation.

Section 3 General Requirements

301. General Requirements

In addition to the requirements in **Ch 6, Sec 2** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following apply:

1. In applying **Ch 6, 301. 1** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, LPG may be stored with a maximum allowable relief valve setting (MARVS) of over 1.0 MPa.
2. In applying **Ch 6, 301. 4** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, for the fuel tank located in enclosed space, a tank connection space is to be provided separately from a fuel storage hold space. For the fuel tank located on open deck, a tank connection space is also to be provided where escaped gas may accumulate on open deck or enter in non-hazardous area such as accommodation space and machinery space based on the risk assessment required in Ch 3, 201. 4.

Section 4 Liquefied gas fuel containment

401. General

Ch 6, 401. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

402. Liquefied gas fuel containment safety principles

In addition to the requirements in **Ch 6, 402.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following apply:

1. In applying **Ch 6, 402. 1** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, no secondary barrier is required where the fuel temperature at atmospheric pressure is at or above −10°C.
2. In applying **Ch 6, 402. 1** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, where the fuel temperature at atmospheric pressure is not below −55°C, the hull structure may act as a secondary barrier.

403. Secondary barriers in relation to tank types

Ch 6, 403. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

404. Design of secondary barriers

Ch 6, 404. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

405. Partial secondary barriers and primary barrier small leak protection system

Ch 6, 405. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

406. Supporting arrangements

Ch 6, 406. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

407. Associated structure and equipment

Ch 6, 407. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

408. Thermal insulation

Ch 6, 408. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

409. Design load

In addition to the requirements in Ch 6, 409. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the following apply:

1. In applying Ch 6, 409. 3 (3) (A) (b) of Rules for the Classification of Ships Using Low-flashpoint Fuels, design vapour pressure P_0 is not to be less than the gauge vapour pressure corresponding to a maximum temperature of fuel that may be increased due to heat ingress from the upper ambient design temperatures.

410. Structural integrity

Ch 6, 410. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

411. Structural analysis

Ch 6, 411. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

412. Design conditions

Ch 6, 412. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

413. Materials and construction

Ch 6, 413. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

414. Construction processes

Ch 6, 414. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

415. Tank types

Ch 6, 415. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

416. Limit state design for novel concepts

Ch 6, 416. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 5 Portable Liquefied Gas Fuel Tanks

Ch 6, Sec 5 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 6 Compressed Petroleum Gas Fuel Containment

As storage in compressed gas form is not applicable for LPG, Ch 6, Sec 6 of Rules for the Classification of Ships Using Low-flashpoint Fuels is not applied.

Section 7 Pressure Relief System

701. General

Ch 6, 701. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

702. Pressure relief systems for liquefied gas fuel tanks

In addition to the requirements in Ch 6, 702. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the following apply:

1. In applying Ch 6, 702. 7 (1) of Rules for the Classification of Ships Using Low-flashpoint Fuels, the vapour discharge is to be directed vertically upwards in the form of unimpeded jets. Vent exits are to be arranged based on the gas dispersion analysis required in Ch 3, 201. 4 (3) (G) and the followings are to be confirmed;
   (1) escaped gas does not escape to non-hazardous area through the opening around the vent exit,
   (2) escaped gas does not accumulated on open deck and,
   (3) escaped gas does not form flammable atmosphere in the way of exhaust gas outlet and other ignition source.
2. In applying Ch 6, 702. 10 of Rules for the Classification of Ships Using Low-flashpoint Fuels, The drain line is to be fitted with a stop valve and a self closing valve in series near the vent line and these valves are to be opened sequentially to prevent gas from escaping through the drain line.
3. Vent lines from fuel tank relief valves are to be fitted with means of purging with inert gas when gas is detected.

703. Sizing of pressure relieving system

Ch 6, 703. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 8 Loading Limit for Liquefied Gas Fuel Tanks

Ch 6, Sec8 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 9 Maintaining of fuel storage condition

901. Control of tank pressure and temperature

In addition to the requirements in Ch 6, 901. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the following apply:

1. In applying Ch 6, 901. 1 of Rules for the Classification of Ships Using Low-flashpoint Fuels, for the pressurized tank, 'the full gauge vapour pressure of the fuel under conditions of the upper ambient design temperature' is to apply the gauge vapour pressure corresponding to a maximum temperature of fuel that may be increased due to heat ingress from the upper ambient design temperatures.

2. With the exception of Par 1, control means of tank pressure and temperature in accordance with Ch 6, 901. 1 of Rules for the Classification of Ships Using Low-flashpoint Fuels are to be provided.

902. Design of systems

Ch 6, 902. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

903. Reliquefaction systems

Ch 6, 903. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

904. Thermal oxidation systems

Ch 6, 904. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

905. Compatibility

Ch 6, 905. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

906. Availability of systems

Ch 6, 906. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 10 Atmospheric Control within the Fuel Containment System

Ch 6, Sec 10 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 11 Atmosphere Control within Fuel Storage Hold Spaces (Fuel Containment Systems other than Type C Independent Tanks)

Ch 6, Sec 11 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 12 Environmental control of spaces surrounding type C independent tanks

Ch 6, Sec 12 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 13 Inerting

Ch 6, Sec 13 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 14 Inert Gas Production and Storage on Board

Ch 6, Sec 14 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied. ⚓

CHAPTER 7 MATERIAL AND GENERAL PIPE DESIGN

Ch 7 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied. ⚓

CHAPTER 8 BUNKERING

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

201. Functional requirements

In addition to **Ch 8, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. Bunkering systems are to be suitable temperature, pressure and composition of all expected LPG.
2. Means are to be provided to manage vapour generated during bunker transfer. Where means of vapour management are not provided in accordance with **Ch 6, 901.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, vapour return connection is to be fitted at bunkering manifold.

Section 3 Bunkering Station

301. General requirements

In addition to **Ch 8, 301.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. In applying **Ch 6, 301. 1** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, gas detectors are to be fitted below bunkering manifolds even though manifolds are located in open spaces and to be fitted under 30 cm height from the bottom at an proper interval. Where gas is detected, gas detectors are to activate alarm and emergency shutdown.
2. Bunkering manifolds are to be observable from bunkering control station by providing permanent watch or CCTV during bunker transfer.

302. Ships' fuel hoses

Ch 8, 302. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 4 Manifold

Ch 8, Sec 4 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 5 Bunkering System

Ch 8, Sec 5 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied. ⚓

CHAPTER 9 FUEL SUPPLY TO CONSUMERS

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

201. Functional requirements

In addition to **Ch 9, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. Fuel supply systems are to be able to supply fuel at the required pressure, temperature and flow rate.
2. Where fuel supply systems supply LPG in the liquid phase, purging, drain, vent and leakage are to be subject to special consideration to provide an equivalent level of safety of fuel in the gas phase.
3. Fuel supply systems are design to be prevented unintended phase changes in processing of fuel supply to consumers considering vapour pressure at the working temperature as the followings;
   (1) Where fuel is supplied in the gaseous state, measures are to be taken so that the temperature of fuel is not lowered to the dew point at the working pressure.
   (2) Where fuel is supplied in the liquid state, measures are to be taken so that the pressure of fuel is not lowered to the vapour pressure at the working temperature.
4. Vent, purging and bleed lines of fuel supply systems are to be so designed as to prevent LPG liquid from being released to the atmosphere.

Section 3 Redundancy of Fuel Supply

Ch 9, Sec 3 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 4 Safety Functions of Gas Supply System

401. Safety functions of gas supply system

In addition to **Ch 9, 401.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. In applying **Ch 9, 401. 4** (1) of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, where fuel supply systems supply LPG in the liquid phase, bleed lines are to be led to the fuel tank.
2. In applying **Ch 9, 401. 4** (1) of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, a purging line is to be connected between two block valves to prevent heavy gas from remaining in bleed line by automatically purging bleed line when a bleed valve is open.
3. In applying **Ch 9, 401. 7** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, where fuel supply systems supply LPG in the liquid state, vent lines are to be led to the fuel tank or knock out drum.

Section 5 Fuel Distribution Outside of Machinery Space

Ch 9, Sec 5 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 6 Fuel Supply to Consumers in Gas-safe Machinery Spaces

Ch 9, Sec 6 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 7 Fuel Supply to Consumers in ESD-protected Machinery Spaces

As ESD protected machinery space concept is not be permitted, Ch 9, Sec 7 of Rules for the Classification of Ships Using Low-flashpoint Fuels is not applied.

Section 8 Design of Ventilated Duct, Outer Pipe Against Inner Pipe Gas Leakage

801. Design pressure of the outer pipe or duct

Ch 9, 801. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

802. Design pressure of the outer pipe or duct for high-pressure fuel piping

In addition to Ch 9, 802. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the followings are to be applied;

1. In applying Ch 9, 802. 1 (2) of the Rules, most conservative value is to be selected for k considering expected composition of fuel. (propane: 1.13, butane : 1.096)

803. Verification of the strength

Ch 9, 803. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

804. Testing and Dimension of Ducts

Ch 9, 804. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 9 Compressors and Pumps

Ch 9, Sec 9 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied. ⚓

CHAPTER 10 POWER GENERATION INCLUDING PROPULSION AND OTHER GAS CONSUMER

Section 1 Goal

101. Goal

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

Section 2 Function Requirements

201. Function requirements

In addition to **Ch 10, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. Fuel consumers are to be suitably designed for operation with possible composition of intended LPG fuel.

2. The temperature of exhaust gas is be subject to special consideration to prevent self-ignition of unburned gas in exhaust systems. However, where reducing the temperature of exhaust gas is impractical, documents are to be submitted demonstrating safety to based on the risk assessment.

Section 3 Internal Combustion Engines of Piston Type

301. General

In addition to **Ch 10, 301.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. Internal combustion engines are to be type-approved by the Society and the followings, but not limited to, are to be demonstrated;
   (1) Measures to prevent accumulation of LPG gas in the space below the piston and extract LPG gas in the space.
   (2) Safety precaution for unburned LPG gas in exhaust systems
   (3) Measures to extract unburned gas in the event of ignition failure

Section 4 Main and Auxiliary Boilers, Gas Turbine

Ch 10, Sec 4 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 5 Gas Turbines

501. Gas turbines

In addition to **Ch 10, 501.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. In applying **Ch 10, 501. 2** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the gas turbine is to be fitted in a gas-tight enclosure arranged in accordance with the ESD principle outlined in **Rules for the Classification of Ships Using Low-flashpoint Fuels.** Gas leakage in the gas-tight enclosure and the consequence are to be evaluated based on the risk assessment. ⚓

CHAPTER 11 FIRE SAFETY

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

Ch 11, Sec 2 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 3 Fire Protection

301. Fire protection

In addition to **Ch 11, 301.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. In applying **Ch 11, 301. 3** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the fuel preparation room is to be separated from a machinery space of category A and rooms with high fire risks. The separation is to be done by a cofferdam of at least 900 mm with insulation of A-60 class.

Section 4 Fire main

Ch 11, Sec 4 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 5 Water spray systems

Ch 11, Sec 5 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 6 Dry chemical powder fire-extinguishing system

Ch 11, Sec 6 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 7 Fire detection and alarm system

Ch 11, Sec 7 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 8 Fixed fire-extinguishing system

1. Fuel preparation rooms are to be provided with a fixed fire-extinguishing system complying with the provisions of the FSS Code and taking into account the necessary concentrations/application rate required for extinguishing gas fires. ⚓

CHAPTER 12 EXPLOSION PREVENTION

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

Ch 12, Sec 2 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 3 General Requirements

Ch 12, Sec 3 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 4 Area classification

401. Area classification

In addition to **Ch 12, 401.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. In applying **Ch 12, 401. 2** of the Rules, classification of hazardous area are to be subject to special consideration from the aspect that LPG gas is heavier than air. **IEC 60079-10-1** may be referred if necessary.

Section 5 Hazardous Area Zones

Ch 12, Sec 5 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied. ⚓

CHAPTER 13 VENTILATION

Section 1 Goal

101. Goal

The goal of this Chapter is to provide for the ventilation required for safe operation of LPG-fuelled machinery and equipment.

Section 2 Functional Requirements

201. Functional requirements

In addition to **Ch 13, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. Capacity and layout of ventilation system are to be so designed that efficiency of ventilation is ensured considering heavy density of LPG gas.

Section 3 General Requirements

301. Ventilation of hazardous spaces

In addition to **Ch 13, 301.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. Ventilation ducts serving hazardous areas are not to be led through accommodation, service space, machinery space, control stations and ro-ro space, except as allowed in **Ch 13, Sec 8** of the Rules.
2. The ventilation suction of hazardous spaces are to be located at the lowest part of the space and close to the bottom as far as ventilation is not interfered considering LPG gas is heavier than air. In addition, An emergency suction located nearly 2 m above the bottom is to be arranged to the ducts for the space where is adjacent to side shell or may be flooded following hull damage caused by some external force, and this emergency intake is to have a damper which is capable of being opened or closed from the weather deck and in the spaces.
3. The number and location of the ventilation outlets in each space are to be considered taking into account the size, layout of the space. Where bottom arrangements are complicated, it is to be demonstrated based on ventilation analysis that capacity and duct arrangements of ventilation are adequate for the space.

302. Electric motors for ventilation fans

Ch 13, 302. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

303. Design of ventilation fans serving spaces containing gas sources

Ch 13, 303. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

304. Separation of ventilation systems

Ch 13, 304. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

305. Air inlets for hazardous enclosed spaces

In addition to **Ch 13, 305.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. Air outlets and air inlets for hazardous enclosed spaces are to be arranged to prevent exhausted gas from re-entering to the space through air inlets. Satisfaction of this arrangement is to be demon-

strated by dispersion analysis, if necessary.

2. Ventilation exhaust ducts from gas-dangerous spaces are to discharge upwards.

306. Air outlets from non-hazardous spaces

Ch 13, 306. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

307. Air outlets from hazardous enclosed spaces

Ch 13, 307. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

308. Required capacity of the ventilation plant

In addition to Ch 13, 308. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the followings are to be applied;

1. An increase in required ventilation capacity may also be necessary to ensure effectiveness of ventilation with special consideration of heavy density and lower explosion limit (LEL) of LPG gas in accordance with IEC 60072-10-1 or, if necessary, using CFD analysis.

309. Non-hazardous spaces with entry openings to a hazardous area

Ch 13, 309. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

310. Non-hazardous spaces with entry openings to a hazardous enclosed space

Ch 13, 310. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 4 Tank Connection Space

Ch 13, Sec 4 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 5 Machinery Spaces

Ch 13, Sec 5, 501. 1 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 6 Fuel Preparation Room

601. Fuel preparation room

In addition to Ch 13, 601. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the followings are to be applied;

1. In applying Ch 13, 601. of Rules for the Classification of Ships Using Low-flashpoint Fuels, approved automatic fail-safe fire dampers are to be fitted in the ventilation trunk for the fuel preparation room.

Section 7 Bunkering station

Ch 13, Sec 7 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 8 Ducts and Double Pipes

801. Ducts and double pipes

In addition to **Ch 13, 801.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. In applying **Ch 13, 801. 1** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, Ventilation inlets and outlets of double wall piping and ducts are to be located so that negative pressures is maintained in the whole space between inner pipes and outer ducts/pipes.

2. In applying **Ch 13, 801. 3** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, The ventilation inlets for the double wall piping and ducts are always to be located in a non-hazardous open area away from ignition sources. ⚓

CHAPTER 14 ELECTRICAL INSTALLATIONS

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

Ch 14, Sec 2 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 3 General Requirements

301. General requirements

In addition to **Ch 14, 301.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. In applying **Ch 14, 301. 3** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, equipment for hazardous areas is to be of a certified safe type appropriate for compositions of LPG in accordance with **IEC 60079-20**. **IEC 60079-20** classifies the temperature class and equipment groups for propane and butane as the followings;

	Temperature class	Equipment group
Propane	T2	IIA
Butane	T2	IIA

CHAPTER 15 CONTROL, MONITORING AND SAFETY SYSTEMS

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

Ch 15, Sec 2 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 3 General Requirements

Ch 15, Sec 3 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 4 Bunkering and Liquefied Gas Fuel Tank Monitoring

Ch 15, Sec 4 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 5 Bunkering Control

Ch 15, Sec 5 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 6 Gas Compressor Monitoring

Ch 15, Sec 6 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 7 Gas Engine Monitoring

Ch 15, Sec 7 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 8 Gas Detection

801. Gas detection

In addition to **Ch 15, 801.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. In addition to location required in **Ch 15, 801. 1** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, permanently installed gas detectors are to be fitted in:
   (1) ventilation inlet of ro-ro space if required based on the risk assessment
   (2) bunkering station
2. In applying **Ch 15, 801. 6** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, in the detection of leakage of gas in the bunkering station, an alarm and emergency shutdown of bunking operation shall be activated.

Section 9 Fire Detection

Ch 15, Sec 9 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 10 Ventilation

Ch 15, Sec 10 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 11 Safety Functions of Fuel Supply Systems

Ch 15, Sec 11 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied. ⚓

CHAPTER 16 MANUFACTURE, WORKMANSHIP AND TESTING

Ch 16 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied. ⚓

CHAPTER 17 SPECIAL CONSIDERATION FOR SHIP TYPES

Section 1 Special Consideration for Passenger Ships

101. Special Consideration for Passenger Ships

1. Gas detection systems are to be fitted at openings of passenger spaces facing gas dangerous area.
2. Risks of gas facilities and gas leakage on board that may affect safety of passengers are to be identified based on the risk assessment. ⚓

Annex 1 REQUIREMENTS FOR LPG FUEL READY

Section 1 General

101. Application

1. This Annex applies to ships which are prepared for conversion with the design or the partial installation related with LPG fuel during the new building phase(hereafter referred to as "LPG fuel ready ships" in the Guidance) for the purpose of a conversion from a ship using conventional marine fuels to LPG fuel after delivery.
2. This Annex contains levels of readiness for use of LPG as fuel(hereafter referred to as "LPG fuel ready levels" in the Guidance) and requirements applicable thereto, and the scope of preparation is defined by the agreement between the shipowner and the shipbuilder.
3. The design and the installation of LPG fuel systems of LPG fuel ready ships are to apply this Guidelines in force at the time of contract for construction for the new-building. However, where a LPG fuel ready ship in accordance with this Guidance is converted to a LPG fuelled ship after delivery, the ship shall comply with this Guidelines in force at the time of the ship conversion.

102. LPG fuel ready levels

1. LPG fuel ready levels are defined in 2 steps as follows:
   (1) The level of preparing the generic design
   (2) The level of installing parts of the systems with the detailed design in addition to above (1)
2. The class notations defined in **Sec 2** may be assigned where the ready level in **Para 1** is in compliance with this Annex.

Section 2 Class Notation

201. General

1. The class notations specified in **202.** and **203.** may be assigned according to the LPG fuel ready level
2. The requirements for the class notations in this Section are to comply with **Sec 3**.

202. LPG Ready D

1. LPG Ready D as an additional special feature notation may be assigned to ships for which the generic design is prepared.
2. LPG Ready D is not to be assign to ships having LPG Ready I.

203. LPG Ready I

1. LPG Ready I as an additional special feature notation may be assigned to ships for which parts of the systems are installed with the detailed design in addition to the generic design.
2. In assignment of the LPG Ready I, the characters corresponding to the installed items may be assigned in the bracket one or a combination of them in addition to LPG Ready I. The characters corresponding to the installed items are as follows:
   (1) Hull structural reinforcement for LPG fuel tank - SR
   (2) LPG fuel tank - FT
   (3) LPG fuel tank venting systems - TV
   (4) LPG fuel supply systems - FS
   (5) LPG fuel bunkering systems - BS
   (6) LPG fired main engines - ME

(7) LPG fired auxiliary engines - AE
(8) LPG fired boilers - B
(9) Main engines that can be converted to LPG fuel operation - ME-C
(10) Auxiliary engines that can be converted to LPG fuel operation - AE-C
(11) Boilers that can be converted to LPG fuel operation - B-C

For example, LPG Ready I(SR, FT) may be assigned to the ship on which structural reinforcement for LPG fuel tank and LPG fuel tank are installed, and LPG Ready I(FS, ME) may be assigned to the ship on which LPG fuel supply systems and LPG fired main engines are installed.

Section 3 Requirements for Levels of LPG Fuel Ready

301. General

1. This Guidance prescribes plans to be submitted and systems to be installed. The design and installation of structures and systems are to be in accordance with applicable requirements in **Pt 1** of this Guidelines.

2. Drawing approval and survey for LPG fuel ready are not accepted as Drawing approval and survey for conversion to LPG fuel ship. When the ship is converted, drawing approval and survey are to be carried out in accordance with this Guidelines in force at the time of the ship conversion. Approved Drawings and certifications from new building stage may be used as reference for conversion.

302. General Level of Preparing Generic Design

1. General

(1) This Section prescribes plans and documents to be submitted for LPG Ready D. The detail requirements for designs are to be in accordance with applicable requirements in **Pt 1** of this Guidelines.
(2) The plans and documents required in this Section is to be marked "LPG Ready" to separate them from the normal plans and documents of new building.
(3) Where parts of plans and documents required in this Section are not available, alternative documents may be accepted by the Society's review.

2. Plans and documents to be submitted

(1) The following plans and documents are to be submitted to the Society for review
  (A) General arrangement plans showing location of:
    (a) Machinery spaces, accommodation, service and control station spaces
    (b) LPG fuel containment systems
    (c) fuel preparation room
    (d) LPG fuel piping routing with shore connections
    (e) Tank hatches, ventilation pipes and any other openings to the LPG fuel tanks
    (f) Ventilating pipes, doors and openings to fuel preparation room and other hazardous areas
    (g) Entrances, air inlets and openings to accommodation, service and control station spaces
    (h) Hazardous areas of zone 0, 1 and 2
  (B) Following plans and data of the LPG fuel containment system:
    (a) LPG fuel tank type, dimension and volume
    (b) Drawings of support and staying of LPG fuel tanks
    (c) LPG fuel tank arrangement including tank connection space
    (d) Specification of design loads and structural analysis for the LPG fuel tank supporting structure
    (e) Drawing and specification of LPG fuel tank thermal insulation with heat transfer calculation
  (C) Following plans and data of LPG fuel supply systems:
    (a) Arrangement of engine room, fuel preparation room and other spaces containing LPG equipment
    (b) LPG fuel supply piping diagram
    (c) Ventilation system arrangement of engine room, fuel preparation room and other spaces containing LPG equipment

(D) Following plans and data of LPG fuel bunkering systems:
  (a) Arrangement of LPG fuel bunkering systems
  (b) LPG fuel bunkering piping diagram
  (c) Ventilation system arrangement of LPG fuel bunkering station
(E) Following plans and particulars for the safety relief valves
  (a) Arrangement for LPG fuel tank relief valves and associated ventilation piping
  (b) Calculation of required LPG fuel tank relief valve capacity
(F) Following plans and data for equipment and systems regarding fire protection :
  (a) Arrangement of construction for fire protection in relation to LPG fuel tank and other spaces containing LPG equipment
  (b) Arrangement and specification of water spray system
  (c) Arrangement and specification of dry chemical powder installation
(G) Data for a risk analysis according to **Pt1, Ch 3, Sec 2** of this Guidelines.
(H) Stability calculations with LPG fuel tanks included
(I) Longitudinal strength calculations with LPG fuel tanks included

303. Level of Installing Parts of Systems

1. General

(1) This Section prescribes parts of the systems to be installed and plans and documents to be submitted for LPG Ready I. The detail requirements for designs and installation of installed systems are to be in accordance with applicable requirements in **Pt 1** of this Guidelines.
(2) The plans and documents for generic design required in **302.** are to be submitted and reviewed by the Society except those required for approval in **Para 2** to **6.**
(3) Parts of the systems are categorized in the follows:
  (A) Hull structural reinforcement for LPG fuel tank
  (B) LPG fuel tank
  (C) LPG fuel tank venting systems
  (D) LPG fuel supply systems
  (F) LPG fuel bunkering systems
  (G) LPG fired main engines
  (H) LPG fired auxiliary engines
  (I) LPG fired boilers
  (J) Main engines that can be converted to LPG fuel operation
  (K) Auxiliary engines that can be converted to LPG fuel operation
  (L) Boilers that can be converted to LPG fuel operation
(4) The parts which are installed on board are to be reflected in the normal plans of new building and "LPG Ready" is not to be marked on those plans.

2. Hull structural reinforcement for LPG fuel tank

(1) The structures below the LPG fuel tanks are to be reinforced in accordance with **Pt 1, Ch 6** of this Guidelines.
(2) The following plans and documents are to be submitted to the Society for approval.
  (A) Detail drawing of LPG fuel tanks and support of LPG fuel tanks
  (B) Material specification for tank support and steel grade selection for the hull in way of the tank
  (C) Welding procedures, stress relieving procedures and non-destructive testing plans
  (D) Specification of design loads and structural analysis for the LPG fuel tank supporting structure
  (E) Drawing and specification of LPG fuel tank thermal insulation with heat transfer calculation

3. LPG fuel tank

(1) LPG fuel tanks are to be installed in accordance with **Pt 1, Ch 5, Sec 3** and **Ch 6** of this Guidelines
(2) The plans and documents in **Pt 1, Ch 4, 203. 3** and **4** of this Guidelines and LPG fuel tank arrangement including tank connection space are to be submitted to the Society for approval.

4. LPG fuel tank venting systems

(1) LPG fuel tank venting systems are to be installed in accordance with **Pt 1, Ch 5, Sec 13** and **Ch 6** of this Guidelines.

(2) The plans and documents in **Pt 1, Ch 4, 203. 3** and **4** of this Guidelines are to be submitted to the Society for approval.

5. LPG fuel supply systems

(1) LPG fuel supply systems are to be installed in accordance with **Pt 1, Ch 7** and **Ch 9** of this Guidelines.

(2) The following plans and documents are to be submitted to the Society for approval.

(A) Arrangement of engine room, fuel preparation room and other spaces containing LPG equipment

(B) Ventilation system arrangement of engine room, fuel preparation room and other spaces containing LPG equipment

(C) Drawings and specifications of LPG supply piping

(D) Drawings and specifications of offsets, loops, bends and mechanical expansion joints, such as bellows, slip joints(only inside tank) or similar means in the LPG piping

(E) Drawings and specifications of flanges, valves and other fittings in the LPG piping system. For valves intended for piping systems with a design temperature below − 55 °C, documentation for leak test and functional test at design temperature (type test) is required

(F) Documentation of type tests for expansion components in the LPG piping system.

(G) Specification of materials, welding, post-weld heat treatment and non-destructive testing of LPG piping

(H) Specification of pressure tests (structural and tightness tests) of LPG piping

(I) Program for functional tests of all piping systems including valves, fittings and associated equipment for handling LPG (liquid or vapour)

(J) Drawings and specifications of insulation for low temperature piping where such insulation is installed

(K) Specification of electrical bonding of piping

(L) Cooling or heating water system in connection with LPG fuel system, if fitted.

6. LPG fuel bunkering systems

(1) LPG fuel bunkering systems are to be installed in accordance with **Pt 1, Ch 7** and **Ch 8** of this Guidelines.

(2) The following plans and documents are to be submitted to the Society for approval.

(A) Arrangement of LPG fuel bunkering systems

(B) Ventilation system arrangement of LPG fuel bunkering station

(C) Drawings and specifications of LPG supply piping

(D) Drawings and specifications of offsets, loops, bends and mechanical expansion joints, such as bellows, slip joints(only inside tank) or similar means in the LPG piping

(E) Drawings and specifications of flanges, valves and other fittings in the LPG piping system. For valves intended for piping systems with a design temperature below −55 °C, documentation for leak test and functional test at design temperature (type test) is required

(F) Documentation of type tests for expansion components in the LPG piping system.

(G) Specification of materials, welding, post-weld heat treatment and non-destructive testing of LPG piping

(H) Specification of pressure tests (structural and tightness tests) of LPG piping

(I) Program for functional tests of all piping systems including valves, fittings and associated equipment for handling LPG (liquid or vapour)

(J) Drawings and specifications of insulation for low temperature piping where such insulation is installed

(K) Specification of electrical bonding of piping

(L) Specification of means for removal of liquid contents from bunkering pipes prior to disconnecting the shore connection

7. LPG fired main engines

Main engines are to be installed in accordance with **Pt 1, Ch 10, Sec 3** of this Guidelines.

8. LPG fired auxiliary engines

Auxiliary engines are to be installed in accordance with **Pt 1, Ch 10, Sec 3** of this Guidelines.

9. LPG fired boilers

Boilers are to be installed in accordance with **Pt 1, Ch 10, Sec 4** of this Guidelines.

10. Main engines that can be converted to gas fuel operation

(1) Main engines of gas-convertible types are to be installed.
(2) Following plans are to be submitted for reference:
  (A) details of the gas conversion
  (B) list of the components that need to be replaced
  (C) list of new components

11. Auxiliary engines that can be converted to gas fuel operation

(1) Auxiliary engines of gas-convertible types are to be installed.
(2) Following plans are to be submitted for reference:
  (A) details of the gas conversion
  (B) list of the components that need to be replaced
  (C) list of new components

12. Boilers that can be converted to gas fuel operation

(1) Boilers of gas-convertible types are to be installed.
(2) Following plans are to be submitted for reference:
  (A) details of the gas conversion
  (B) list of the components that need to be replaced
  (C) list of new components

304. Survey

1. Classification survey during construction

Systems are to be tested at the shops of manufacturer and after installation on board in accordance with Pt 1 of this Guidelines.

2. Periodical surveys

In application of this Guidance, the general condition of the relevant systems installed on board is to be examined visually at periodical surveys for the vessels having LPG Ready I notation. The systems are to be surveyed and evaluated for the condition at time of conversion, and the scope of test will be defined depending on time elapsed from new building and maintenance level of the systems. ⚓

PART 2
LPG Carriers using LPG as Fuels
(IGC Ships)

CHAPTER 1 GENERAL

Section 1 General

101. Application

1. This Part, as a substitution for **Pt 7, Ch 5, Sec 16** of **Rules for the classification of steel ships,** applies to LPG carriers using LPG cargo as fuel and complying with **Pt 7, Ch 5** of **Rules** and **Guidance for the classification of steel ships.** However, This Part dose not apply to ships subject to Korean Ship Safety Act.
2. Except **Pt 7, Ch 5, Sec 16** of **Rules for the classification of steel ships, Pt 7, Ch 5** of **Rules for the classification of steel ships** applies.

Section 2 Goal and Functional Requirements

201. Goal

The goal of this Part is to ensure safe and reliable distribution of fuel to the consumers and operation of consumers for use of LPG cargo as fuel.

202. Functional Requirements

1. Single failure is not to cause leakage into the space where LPG fuel consumers are installed.
2. Effectiveness of the ventilation and detection for LPG leakage is to be ensured taking into account characteristics of LPG.
3. Sources of release (i.e. vent masts, ventilation outlets of hazardous spaces, vent outlets of fuel piping) are to be located to prevent released gas from entering the gas safe spaces(e.g. accommodations, machinery spaces) through openings. Gas detectors, if necessary, are to be fitted at the openings of those spaces.
4. Since LPG has different properties depending on the composition ratio of propane and butane, the composition ratio of fuel LPG is to be suitable for normal operation of the fuel consumer.
5. Fuel supply systems are design to be prevented unintended phase changes in processing of fuel supply to consumers considering vapour pressure at the working temperature as the followings;
   (1) Where fuel is supplied in the gaseous state, measures are to be taken so that the temperature of fuel is not lowered to the dew point at the working pressure.
   (2) Where fuel is supplied in the liquid state, measures are to be taken so that the pressure of fuel is not lowered to the vapour pressure at the working temperature.
6. Vent, purging and bleed lines of fuel supply systems are to be so designed as to prevent LPG liquid from being released to the atmosphere.

Section 3 General Requirements

301. Risk assessment

1. A risk assessment is to be conducted to ensure that risks arising from use of LPG fuel affecting the person on board, the environment and the ship are addressed. Consideration is to be given to the hazards associated with physical layout, operation and maintenance, following any reasonably foreseeable failure.
2. The risk assessment is to address the possible leakage of the fuel and the consequences thereof. In particular, considering the properties of LPG gas heavier than air, consideration is to be given to

the possibility of gas accumulation at the bottom and escape of gas into other space.

3. In risk assessment, the followings are to be as a minimum considered, but not limited to:
   (1) Leakage potential of LPG and its consequence
   (2) Dispersion characteristics of leaked LPG in ship
   (3) For the following areas/spaces, but not limited to, the risk assessment is to address the possibility of leakage gas entering the non-hazardous area and its consequence. If necessary, analysis of dispersion and/or ventilation is to be conducted to demonstrate the dispersion characteristics and ventilation characteristics of the leakage gas in the area/space.
      (A) LPG fuel tank
      (B) fuel preparation room
      (C) a space where single walled fuel pipes are installed.
      (D) gas valve unit room
      (E) in the way of vent mast
      (F) ventilation outlet of hazardous spaces
   (4) The gas leakage in the gas turbine space according to 108. 1 (1)
   (5) Possibility of staying of the LPG fuel in the vent pipe
   (6) The purging and venting of the LPG liquid in the fuel pipe where high pressure liquid fuel is supplied to the engine,
   (7) Drainage of leaked LPG liquid in annular space of a double walled pipe ⚓

CHAPTER 2 SUBSTITUTED REQUIREMENTS FOR PT 7, CH 5, SEC 16 OF RULES FOR THE CLASSIFICATION OF STEEL SHIPS.

101. General

1. Application

This Chapter specifies requirements for use of LPG cargo as fuel which are substituted for **Pt 7, Ch 5, Sec 16** of **Rules for the classification of steel ships.**

2. General

(1) LPG may be utilized in machinery spaces of category A, and, in these spaces, it may be utilized only in systems such as boilers, inert gas generators, internal combustion engines, gas combustion unit and gas turbines.

(2) LPG in this Part means liquefied petroleum gas. It is mainly composed of propane, butane or a mixture of propane (C_3H_8) and butane (C_4H_{10}) and contains small amounts of propylene and butylene. In this Part, not only liquid but also gaseous petroleum gas is referred to as LPG. However, when it is necessary to distinguish between the liquid state and the gas state, LPG in the liquid state is referred to as LPG liquid, and LPG in the gaseous state is referred to as LPG gas.

102. Use of cargo vapour as fuel

1. This Article addresses the use of cargo vapour as fuel in systems such as boilers, inert gas generators, internal combustion engines, gas combustion units and gas turbines.

(1) LPG may be used as fuel both in liquid state and gas state.

(2) Fuel consumers are to be suitably designed for operation with possible composition of intended LPG fuel.

(3) The fuel supply system is to comply with the requirements of **104. 1**, **2** and **3**.

(4) Gas consumers are to exhibit no visible flame and are to maintain the uptake exhaust temperature below auto-ignition temperature of LPG fuel in use to prevent spontaneous combustion of unburned gas in the exhaust system. Temperature monitoring of exhaust gas is to be provided.

103. Arrangement of spaces containing gas consumers

1. A single failure of fuel systems in the machinery space is not to lead to a gas release in the machinery space. Therefore, fuel piping is of a double-wall design and outer pipe or duct is to be continuous. Air inlet of outer pipe or duct is not to be the machinary space.

2. Spaces in which gas consumers are located are to be fitted with a mechanical ventilation system that is arranged to avoid areas where gas may accumulate, taking into account the density of the vapour and potential ignition sources. The ventilation system is to be separated from those serving other spaces.

3. Gas detectors are to be fitted in these spaces, particularly where air circulation is reduced. The gas detection system is to comply with the requirements of **Pt 7, Ch 5, Sec 13** of **Rules for the classification of steel ships.**

4. Electrical equipment located in the double wall pipe or duct specified in **104. 3** is to comply with the requirements of **Pt 7, Ch 5, Sec 10** of **Rules for the classification of steel ships.**

5. All vents and bleed lines that may contain or be contaminated by LPG fuel are to be routed to a safe location external to the machinery space and be fitted with a flame screen. LPG liquid is not to be released to the atmosphere through vent pipe and bleed pipe.

104. Gas fuel supply

1. General

(1) The requirements of this Article are to apply to LPG fuel supply piping outside of the cargo

area. LPG Fuel piping is not to pass through accommodation spaces, service spaces, electrical equipment rooms or control stations. The routeing of the pipeline is to take into account potential hazards, due to mechanical damage, in areas such as stores or machinery handling areas.

(2) Provision is to be made for inerting and gas-freeing that portion of the LPG fuel piping systems located in the machinery space. To prevent the return of LPG fuel to inert gas piping, the inert gas supply line connected to LPG fuel piping is to be fitted with double block and bleed valves.

2. Leak detection

Continuous monitoring and alarms are to be provided to indicate a leak in the piping system in enclosed spaces and shut down the relevant gas fuel supply.

3. Routeing of fuel supply pipes

Fuel piping may pass through or extend into enclosed spaces other than those mentioned in **Para 1**, provided it fulfills one of the following conditions:

(1) it is of a double-wall design with the space between the concentric pipes pressurized with inert gas at a pressure greater than the LPG fuel pressure. The master fuel valve, as required by **Para 6**, closes automatically upon loss of inert gas pressure; or

(2) it is installed in a pipe or duct equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour and is arranged to maintain a pressure less than the atmospheric pressure. Ventilation is to be in accordance with the followings;

(A) The mechanical ventilation is in accordance with **Pt 7, Ch 5, Sec 12** of **Rules for the classification of steel ships**, as applicable.

(B) The ventilation is always in operation when there is fuel in the piping and the master gas fuel valve, as required by **Para 6**, closes automatically if the required air flow is not established and maintained by the exhaust ventilation system.

(C) The ventilation inlets for the double wall piping and ducts are always to be located in a non-hazardous open area away from ignition sources and ventilation outlets for the double wall piping and ducts are in the cargo area.

(D) Ventilation inlets and outlets of double wall piping and ducts are to be located so that negative pressures is maintained in the whole space between inner pipes and outer ducts/pipes.

4. Requirements for gas fuel with pressure greater than 1 MPa

(1) Fuel delivery lines between the high-pressure fuel pumps/compressors and consumers are to be protected with a double-walled piping system capable of containing a high pressure line failure, taking into account the effects of both pressure and low temperature. A single-walled pipe in the cargo area up to the isolating valve(s) required by **6** is acceptable.

(2) In application of above (1), when fuel is of ordinary temperature, single wall pipe after the isolating valve(s) required by **6** may be accepted by risk assessment in accordance with **Ch.1, 301. 1 (1).**

5. Gas consumer isolation

(1) The supply piping of each gas consumer unit is to be provided with gas fuel isolation by automatic double block and bleed, vented to a safe location, under both normal and emergency operation. The automatic valves are to be arranged to fail to the closed position on loss of actuating power. In a space containing multiple consumers, the shutdown of one is not to affect the gas supply to the others.

(2) Where fuel supply systems supply LPG in the liquid state, vent lines are to be led to the fuel tank or knock out drum.

(3) A purging line is to be connected between two block valves to prevent heavy gas from remaining in bleed line by automatically purging bleed line when a bleed valve is open.

6. Spaces containing gas consumers

(1) It is to be possible to isolate the gas fuel supply to each individual space containing a gas consumer(s) or through which fuel gas supply piping is run, with an individual master valve, which is located within the cargo area. The isolation of gas fuel supply to a space is not to affect the gas supply to other spaces containing gas consumers if they are located in two or more spaces, and it is not to cause loss of propulsion or electrical power. An individual master valve located in the cargo area may be provided for each gas consumer or each group of gas consumers of inside the space.

(2) The master valve is to operate under the following circumstances:

(A) automatically by:

(a) leak detection in the annular space of a double-walled pipe served by that master valve;

(b) leak detection in other compartments containing single-walled gas piping that is part of the supply system served by the master valve; and
(c) loss of ventilation or loss of pressure in the annular space of a double-walled pipe and other compartments containing single-walled gas piping; and

(B) manually from within the space, and at least one remote location.

7. Piping and ducting construction

Gas fuel piping in machinery spaces is to comply with **Pt 7, Ch 5, 501.** to **509.** of **Rules for the classification of steel ships**, as applicable. The piping is to, as far as practicable, have welded joints. Those parts of the gas fuel piping that are not enclosed in a ventilated pipe or duct according to **3**, and are on the weather decks outside the cargo area, is to have full penetration butt-welded joints and is to be fully radiographed.

8. Gas detection

Gas detection systems provided in accordance with the requirements of this Section are to activate the alarm at 30 % LFL and shut down the master gas fuel valve required by **6** at not more than 60 % LFL (see **Pt 7, Ch 5, 1306. 17** of **Rules for the classification of steel ships**).

105. Gas fuel plant and related storage tanks

1. Provision of gas fuel

(1) All equipment (heaters, compressors, vaporizers, filters, etc.) for conditioning the cargo and/or cargo boil off vapour for its use as fuel, and any related storage tanks, is to be located in the cargo area with sufficient distance from the gas safe spaces(e.g. accommodations, machinery spaces) to prevent released gas from entering the spaces(e.g. machinery spaces, accommodations) through openings.

(2) Where tank connections and tank valves are not located on the open deck, these connection and valves are to be enclosed in a gas tight tank connection spaces. Tank connection spaces are to comply with **Pt 1** of this Guidelines

(3) If the equipment is in an enclosed space, the space is to be ventilated according to **Pt 7, Ch 5, 1201.** of **Rules for the classification of steel ships** and be equipped with a fixed fire extinguishing system, according to **Pt 7, Ch 5, 1105.** of **Rules for the classification of steel ships**, and with a gas detection system according to **Pt 7, Ch 5, 1306.** of **Rules for the classification of steel ships**, as applicable. Ventilation and gas detection are to comply with the followings;

(A) Ventilation
(a) Spaces in which LPG fuel supply systems are located are to be fitted with a mechanical ventilation system that is arranged to avoid areas where gas may accumulate, taking into account the density of the vapour and potential ignition sources. The ventilation suction of hazardous spaces are to be located at the lowest part of the space and close to the bottom as far as ventilation is not interfered considering LPG gas is heavier than air. The ventilation system is to be separated from those serving other spaces.
(b) The ventilation system is to be separated from those serving other spaces.
(c) Ventilation exhaust ducts from gas-dangerous spaces are to discharge upwards. Air outlets and air inlets for hazardous enclosed spaces are to be arranged to prevent exhausted gas from re-entering to the space through air inlets. Satisfaction of this arrangement is to be demonstrated by dispersion analysis, if necessary.

(B) Gas detectors are to be located in the followings;
(a) where gas may be accumulated in the space such as location where air circulation is reduced and is near bottom, and
(b) ventilation outlet

2. Remote stops

(1) All rotating equipment utilized for conditioning the cargo for its use as fuel is to be arranged for manual remote stop from the engine-room. Additional remote stops are to be located in areas that are always easily accessible, typically cargo control room, navigation bridge and fire control station.

(2) The fuel supply equipment is to be automatically stopped in the case of low suction pressure or fire detection. Unless expressly provided otherwise, the requirements of **Pt 7, Ch 5, 1810.** of **Rules for the classification of steel ships.** need not apply to gas fuel compressors or pumps when used to supply gas consumers.

3. Heating and cooling mediums

If the heating or cooling medium for the gas fuel conditioning system is returned to spaces outside the cargo area, provisions are to be made to detect and alarm the presence of cargo/cargo vapour in the medium. Any vent outlet is to be in a safe position and fitted with an effective flame screen of an approved type.

4. Piping and pressure vessels

Piping or pressure vessels fitted in the gas fuel supply system are to comply with **Pt 7, Ch 5, Sec 5** of **Rules for the classification of steel ships.**

106. Special requirements for boilers

1. Arrangements

(1) Each boiler is to have a separate exhaust uptake.
(2) Each boiler is to have a dedicated forced draught system. A crossover between boiler force draught systems may be fitted for emergency use providing that any relevant safety functions are maintained.
(3) Combustion chambers and uptakes of boilers are to be designed to prevent any accumulation of gaseous fuel.

2. Combustion equipment

(1) The burner systems are to be of dual type, suitable to burn either: oil fuel or gas fuel alone, or oil and gas fuel simultaneously.
(2) Burners are to be designed to maintain stable combustion under all firing conditions.
(3) An automatic system is to be fitted to change over from gas fuel operation to oil fuel operation without interruption of the boiler firing, in the event of loss of gas fuel supply.
(4) Gas nozzles and the burner control system are to be configured such that gas fuel can only be ignited by an established oil fuel flame, unless the boiler and combustion equipment is designed and approved by Society to light on gas fuel.

3. Safety

(1) There are to be arrangements to ensure that gas fuel flow to the burner is automatically cut-off, unless satisfactory ignition has been established and maintained.
(2) On the pipe of each gas-burner, a manually operated shut-off valve is to be fitted.
(3) Provisions are to be made for automatically purging the gas supply piping to the burners, by means of an inert gas, after the extinguishing of these burners.
(4) The automatic fuel changeover system required by **2** (3) is to be monitored with alarms to ensure continuous availability.
(5) Arrangements are to be made that, in case of flame failure of all operating burners, the combustion chambers of the boilers are automatically purged before relighting.
(6) Arrangements are to be made to enable the boilers to be manually purged.

107. Special requirements for gas-fired internal combustion engines

Dual fuel engines are those that employ LPG fuel (with pilot oil) and oil fuel. Oil fuels may include distillate and residual fuels. LPG only engines are those that employ LPG fuel only.

1. Arrangements

(1) When gas is supplied in a mixture with air through a common manifold, flame arrestors are to be installed before each cylinder head.
(2) Each engine is to have its own separate exhaust.
(3) The exhausts are to be configured to prevent any accumulation of unburnt LPG fuel.
(4) Unless designed with the strength to withstand the worst case overpressure due to ignited gas leaks, air inlet manifolds, scavenge spaces, exhaust system and crank cases are to be fitted with suitable pressure relief systems. Pressure relief systems are to lead to a safe location, away from personnel.
(5) Each engine is to be fitted with vent systems independent of other engines for crankcases, sumps and cooling systems.

2. Combustion equipment

(1) Prior to admission of gas fuel, correct operation of the pilot oil injection system on each unit is

to be verified.

(2) For a spark ignition engine, if ignition has not been detected by the engine monitoring system within an engine specific time after opening of the gas supply valve, this is to be automatically shut off and the starting sequence terminated. It is to be ensured that any unburnt gas mixture is purged from the exhaust system.

(3) For dual-fuel engines fitted with a pilot oil injection system, an automatic system is to be fitted to change over from gas fuel operation to oil fuel operation with minimum fluctuation of the engine power.

(4) In the case of unstable operation on engines with the arrangement in (3) when gas firing, the engine is to automatically change to oil fuel mode.

3. Safety

(1) During stopping of the engine, the gas fuel is to be automatically shut off before the ignition source.

(2) Arrangements are to be provided to ensure that there is no unburnt gas fuel in the exhaust gas system prior to ignition.

(3) Crankcases, sumps, scavenge spaces and cooling system vents are to be provided with gas detection (see **Pt 7, Ch 5, 1306. 17** of **Rules for the classification of steel ships.**).

(4) Provision is to be made within the design of the engine to permit continuous monitoring of possible sources of ignition within the crank case. Instrumentation fitted inside the crankcase is to be in accordance with the requirements of **Pt 7, Ch 5, Sec 10** of **Rules for the classification of steel ships**.

(5) For engines where the space below the piston is in direct communication with the crankcase a detailed evaluation regarding the hazard potential of fuel gas accumulation in the crankcase is to be carried out and reflected in the safety concept of the engine. Measures to prevent accumulation of LPG gas in the space below the piston and extract LPG gas in the space are to be provided taking into account of heavy density of LPG gas.

(6) A means is to be provided to monitor and detect poor combustion or misfiring that may lead to unburnt gas fuel in the exhaust system during operation. In the event that it is detected, the gas fuel supply is to be shut down. Instrumentation fitted inside the exhaust system is to be in accordance with the requirements of **Pt 7, Ch 5, Sec 10** of **Rules for the classification of steel ships**. Measures to extract unburned gas caused by poor combustion or misfiring are to be provided.

108. Special requirements for gas turbine

1. Arrangements

(1) The gas turbine is to be fitted in a gas-tight enclosure arranged in accordance with the ESD principle outlined in **Rules for the Classification of Ships Using Low-flashpoint Fuels.** Gas leakage in the gas-tight enclosure and the consequence are to be evaluated based on the risk assessment.

(2) Ventilation for the enclosure is to be arranged with full redundancy (2 x 100 % capacity fans from different electrical circuits).

(3) Each turbine is to have its own separate exhaust.

(4) The exhausts are to be appropriately configured to prevent any accumulation of unburnt gas fuel.

(5) Unless designed with the strength to withstand the worst case overpressure due to ignited gas leaks, pressure relief systems are to be suitably designed and fitted to the exhaust system, taking into consideration explosions due to gas leaks. Pressure relief systems within the exhaust uptakes are to be lead to a nonhazardous location, away from personnel.

2. Combustion equipment

An automatic system is to be fitted to change over easily and quickly from gas fuel operation to oil fuel operation with minimum fluctuation of the engine power.

3. Safety

(1) Means is to be provided to monitor and detect poor combustion that may lead to unburnt gas fuel in the exhaust system during operation. In the event that it is detected, the gas fuel supply is to be shut down.

(2) Each turbine is to be fitted with an automatic shutdown device for high exhaust temperatures. ⚓

PART 3
Ships using Methly/Ethyl Alcohol as Fuels (IGF Ships)

CHAPTER 1 GENERAL

Section 1 General

101. Application

The requirements of this Part apply to ships using methyl/ethyl alcohol as fuel.

102. Definitions

Except where specified in this Part, the relevant definitions in **Rules for the Classification of Ships Using Low-flashpoint Fuels** are to be applied.

1. **Bunkering** means the transfer of fuel from land-based or floating facilities into ship's permanent tanks or connection of portable tanks to the fuel supply system.
2. **Fuel** means methyl/ethyl alcohol fuels, containing allowable additives or impurities, suitable for the safe operation on board ships, complying with an international standard.
3. **Fuel tank** is any integral, independent or portable tank used for storage of fuel. The spaces around the fuel tank are defined as follows:
   (1) **Fuel storage hold space** is the space enclosed by the ship's structure in which a fuel tank is situated. If tank connections are located in the fuel storage hold space, a fuel storage hold space should also be considered as tank connection space. Integral fuel tanks do not have a fuel storage hold space;
   (2) **Cofferdam** is a structural space surrounding a fuel tank which provides an added layer of gas and liquid tightness protection against external fire, toxic and flammable vapours between the fuel tank and other areas of the ship; and
   (3) **Tank connection space** is a space surrounding all tank connections and tank valves that is required for tanks with such connections in enclosed spaces.
4. **Fuel preparation space** means any space containing equipment for fuel preparation purposes, such as fuel pumps, fuel valve train, heat exchangers and filters.
5. **Gas freeing** is the process carried out to achieve a safe tank atmosphere. It includes two distinct operations:
   (1) purging the hazardous tank atmosphere with an inert gas or other suitable medium (e.g. water) to dilute the hazardous vapour to a level where air can be safely introduced; and
   (2) replacing the diluted inert atmosphere with air.
6. **Independent tanks** are self-supporting, do not form part of the ship's hull and are not essential to the hull strength.
7. **Integral tank** means a fuel-containment envelope tank which forms part of the ship's hull and which may be stressed in the same manner and by the same loads which stress the contiguous hull structure and which is normally essential to the structural completeness of the ship's hull.
8. **Portable tank** means an independent tank being able to be:
   (1) easily connected and disconnected from ship systems; and
   (2) easily removed from ship and installed on board ship.
9. **Single failure** is where loss of intended function occurs through one fault or action.
10. **Single fuel engine** means an engine capable of operating on a fuel defined as in **2** only.

103. Alternative design

1. **Ch 1, 103.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied. ⚓

CHAPTER 2 GOAL AND FUNCTIONAL REQUIREMENTS

Section 1 Goal

101. Goal

1. Ch 2, 101. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 2 Functional Requirements

201. Functional requirements

1. With the exception of **Ch 2, 201.**, **12** of **Rules for the Classification of Ships Using Low-flashpoint Fuels, Ch 2, 201.** of the Rules is to be applied. ⚓

CHAPTER 3 GENERAL REQUIREMENTS

Section 1 Goal

101. Goal

1. Ch 3, 101. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 2 Risk Assessment

201. Risk assessment

1. A risk assessment should be conducted to ensure that risks arising from the use of methyl/ethyl alcohol fuels affecting persons on board, the environment, the structural strength or the integrity of the ship are addressed. Consideration should be given to the hazards associated with physical lay-out, operation and maintenance, following any reasonably foreseeable failure.

2. The risks should be analysed using acceptable and recognized risk analysis techniques. Loss of function, component damage, fire, explosion, toxicity and electric shock should, as a minimum, be considered. The analysis should ensure that risks are eliminated wherever possible. Risks which cannot be eliminated should be mitigated as necessary. Details of risks, and the means by which they are mitigated, should be documented in accordance with applicable requirements in **Guidance for Approval of Risk-based Ship Design**.

Section 3 Limitation of Explosion Consequences

301. Limitation of explosion consequences

1. Ch 3, 301. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied. ⚓

CHAPTER 4 CLASSIFICATION AND SURVEYS

Section 1 General

101. General

1. Classification and surveys are to be complied with applicable requirements in this Chapter.
2. In the case of items not specified in this Chapter, the requirements specified in **Pt 1** of **Rules for the classification of steel ships** are to be applied.

Section 2 Classification

201. Class notation

Ships satisfying the requirements of this Part may be given a notation LFFS (DF-Methyl, SF-Methyl, DF-Ethyl, SF-Ethyl) as additional special feature notations.

202. Maintenance of classification

1. Ships classed with the Society are to be subjected to the surveys to maintain the classification and are to be maintained in good condition in accordance with the requirements specified in this Chapter.
2. Plans and particulars of any proposed alterations to the approved scantlings or arrangements of hull, machinery or equipment are to be submitted for approval by the Society before the work is commenced and such alterations are to be Surveyed by the Society.

203. Classification Survey during Construction.

1. General

   At the Classification Survey during Construction, the hull, machinery and equipment are to be examined in detail in order to ascertain that they meet the relevant requirements of this Guidelines.

2. Plan and Documents

   For a ship in which Methyl/Ethyl-fuelled engine installations are installed, plans and documents(triplicate for approval and 1 copy for reference), specified below **3** and **4**, are to be submitted and approved before the work is commenced. And, the Society, where considered necessary, may require further plans and documents other than those specified below.

3. Plan and data for approval

   Ch 4, 203. 3 of **Rules for the Classification of Ships Using Low-flashpoint Fuels**.

4. Plans and documents for reference

   In addition to **Ch 4, 203. 4** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the following plans and documents are to be submitted.
   (1) Lists showing chemical and physical properties and other special properties of fuel
   (2) Data of reactivity hazard between fuel and coating or lining in cargo tanks and of piping and equipment that may come into contact with cargo liquid or vapour
   (3) Data of suitability of corrosion-resistance materials for the fuel having corrosive properties

Section 3 Periodical Surveys

Ch 4, Sec 3 of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.⚓

CHAPTER 5 SHIP DESIGN AND ARRANGEMENT

Section 1 Goal

101. Goal

1. **Ch 5, 101.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 2 Functional Requirements

201. Functional requirements

Functional requirements **1~7, 13, 15, 17** of **Ch 2, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels** are to be applied.

1. Functional requirements **1~5** of **Ch 5, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels** are to be applied.
2. The probability of a fire or explosion in a machinery space as a result of a fuel release should be minimized in the design, with special attention to the risk of leakage from pumps, valves and connections.

Section 3 Fuel Tank Arrangement

301. General

1. Tanks containing fuel should not be located within accommodation spaces or machinery spaces of category A.
2. Integral fuel tanks should be surrounded by protective cofferdams, except on those surfaces bound by shell plating below the lowest possible waterline, other fuel tanks containing methyl/ethyl alcohol, or fuel preparation space.
3. The fuel containment system should be abaft of the collision bulkhead and forward of the aft peak bulkhead.
4. Fuel tanks located on open decks should be protected against mechanical damage.
5. Fuel tanks on open decks should be surrounded by coamings and spills should be collected in a dedicated holding tank.
6. Special consideration should be given to chemical tankers using methyl/ethyl alcohol cargoes as fuel.

302. Independent fuel tanks

1. Independent tanks may be accepted on open decks or in a fuel storage hold space.
2. Independent tanks should be fitted with:
   (1) mechanical protection of the tanks depending on location and cargo operations;
   (2) if located on an open deck, drip tray arrangements for leak containment and water spray systems for emergency cooling; and
   (3) if located in a fuel storage hold space, the space should meet the provisions of **Ch 11** and **Ch 13**.
3. Independent fuel tanks should be secured to the ship's structure. The arrangement for supporting and fixing the tanks should be designed for the maximum expected static, dynamic inclinations and accidental loads as well as the maximum expected values of acceleration, taking into account the ship characteristics and the position of the tanks.

303. Portable tanks

1. Portable fuel tanks should be located in dedicated areas fitted with:
   (1) mechanical protection of the tanks depending on location and cargo operations;
   (2) if located on an open deck, drip tray arrangements for leak containment and water spray systems for emergency cooling; and
   (3) if located in a fuel storage hold space, the space should meet the provisions of Ch 11 and Ch 13.
2. Portable fuel tanks should be secured to the deck while connected to the ship systems. The arrangement for supporting and fixing the tanks should be designed for the maximum expected static and dynamic inclinations, as well as the maximum expected values of acceleration, taking into account the ship characteristics and the position of the tanks.
3. Consideration should be given to the ship's strength and the effect of the portable fuel tanks on the ship's stability.
4. Connections to the ship's fuel piping systems should be made by means of approved flexible hoses suitable for methyl/ethyl alcohol or other suitable means designed to provide sufficient flexibility.
5. Arrangements should 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 should be connected to a fixed venting system.
7. Control and monitoring systems for portable fuel tanks should be integrated in the ship's control and monitoring system. A safety system for portable fuel tanks should be integrated in the ship's safety system (e.g. shutdown systems for tank valves, leak/vapour detection systems).
8. Safe access to tank connections for the purpose of inspection and maintenance should be ensured.
9. When connected to the ship's fuel piping system:
   (1) each portable tank should be capable of being isolated at any time;
   (2) isolation of one tank should not impair the availability of the remaining portable tanks; and
   (3) the tank should not exceed its filling limits.

Section 4 Machinery Space

401. Machinery space

1. A single failure within the fuel system should not lead to a release of fuel into the machinery space.
2. All fuel piping within machinery space boundaries should be enclosed in gas and liquid tight enclosures in accordance with Ch 9, 302..

Section 5 Location and Protection of Fuel Piping

501. Location and protection of fuel piping

1. Fuel pipes should not be located less than 800 mm from the ship's side.
2. Fuel piping should not be led directly through accommodation spaces, service spaces, electrical equipment rooms or control stations as defined in the SOLAS Convention.
3. Fuel pipes led through ro-ro spaces, special category spaces and on open decks should be protected against mechanical damage.
4. Fuel piping should comply with the following:
   (1) Fuel piping that passes through enclosed spaces in the ship should be enclosed in a pipe or duct that is gas and liquid tight towards the surrounding spaces with the fuel contained in the inner pipe. Such double walled piping is not required in cofferdams surrounding fuel tanks, fuel preparation spaces or spaces containing independent fuel tanks as the boundaries for these spaces will serve as a second barrier

(2) All fuel pipes should be self-draining to suitable fuel or collecting tanks in normal condition of trim and list of the ship. Alternative arrangements for draining the piping may be accepted by the Society.

Section 6 Fuel Preparation Spaces Design

601. Fuel preparation spaces design

1. Fuel preparation spaces should be located outside machinery spaces of category A.

Section 7 Bilge systems

701. Bilge systems

1. Bilge systems installed in areas where methyl/ethyl alcohol can be present should be segregated from the bilge system of spaces where methyl alcohol or ethyl alcohol cannot be present.
2. One or more holding tanks for collecting drainage and any possible leakage of methyl/ethyl alcohol from fuel pumps, valves or from double walled inner pipes, located in enclosed spaces should be provided. Means should be provided for safely transferring contaminated liquids to onshore reception facilities.
3. The bilge system serving the fuel preparation space should be operable from outside the fuel preparation space.

Section 8 Drip trays

801. Drip trays

1. Drip trays should be fitted where leakage and spill may occur, in particular in way of single wall pipe connections.
2. Each tray should have a sufficient capacity to ensure that the maximum amount of spill according to the risk assessment can be handled.
3. Each drip tray should be provided with means to safely drain spills or transfer spills to a dedicated holding tank. Means for preventing backflow from the tank should be provided.
4. Drip trays for leakage of less than 10 litres may be provided with means for manual emptying.
5. The holding tank should be equipped with a level indicator and alarm and should be inerted at all times during normal operation.

Section 9 Arrangement of Entrances and Other Openings in Enclosed Spaces

901. Arrangement of entrances and other openings in enclosed spaces

1. Direct access should not be permitted from a non-hazardous area to a hazardous area. Where such openings are necessary for operational reasons, an airlock which complies with the provisions of 1001. should be provided.
2. Fuel preparation spaces should have independent access direct from open deck. Where a separate access from open deck is not practicable, an airlock complying with 1001. should be provided.
3. Fuel tanks and surrounding cofferdams should have suitable access from the open deck, where practicable, for gas-freeing, cleaning, maintenance and inspection.

4. Without direct access to open deck, an entry space to fuel tanks or surrounding cofferdams should be provided and comply with the following:
   (1) be fitted with an independent mechanical extraction ventilation system, providing a minimum of six air changes per hour; a low oxygen alarm and a gas detection alarm should be fitted;
   (2) have sufficient open area around the fuel tank hatch for efficient evacuation and rescue operation;
   (3) not be an accommodation space, service space, control station or machinery space of category A; and
   (4) a cargo space may be accepted as an entry space, depending upon the type of cargo, if the area is cleared of cargo and no cargo operation is undertaken during entry to the space.
5. The area around independent fuel tanks should be sufficient to carry out evacuation and rescue operations.
6. For safe access, horizontal hatches or openings to or within fuel tanks or surrounding cofferdams should have a minimum clear opening of 600 X 600 mm that also facilitates the hoisting of an injured person from the bottom of the tank/cofferdam. For access through vertical openings providing main passage through the length and breadth within fuel tanks and cofferdams, the minimum clear opening should not be less than 600 X 800 mm at a height of not more than 600 mm from bottom plating unless gratings or footholds are provided. Smaller openings may be accepted provided evacuation of an injured person from the bottom of the tank/cofferdam can be demonstrated.

Section 10 Airlocks

1001. Airlocks

1. An airlock 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, the door sill should not be less than 300 mm in height. The doors should be self-closing without any hold-back arrangements.
2. Airlocks should be mechanically ventilated at an overpressure relative to the adjacent hazardous area or space.
3. Airlocks should have a simple geometrical form. They should provide for free and easy passage, and should have a deck area not less than 1.5 m^2. Airlocks should not be used for other purposes, for instance as storerooms.
4. An audible and visual alarm system to give a warning on both sides of the airlock should be provided to indicate if more than one door is moved from the closed position.
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 should be restricted until the ventilation has been reinstated. Audible and visual alarms should be given at a manned location to indicate both loss of pressure and opening of the airlock doors when pressure is lost.
6. Essential equipment required for safety should not be de-energized and should be of a certified safe type. This may include lighting, fire detection, gas detection, public address and general alarms systems.
7. Electrical equipment which is not of the certified safe type for propulsion, power generation, manoeuvring, anchoring and mooring equipment as well as the emergency fire pumps should not be located in spaces to be protected by airlocks. ⚓

CHAPTER 6 FUEL CONTAINMENT SYSTEM

Section 1 Goal

101. Goal

1. Ch 6, 101. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 2 Functional Requirements

201. Functional requirements

1. This chapter refers to Functional requirements 1, 2, 5, 8~11 and 13~17 of Ch 2, 201. of Rules for the Classification of Ships Using Low-flashpoint Fuels are to be applied.
2. The fuel tanks should be designed such that a leakage from the fuel tank or its connections does not endanger the ship, persons on board or the environment. Potential dangers to be avoided include:
   (1) flammable fuels spreading to locations with ignition sources;
   (2) toxicity potential and risk of oxygen deficiency or other negative impacts on crew health due to fuels and inert gases;
   (3) restriction of access to muster stations, escape routes or LSAs; and
   (4) reduction in availability of LSAs.
3. The fuel containment system and the fuel supply system should be designed such that safety actions after any leakage, irrespective of in liquid or vapour phase, do not lead to an unacceptable loss of power.
4. If portable tanks are used for fuel storage, the design of the fuel containment system should be equivalent to permanent installed tanks as described in this section.

Section 3 Atmosphere Control within the Fuel Containment System

301. Fuel tanks venting and gas freeing system

1. The fuel tanks should be fitted with a controlled tank venting system.
2. A fixed piping system should be arranged to enable each fuel tank to be safely gas-freed, and to be safely filled with fuel from a gas-free condition.
3. The formation of gas pockets during gas freeing operation should be avoided by considering the arrangement of internal tank structure and location of gas freeing inlets and outlets.
4. Pressure and vacuum relief valves should 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 containment system. If pressure relief valves (PRVs) of the high velocity type are fitted to the end of the vent pipes, they should be certified for endurance burning in accordance with IMO MSC/Circ.677. If PRVs are fitted in the vent line, the vent outlet should be fitted with a flame arrestor certified for endurance burning in accordance with IMO MSC/Circ.677.
5. Shut-off valves should not be arranged either upstream or downstream of the PRVs. By-pass valves may be provided. For temporary tank segregation purposes (maintenance) shut-off valves in common vent lines may be accepted if a secondary independent over/underpressure protection is provided to all tanks as per 6.3.7.
6. The fuel tank-controlled venting system should 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 PRVs should not be lower than 0.007 MPa below atmospheric pressure.

7. PRVs should vent to a safe location on open deck and should be of a type which allows the functioning of the valve to be easily checked.

8. The fuel tank vent system should be sized to permit bunkering at a design loading rate without over-pressurizing the fuel tank.

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

302. Inerting and atmospheric control within the fuel storage system

1. All fuel tanks should be inerted at all times during normal operation.

2. Cofferdams should be arranged either for purging or filling with water through a non-permanent connection. Emptying the cofferdams should be done by a separate drainage system, e.g. bilge ejector.

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

4. To prevent the return of flammable liquid and vapour to the inert gas system, the inert gas supply line should 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 should be installed between the double block and bleed arrangement and the fuel system. These valves should be located inside hazardous spaces.

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

6. Blanking arrangements should be fitted in the inert gas supply line to individual tanks. The position of the blanking arrangements should be immediately obvious to personnel entering the tank. Blanking should be via removable spool piece.

7. Fuel tank vent outlets should be situated normally not less than 3 m above the deck or gangway if located within 4 m from such gangways. The vent outlets are also 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. The vapour discharge should be directed upwards in the form of unimpeded jets.

8. Vapour outlets from fuel tanks should be provided with devices tested and type approved to prevent the passage of flame into the tank. Due attention should be paid in the design and position of the PRVs with respect to blocking and due to ice during adverse weather conditions. Provision for inspection and cleaning should be arranged.

9. The arrangements for gas-freeing and ventilation of fuel tanks should be such as to minimize the hazards due to the dispersal of flammable vapours to the atmosphere and to flammable gas mixture in the tanks. The ventilation system for fuel tanks should be exclusively for ventilating and gas-freeing purposes. Connection between fuel tank and fuel preparation space ventilation will not be accepted.

10. Gas-freeing operations should be carried out such that vapour is initially discharged in one of the following ways:
    (1) through outlets at least 3 m above the deck level with a vertical efflux velocity of at least 30 m/s maintained during the gas-freeing operation;
    (2) through outlets at least 3 m 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; or
    (3) through outlets underwater.

11. In designing a gas-freeing system in conformity with 301. 2 due consideration should be given to the following:
    (1) materials of construction of system;

(2) time to gas-free;
(3) flow characteristics of fans to be used;
(4) the pressure losses created by ducting, piping, fuel tank inlets and outlets;
(5) the pressure achievable in the fan driving medium (e.g. water or compressed air); and
(6) the densities of the fuel vapour/air mixture.

303. Inert gas availability on board

1. Inert gas should 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. A production plant and/or adequate storage capacities might be used to achieve availability target defined in 1.
3. Fluid used for inerting should not modify the characteristics of the fuel.
4. The production plant, if fitted, should be capable of producing inert gas with oxygen content at no time greater than 5% by volume. A continuous-reading oxygen content meter should be fitted to the inert gas supply from the equipment and should be fitted with an alarm set at a maximum of 5% oxygen content by volume. The system should be designed to ensure that if the oxygen content exceeds 5% by volume, the inert gas should be automatically vented+ to atmosphere.
5. The system should be able to maintain an atmosphere with an oxygen content not exceeding 8% by volume in any part of any fuel tank.
6. An inert gas system should have pressure controls and monitoring arrangements appropriate to the fuel containment system.
7. Where a nitrogen generator or nitrogen storage facilities are installed in a separate compartment outside of the engine-room, the separate compartment should be fitted with an independent mechanical extraction ventilation system, providing a minimum of six air changes per hour. If the oxygen content is below 19% in the separate compartment, an alarm should be given. A minimum of two oxygen sensors should be provided in each space. Visual and audible alarms should be placed at each entrance to the inert gas room.
8. Nitrogen pipes should only be led through well ventilated spaces. Nitrogen pipes in enclosed spaces should:
   (1) have only a minimum of flange connections as needed for fitting of valves and be fully welded; and
   (2) be as short as possible.
9. Notwithstanding the provisions of 303., inert gas utilized for gas-freeing of tanks may be provided externally to the ship. ⚓

CHAPTER 7 MATERIAL AND GENERAL PIPE DESIGN

Section 1 Goal

101. Goal

1. Ch 7, 101. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 2 Functional Requirements

201. Functional requirements

This Chater relates to functional requirements **1**, **6**, **8**, **9** and **10** of **Ch 2, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**. In particular, all materials used should be suitable for the fuel under the maximum working pressure and temperature.

Section 3 Pipe Design

301. General pipe design

1. The design pressure for any section of the fuel piping system 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. The wall thickness of pipes made of steel is to be applied in accordance with **Ch 7, 302. 1** of **Rules for the Classification of Ships Using Low-flashpoint Fuels.**
3. For pipes made of steel the allowable stress K to be considered in the formula for t0 in **2** is the lower of the following values:

   Rm / A or Re / B

   where:
   Rm = 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

   The values of A and B should be at least A = 2.7 and B = 1.8.
4. Where necessary for mechanical strength to prevent damage, collapse, excessive sag or buckling of pipes due to superimposed loads, the wall thickness should be increased over that required by **2** or, if this is impracticable or would cause excessive local stresses, these loads should 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.
5. For pipes made of materials other than steel, the allowable stress should be considered by the Society.
6. High pressure fuel piping systems should have sufficient constructive and fatigue strength. This should 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.
7. Fuel pipes and all the other piping needed for safe and reliable operation and maintenance should

be colour marked in accordance with a standard at least equivalent to those acceptable to the Society.

8. All fuel piping and independent fuel tanks should be electrically bonded to the ship's hull. Electrical conductivity should be maintained across all joints and fittings. Electrical resistance between piping and the hull should be maximum 10^6 Ohm.

9. Piping other than fuel supply piping and cabling may be arranged in the double wall piping or duct provided that it does not create a source of ignition or compromise the integrity of the double pipe or duct. The double wall piping or duct should only contain piping or cabling necessary for operational purposes.

10. Filling lines to fuel tanks should be arranged to minimize the possibility for static electricity, e.g. by reducing the free fall into the fuel tank to a minimum.

11. The arrangement and installation of fuel piping should provide the necessary flexibility to maintain the integrity of the piping system in the actual service situations, taking potential for fatigue into account. Expansion bellows should not be used.

12. Piping fabrication and joining details

(1) The inner piping, where a protective duct is required, is to be full penetration butt-welded, and fully radiographed. Flange connections in this piping are to only be permitted within the tank connection space and fuel preparation space or similar;
  (A) during the use of the fuel piping, all doors, ports and other openings on the corresponding superstructure or deckhouse side should normally be kept closed; and
  (B) the annular space in the double walled fuel piping should be segregated at the engine room bulkhead; this implies that there should be no common ducting between the engine-room and other spaces.

(2) Piping for fuel should be joined by welding except:
  (A) for approved connections to shut-off valve and expansion joints, if fitted; and
  (B) for other exceptional cases specifically approved by the Society.

(3) The following direct connections of pipe length without flanges may be considered:
  (A) butt-welded joints with complete penetrations at the root;
  (B) slip-on welded joints with sleeves and related welding having dimensions in accordance with recognized standards should only be used in pipes having an external diameter of 50 mm or less; the possibility for corrosion is to be considered; and
  (C) screwed connections, in accordance with recognized standards, should only be used for piping with an external diameter of 25 mm or less.

(4) Welding, post-weld heat treatment, radiographic testing, dye penetrating testing, pressure testing, leakage testing and non-destructive testing should be performed in accordance with recognized standards. Butt welding should be subject to 100% non-destructive testing, while sleeve welds should be subject to at least 10% liquid penetrant testing(PT) or magnetic particle testing(MT).

(5) Where flanges are used, they should be of the welded-neck or slip-on type. Socket welds are not to be used in nominal sizes above 50 mm.

(6) Expansion of piping should normally be allowed for by the provision of expansion loops or bends in the fuel piping system. Use of expansion joints used in high pressure4 fuel systems should be approved by the Society. Slip joints should not be used.

(7) Other connections: Piping connections should be joined in accordance with (2), but for other exceptional cases the Society may consider alternative arrangements.

Section 4 Materials

401. Provisions for materials

Due consideration should be taken with respect to the corrosive nature of fuel when selecting materials. ⚓

CHAPTER 8 BUNKERING

Section 1 Goal

101. Goal

1. Ch 8, 101. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 2 Functional Requirements

201. Functional requirements

1. Ch 8, 201. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 3 Bunkering Station

301. General

1. The bunkering station should be located on open deck so that sufficient natural ventilation is provided. Closed or semi-enclosed bunkering stations should be subject to special consideration with respect to provisions for mechanical ventilation. The Society may require special risk assessment.
2. Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations should not face the bunkering station.
3. Closed or semi-enclosed bunkering stations should be surrounded by gas and liquid-tight boundaries against enclosed spaces.
4. Bunkering lines should not be led directly through accommodation, control stations or service spaces. Bunkering lines passing through non-hazardous areas in enclosed spaces should be double-walled or located in gas-tight ducts.
5. Arrangements should be made for safe management of fuel spills. Coamings and/or drip trays should be provided below the bunkering connections together with a means of safely collecting and storing spills. This could be a drain to a dedicated holding tank equipped with a level indicator and alarm. Where coamings or drip trays are subject to rainwater, provisions should be made to drain rainwater overboard.
6. 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 are to be operable under all ambient conditions.‘

302. Ships bunker hoses

1. Bunker hoses carried on board are to be suitable for methyl/ethyl alcohol. Each type of bunker hose, complete with end-fittings, should be prototype-tested at a normal ambient temperature, with 200 pressure cycles from zero to at least twice the specified maximum working pressure. After this cycle pressure test has been carried out, the prototype test should demonstrate a bursting pressure of at least 5 times its specified maximum working pressure at the upper and lower extreme service temperature. Hoses used for prototype testing should not be used for bunker service.
2. Before being placed in service, each new length of bunker hose produced should be hydrostatically tested at ambient temperature to a pressure not less than 1.5 times its specified maximum working pressure, but not more than two fifths of its bursting pressure. The hose should be stencilled, or otherwise marked, with the date of testing, its specified maximum working pressure and, if used in services other than ambient temperature services, its maximum and minimum service temperature, as applicable. The specified maximum working pressure should not be less than 1 MPa gauge.

3. Means should be provided for draining any fuel from the bunkering hoses upon completion of operation.

4. Where fuel hoses are carried on board, arrangements should 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 six air changes per hour.

Section 4 Manifold

401. Manifold

1. 1. Ch 8, 401. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 5 Bunkering System

501. Provisions for bunkering system

1. Means should be provided for draining any fuel from the bunkering lines upon completion of operation.

2. Bunkering lines should be arranged for inerting and gas freeing. When not engaged in bunkering, the bunkering lines should be free of gas, unless the consequences of not gas freeing is evaluated and approved.

3. A ship-shore link (SSL) or an equivalent means for automatic and manual ESD communication to the bunkering source should be fitted.

4. In the bunkering line, as close to the connection point as possible, there should 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 should be possible to operate this remotely operated valve from the bunkering control station.

5. Where bunkering lines are arranged with a cross-over, suitable isolation arrangements should be provided to ensure that fuel cannot be transferred inadvertently to the ship side not in use for bunkering. ⚓

CHAPTER 9 FUEL SUPPLY TO CONSUMER

Section 1 Goal

101. Goal

1. Ch 9, 101. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 2 Functional requirements

902. Functional requirements

This Chapter is related to functional requirements **1~ 6, 8 ~ 11, 14 ~ 18** of **Ch 2, 201** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**.

Section 3 General Requirements

301. General requirements for fuel supply system

1. The fuel piping system should be separate from all other piping systems.
2. The fuel supply system should be arranged such that the consequences of any release of fuel will be minimized, while providing safe access for operation and inspection. The causes and consequences of release of fuel should be subject to special consideration within the risk assessment.
3. The piping system for fuel transfer to the consumers should be designed in a way that a failure of one barrier cannot lead to a leak from the piping system into the surrounding area causing danger to the persons on board, the environment or the ship.
4. Fuel lines should be installed and protected so as to minimize the risk of injury to persons on board in case of leakage.

302. Requirements for fuel distribution

1. The outer pipe or duct should be gas and liquid tight.
2. The annular space between inner and outer pipe should have mechanical ventilation of underpressure type with a capacity of minimum 30 air changes per hour and be ventilated to open air. Appropriate means for detecting leakage into the annular space should be provided. The double wall enclosure should be connected to a suitable draining tank allowing the collection and the detection of any possible leakage.
3. Inerting of the annular space might be accepted as an alternative to ventilation. Appropriate means of detecting leakage into the annular space should be provided. Suitable alarms should be provided to indicate a loss of inert gas pressure between the pipes.
4. The outer pipe in the double-walled fuel pipes should be dimensioned for a design pressure not less than the maximum working pressure of the fuel pipes. As an alternative the calculated maximum built-up pressure in the duct in the case of an inner pipe rupture may be used for dimensioning of the duct.

Section 4 Redundancy of fuel supply

401. Redundancy of fuel supply

1. Propulsion and power generation arrangements, together with fuel supply systems, should be arranged so that a failure in fuel supply does not lead to an unacceptable loss of power.

Section 5 Safety Functions of the Fuel Supply System

501. Safety functions of the fuel supply system

1. All fuel piping should be arranged for gas-freeing and inerting.
2. Fuel tank inlet and outlet valves should be as close to the tank as possible. Valves required to be operated under normal operation, such as when fuel is supplied to consumers or during bunkering, should be remotely operated if not easily accessible.
3. The main fuel supply line to each consumer or set of consumers should be equipped with an automatically-operated master fuel valve. The master fuel valve(s) should be situated in the part of the piping that is outside the machinery space containing methyl/ethyl alcohol-fuelled consumer(s). The master fuel valve(s) should automatically shut off the fuel supply in accordance with Ch 15 201. 2 and table 1.
4. Means of manual emergency shutdown of fuel supply to the consumers or set of consumers should be provided on the primary and secondary escape routes from the consumer compartment, at a location outside consumer space, outside the fuel preparation space and at the bridge. The activation device should be arranged as a physical button, duly marked and protected against inadvertent operation and operable under emergency lighting.
5. The fuel supply line to each consumer should be provided with a remotely operated shut-off valve.
6. There should be one manually operated shutdown valve in the fuel line to each consumer to ensure safe isolation during maintenance.
7. Valves should be of the fail-safe type.
8. When pipes penetrate the fuel tank below the top of the tank a remotely operated shut-off valve should be fitted to the fuel tank bulkhead. When the fuel tank is adjacent to a fuel preparation space, the valve may be fitted on the tank bulkhead on the fuel preparation space side.

Section 6 Fuel Preparation Spaces

601. Fuel preparation spaces

1. Any fuel preparation space should not be located within a machinery space of category A, should be gas and liquid tight to surrounding enclosed spaces and vented to open air.

602. Pumps

1. Hydraulically powered pumps that are submerged in fuel tanks should be arranged with double barriers preventing the hydraulic system serving the pumps from being directly exposed to methyl/ethyl alcohol. The double barrier should be arranged for detection and drainage of eventual methyl/ethyl alcohol leakage.
2. All pumps in the fuel system should 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 should be provided with relief valves. Each relief valve should 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. ⚓

CHAPTER 10 POWER GENERATION INCLUDING PROPULSION AND OTHER ENERGY CONVERTERS

Section 1 Goal

101. Goal

1. Ch 10, 101. of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 2 Functional Requirements

201. Functional requirements

1. This Chapter is related to functional requirements as described in 1, 11 and 14 ~ 18 of Ch 2, 201 of **Rules for the Classification of Ships Using Low-flashpoint Fuels**. In particular the following apply:
   (1) the exhaust system should be designed to prevent any accumulation of unburnt fuel; and
   (2) each fuel consumer should have a separate exhaust system.
2. One single failure in the fuel system should not lead to an unacceptable loss of power.

Section 3 General

301. General

1. All engine components and engine-related systems should be designed in such a way that fire and explosion risks are minimized.
2. Engine components containing methyl/ethyl alcohol fuel should be effectively sealed to prevent leakage of fuel into the machinery space.
3. For engines where the space below the piston is in direct communication with the crankcase, a detailed evaluation regarding the hazard potential of fuel gas accumulation in the crankcase should be carried out and reflected in the safety concept of the engine.
4. A means should be provided to monitor and detect poor combustion or misfiring. In the event that it is detected, continued operation may be allowed, provided that the fuel supply to the concerned cylinder is shut off and provided that the operation of the engine with one cylinder cut-off is acceptable with respect to torsional vibrations.

Section 4 Engines

401. Dual-fuel engines

1. In case of shut-off of the methyl/ethyl alcohol supply, the engines should be capable of continuous operation by oil fuel only without interruption.
2. An automatic system should be fitted to change over from methyl/ethyl alcohol fuel operation to oil fuel operation with minimum fluctuation of the engine power. Acceptable reliability should be demonstrated through testing. In the case of unstable operation on engines when methyl/ethyl alcohol firing, the engine should automatically change to oil fuel mode. There should also be possibility for manual change over.
3. In case of an emergency stop or a normal stop, the methyl/ethyl alcohol fuel should be automatically shut off not later than the pilot oil fuel. It should 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.

402. Single fuel engines

1. In case of a normal stop or an emergency shutdown, the methyl/ethyl alcohol fuel supply should be shut off not later than the ignition source. It should not be possible to shut off the ignition source without first or simultaneously closing the fuel supply to each cylinder or to the complete engine. ⚓

CHAPTER 11 FIRE SAFETY

Section 1 Goal

101. Goal

The goal of this Chapter is to provide fire protection, detection and fighting for all systems related to storing, handling, transfer and use of methyl/ethyl alcohol as fuel.

Section 2 Functional Requirements

201. Functional requirements

This Chapter is related to functional requirements in **1**, **2**, **4**, **5**, **12**, **14** and **16** of **Ch 2, 201** of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 3 General Requirements

301. General provisions

The provisions in this section are additional to those given in **Pt 8** of **Rules for the classification of steel ships**.

Section 4 Fire Protection

401. Fire protection

1. For the purposes of fire protection, fuel preparation spaces should be regarded as machinery space of category A. Should the space have boundaries towards other machinery spaces of category A, accommodation, control station or cargo areas, these boundaries should not be less than A-60.
2. Any boundary of accommodation up to navigation bridge windows, service spaces, control stations, machinery spaces and escape routes, facing fuel tanks on open deck should have A-60 fire integrity.
3. For fire integrity, the fuel tank boundaries should be separated from the machinery spaces of category-A and other rooms with high fire risks by a cofferdam of at least 600 mm, with insulation of not less than A-60 class.
4. The bunkering station should 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.

Section 5 Fire main

501. Fire main

1. When the fuel storage tank is located on the open deck, isolating valves should be fitted in the fire main in order to isolate damaged sections of the fire main. Isolation of a section of fire main should not deprive the fire line ahead of the isolated section from the supply of water.

502. Fire fighting

1. Where fuel tanks were located on open deck, there should be a fixed fire-fighting system of alcohol-resistant foam type, as set out in **chapter 17** of the **IBC Code** and, where appropriate, **chapter 14** of the **FSS Code**.
2. The alcohol-resistant foam type fire-fighting system should cover the area below the fuel tank where a spill of fuel could be expected to spread.
3. The bunker station should have a fixed fire-extinguishing system of alcohol resistant foam type and a portable dry chemical powder extinguisher or an equivalent extinguisher, located near the entrance of the bunkering station.
4. Where fuel tanks are located on open deck, there should be a fixed water spray system for diluting eventual spills, cooling and fire prevention. The system should cover exposed parts of the fuel tank.
5. A fixed fire detection and fire alarm system complying with **FSS Code** should be provided for all compartments containing the methyl/ethyl alcohol fuel system.
6. Suitable detectors should be selected based on the fire characteristics of the fuel. Smoke detectors should be used in combination with detectors which can more effectively detect methyl/ethyl alcohol fires.
7. Means to ease detection and recognition of methyl/ethyl alcohol fires in machinery spaces should be provided for fire patrols and for fire-fighting purposes, such as portable heat-detection devices.

503. Fire extinguishing of engine-room and fuel preparation space

1. Machinery space and fuel preparation space where methyl/ethyl alcohol-fuelled engines or fuel pumps are arranged should be protected by an approved fixed fire-extinguishing system in accordance with **Pt 8, Ch 8** of **Rules for the classification of steel ships** and the **FSS Code**. In addition, the fire-extinguishing medium used should be suitable for the extinguishing of methyl/ethyl alcohol fires.
2. An approved alcohol-resistant foam system covering the tank top and bilge area under the floor plates should be arranged for machinery space category A and fuel preparation space containing methyl/ethyl alcohol. ⚓

CHAPTER 12 EXPLOSION AND AREA CLASSIFICATION

Section 1 Goal

101. Goal

1. Ch 12, 101. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 2 Functional Requirements

201. Functional requirements

This Chapter is related to functional requirements 1~ 6, 8, 11 and 13~18 of Ch 2, 201 of Rules for the Classification of Ships Using Low-flashpoint Fuels. The probability of explosions should be reduced to a minimum by:

1. reducing the number of sources of ignition;
2. reducing the probability of formation of ignitable mixtures; and
3. the use of certified safe type electrical equipment suitable for the hazardous zone where the use of electrical equipment in hazardous areas is unavoidable.

Section 3 General Requirements

301. General requirements

1. Hazardous areas on open deck and other spaces not addressed in this section should be analysed and classified based on a recognized standard. The electrical equipment fitted within hazardous areas should be according to the same standard.
2. All hazardous areas should be inaccessible to passengers and unauthorized crew at all times.

Section 4 Area Classification

401. Area classification

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.
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, according to Sec 5.. In cases where the prescriptive provisions in Sec 5.. are deemed to be inappropriate, area classification according to IEC 60079-10-1:2015 should be applied with special consideration by the Society.
3. Ventilation ducts should have the same area classification as the ventilated space.

Section 5 Hazardous Area Zones

501. Hazardous area zone 0

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

502. 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 spaces;
3. areas on open deck, or semi-enclosed spaces on deck, within 3 m of any methyl/ethyl fuel tank outlet, gas or vapour outlet, bunker manifold valve, other methyl/ethyl fuel valve, methyl/ethyl fuel pipe flange, methyl/ethyl fuel preparation space 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 space entrances, fuel preparation space 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 fuel are located, e.g. ducts around methyl/ethyl fuel pipes, semi-enclosed bunkering stations; and
8. a space protected by an airlock is considered as non-hazardous area during normal operation, but will require equipment to operate following loss of differential pressure between the protected space and the hazardous area to be certified as suitable for zone 1.

503. 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 in 502. 4;
2. areas within 1.5 m surrounding other open or semi-enclosed spaces of zone 1 defined in 502; and
3. airlocks. ⚓

CHAPTER 13 VENTILATION

Section 1 Goal

101. Goal

The goal of this Chapter is to provide for the ventilation required for safe working conditions for personnel and the safe operation of machinery and equipment where methyl/ethyl alcohol is used as fuel.

Section 2 Functional Requirements

201. Functional requirements

This Chapter is related to functional requirements in **1**, **2**, **4**, **6**, **11** and **13** ~ **18** of **Ch 2, 201.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 3 General Requirements

301. General requirements

1. Ventilation inlets and outlets for spaces required to be fitted with mechanical ventilation should be located such that according to the International Load Line Convention they will not be required to have closing appliances.
2. Any ducting used for the ventilation of hazardous spaces should be separate from that used for the ventilation of non-hazardous spaces. The ventilation should function at all temperatures and environmental conditions the ship will be operating in.
3. Electric motors for ventilation fans should not be located in ventilation ducts for hazardous spaces unless the motors are certified for the same hazard zone as the space served.
4. Design of ventilation fans serving spaces where vapours from fuels may be present should fulfil the following:
   (1) ventilation fans should 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, should be of non-sparking construction defined as:
      (A) impellers or housings of non-metallic material, due regard being paid to the elimination of static electricity;
      (B) impellers and housings of non-ferrous metals;
      (C) impellers and housings of austenitic stainless steel;
      (D) 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; or
      (E) any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm tip design clearance;
   (2) in no case should 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; and
   (3) 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 should not be used in these places.
5. Ventilation systems required to avoid any vapour accumulation should consist of independent fans, each of sufficient capacity, unless otherwise specified in this **Part**. The ventilation system should be of a mechanical exhaust type, with extraction inlets located such as to avoid accumulation of vapour from leaked methyl/ethyl alcohol in the space.

6. Air inlets for hazardous enclosed spaces should be taken from areas that, in the absence of the considered inlet, would be non-hazardous. Air inlets for non-hazardous enclosed spaces should 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 should be gastight and have over-pressure relative to this space.

7. Air outlets from non-hazardous spaces should be located outside hazardous areas.

8. Air outlets from hazardous enclosed spaces should 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.

9. 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.

10. Non-hazardous spaces with entry openings to a hazardous area should be arranged with an airlock and be maintained at overpressure relative to the external hazardous area. The overpressure ventilation should 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 should be required to:
        (A) proceed with purging (at least five air changes) or confirm by measurements that the space is non-hazardous; and
        (B) pressurize the space; and
    (2) operation of the overpressure ventilation should be monitored and in the event of failure of the overpressure ventilation:
        (A) an audible and visual alarm should be given at a manned location; and
        (B) if overpressure cannot be immediately restored, automatic or programmed, disconnection of electrical installations according to a recognized standard6 should be required.

11. Non-hazardous spaces with entry openings to a hazardous enclosed space should be arranged with an airlock and the hazardous space should be maintained at underpressure relative to the non-hazardous space. Operation of the extraction ventilation in the hazardous space should be monitored and in the event of failure of the extraction ventilation:
    (1) an audible and visual alarm should be given at a manned location; and
    (2) if underpressure cannot be immediately restored, automatic or programmed, disconnection of electrical installations according to recognized standards in the non-hazardous space should be required.

12. Double bottoms, cofferdams, duct keels, pipe tunnels, hold spaces and other spaces where methyl/ethyl fuel may accumulate should be capable of being ventilated to ensure a safe environment when entry into the spaces is necessary.

Section 4 Fuel Preparation Spaces

401. Provisions for fuel preparation spaces

1. Fuel preparation spaces should be provided with an effective mechanical forced ventilation system of extraction type. During normal operation the ventilation should be at least 30 air changes per hour.

2. The number and power of the ventilation fans should 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 spaces and other fuel handling spaces should be in operation when pumps or other fuel treatment equipment are working.

Section 5 Bunkering Station

501. Provisions for bunkering station

1. Ch 13, 701. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 6 Ducts and double wall pipes

601. Ducts and double wall pipes

1. Ducts and double wall pipes containing fuel piping fitted with mechanical ventilation system of the extraction type should be provided with a ventilation capacity of at least 30 air changes per hour.
2. The ventilation system for double wall piping and ducts should be independent of all other ventilation systems.
3. The ventilation inlet for the double wall piping or duct should always be located in a non-hazardous area, in open air, away from ignition sources. The inlet opening should be fitted with a suitable wire mesh guard and protected from ingress of water.⚓

CHAPTER 14 ELECTRICAL INSTALLATIONS

Section 1 Goal

101. Goal

1. Ch 14, 101. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 2 Functional Requirements

201. Functional requirements

This Chapter is related to functional requirements in 1, 2, 3, 5, 8, 11, 14, 16, 17, and 18 of Ch 2, 201. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

Section 3 General Requirements

301. General requirements

1. Electrical installations should comply with a recognized standard (IEC 60092 series) at least equivalent to those acceptable.
2. Electrical equipment or wiring should not be installed in hazardous areas unless essential for operational purposes or safety enhancement.
3. Where electrical equipment is installed in hazardous areas as provided in 2, it should be selected, installed and maintained in accordance with IEC 60092-502 or other standards at least equivalent to those acceptable.
4. The lighting system in hazardous areas should be divided between at least two branch circuits. All switches and protective devices should interrupt all poles or phases and should be located in a non-hazardous area.
5. The onboard installation of the electrical equipment units should be such as to ensure the safe bonding to the hull of the units themselves. ⚓

CHAPTER 15 CONTROL, MONITORING AND SAFETY SYSTEMS

Section 1 Goal

101. Goal

1. Ch 15, 101. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 2 Functional Requirements

201. Functional requirements

This Chapter is related to functional requirements in 1, 2, 3, 9, 10, 11, 14, 15, and 18 of Ch 2, 201. of Rules for the Classification of Ships Using Low-flashpoint Fuels. In particular, the following apply:

1. the control, monitoring and safety systems of the methyl/ethyl alcohol installations should be arranged such that there is not an unacceptable loss of power in the event of a single failure;
2. a fuel safety system should be arranged to close down the fuel supply system automatically, upon failure in systems as described in table 1 and upon other fault conditions which may develop too fast for manual intervention;
3. the safety functions 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;
4. the safety systems including the field instrumentation should be arranged to avoid spurious shutdown, e.g. as a result of a faulty vapour detector or a wire break in a sensor loop; and
5. where two fuel supply systems are required to meet the provisions, each system should be fitted with its own set of independent fuel control and safety systems.

Section 3 General Requirements

301. General provisions

1. Suitable instrumentation devices should be fitted to allow a local and a remote reading of essential parameters to ensure a safe management of the whole fuel equipment including bunkering.
2. Liquid leakage detection should be installed in the protective cofferdams surrounding the fuel tanks, in all ducts around fuel pipes, in fuel preparation spaces, and in other enclosed spaces containing single-walled fuel piping or other fuel equipment.
3. The annular space in a double-walled piping system should be monitored for leakages and the monitoring system should be connected to an alarm system. Any leakage detected should lead to shutdown of the affected fuel supply line in accordance with table 1.
4. At least one bilge well with a level indicator should be provided for each enclosed space, where an independent storage tank without a protective cofferdam is located. A high-level bilge alarm should be provided. The leakage detection system should trigger an alarm and the safety functions in accordance with table 1.
5. For tanks not permanently installed in the vessel, a monitoring system equivalent to that provided for permanent installed tanks should be provided.

Section 4 Bunkering and Fuel Tank Monitoring

401. Level indicators for fuel tanks

1. Each fuel tank should be fitted with closed level gauging devices, arranged to ensure a level reading is always obtainable and unless any necessary maintenance can be carried out while the fuel tank is in service, two devices should be installed.

402. Overflow control

1. Each fuel tank should be fitted with a visual and audible high-level alarm. This should be able to be function tested from the outside of the tank and can be common with the level gauging system (configured as an alarm on the gauging transmitter), but should be independent of the high-high level alarm.
2. An additional sensor (high-high level) operating independently of the high liquid level alarm should automatically actuate a shut-off valve to avoid excessive liquid pressure in the bunkering line and prevent the tank from becoming liquid full.
3. The high and high-high level alarm for the fuel tanks should be visual and audible at the location at which gas-freeing by water filling of the fuel tanks is controlled, given that water filling is the preferred method for gas-freeing.

Section 5 Bunkering Control

501. Bunkering control

1. **Ch 15, 501.** of **Rules for the Classification of Ships Using Low-flashpoint Fuels** is to be applied.

Section 6 Engine Monitoring

601. Engine monitoring

In addition to the instrumentation provided in accordance with **Pt 5** of **Rules for the classification of steel ships**, indicators should be fitted on the navigation bridge, the engine control room and the manoeuvring platform for:

1. operation of methyl/ethyl alcohol fuel engines; and
2. operation and mode of operation of the engine in the case of dual fuel engines.

Section 7 Gas Detection

701. Gas detection

1. Permanently installed gas detectors should be fitted in:
   (1) all ventilated annular spaces of the double walled fuel pipes;
   (2) machinery spaces containing fuel equipment or consumers;
   (3) fuel preparation spaces;
   (4) other enclosed spaces containing fuel piping or other fuel equipment without ducting;
   (5) other enclosed or semi-enclosed spaces where fuel vapours may accumulate;
   (6) cofferdams and fuel storage hold spaces surrounding fuel tanks;
   (7) airlocks; and
   (8) ventilation inlets to accommodation and machinery spaces if required based on the risk assessment required in **Ch3, 201.**.

2. The number and placement of detectors in each space should be considered taking into account the size, layout and ventilation of the space. Gas dispersal analysis or a physical smoke test should be used to find the best arrangement.

3. Fuel vapour detection equipment should be designed, installed and tested in accordance with a recognized standard (IEC 60079-29-1).

4. An audible and visible alarm should be activated at a fuel vapour concentration of 20% of the lower explosion limit (LEL). The safety system should be activated at 40% of LEL at two detectors. Special consideration should be given to toxicity in the design process of the detection system.

5. For ventilated ducts and annular spaces around fuel pipes in the machinery spaces containing methyl/ethyl alcohol-fuelled engines, the alarm limit should be set to 20% LEL. The safety system should be activated at 40% of LEL at two detectors.

6. Audible and visible alarms from the fuel vapour detection equipment should be located on the navigation bridge, in the continuously manned central control station, safety centre and at the control location for bunkering as well as locally.

7. Fuel vapour detection required by this section should be continuous without delay.

Section 8 Fire Detection

801. Fire detection

1. Fire detection in machinery space containing methyl/ethyl alcohol engines and fuel storage hold spaces should give audible and visual alarms on the navigation bridge and in a continuously manned central control station or safety centre as well as locally.

Section 9 Ventilation

901. Ventilation

1. Any loss of the required ventilating capacity should give an audible and visual alarm on the navigation bridge and in a continuously manned central control station or safety centre as well as locally.

Section 10 Safety Functions of Fuel Supply Systems

1001. Provisions on safety functions of fuel supply systems

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

2. If a fuel leak leading to a fuel supply shutdown occurs, the fuel supply should not be operated until the leak has been found and dealt with. Instructions to this effect should be placed in a prominent position in the machinery space.

3. A caution placard or signboard should be permanently fitted in the machinery space containing methyl/ethyl-fuelled engines stating that heavy lifting, implying danger of damage to the fuel pipes, should not be done when the engine(s) is running on methyl/ethyl.

4. Pumps and fuel supply should be arranged for manual remote emergency stop from the following locations as applicable:

   (1) navigation bridge;
   (2) cargo control room;

(3) onboard safety centre;
(4) engine control room;
(5) fire control station; and
(6) adjacent to the exit of fuel preparation spaces

Table 1 Monitoring of gas supply system to engines

Parameter	Alarm	Automatic shutdown of tank valve (valve(s) referred to in Ch 9 501. 2)	Automatic shutdown of master fuel valve (valve(s) referred to in Ch 9 501. 3)	Automatic shutdown of bunkering valve	Remarks
High-level fuel tank	X			X	
High, high-level fuel tank	X			X	
Loss of ventilation in the annular space in the bunkering line	X			X	
Gas detection in the annular space in the bunkering line	X			X	
Loss of ventilation in ventilated areas	X				
Manual shutdown	X			X	
Liquid methyl/ethyl alcohol detection in the annular space of the double walled bunkering line	X			X	
Vapour detection in ducts around fuel pipes	X				
Vapour detection in cofferdams surrounding fuel tanks. One detector giving 20% of LEL	X				
Vapour detection in airlocks	X				
Vapour detection in cofferdams surrounding fuel tanks. Two detectors giving 40% of LEL	X	X		X	
Vapour detection in ducts around double walled pipes, 20% LEL	X				
Vapour detection in ducts around double walled pipes, 40% of LEL	X	X	X		
Liquid leak detection in annular space of double-walled pipes	X	X	X		
Liquid leak detection in engine-room	X	X			
Liquid leak detection in fuel preparation space	X	X			
Liquid leakage detection in protective cofferdams surrounding fuel tanks	X				

CHAPTER 16 TRAINING, DRILLS AND EMERGENCY EXERCISES

Section 1 Goal

101. Goal

The goal of this Chapter is to ensure that seafarers on board ships to which this **Part** apply, are adequately qualified, trained and experienced.

1. Methyl/ethyl alcohol fuel-related drills and exercises should be incorporated into schedule for periodical drills.

2. Such drills and exercises related to methyl/ethyl alcohol fuels could include for example:
   (1) tabletop exercise;
   (2) review of fuelling procedures based in the fuel handling manual required by **Ch 17, 201. 3**;
   (3) responses to potential contingencies;
   (4) tests of equipment intended for contingency response; and
   (5) reviews that assigned seafarers are trained to perform assigned duties during fuelling, operation and contingency response.

3. The response and safety system for hazards and accident control should be reviewed and tested.

4. The company should ensure that seafarers on board ships using methyl/ethyl alcohol fuels should have completed training to attain the abilities that are appropriate to the capacity to be filled and duties and responsibilities to be taken up.

5. The master, officers, ratings and other personnel on ships using methyl/ethyl alcohol fuels should be trained and qualified in accordance to the regulation V/3 of the STCW Convention and section A-V/3 of the STCW Code, taking into account the specific hazards of the methyl/ethyl alcohol used as fuel. ⚓

CHAPTER 17 OPERATION

Section 1 Goal

101. Goal

The goal of this Chapter is to ensure that operational procedures for the loading, storage, operation, maintenance and inspection of systems for methyl/ethyl alcohol fuels minimize the risk to personnel, the ship and the environment, and are consistent with practices for a conventional oil-fuelled ship whilst taking into account the nature of these fuels.

Section 2 Functional Requirements

201. Functional requirements

This Chapter is related to functional requirements in 1~3, 9, 11, 15, 16, and 17 of Ch 2, 201. of Rules for the Classification of Ships Using Low-flashpoint Fuels. In particular the following apply:

1. a copy of this Part or national regulations incorporating the provisions of the same, should be on board every ship covered by this Part;
2. maintenance procedures and information for all methanol/ethanol related installations should be available on board;
3. the ship should be provided with operational procedures including a suitably detailed fuel handling manual, such that trained qualified personnel can safely operate the fuel bunkering, storage and transfer systems; and
4. the ship should be provided with suitable emergency procedures.

Section 3 Maintenance

301. Maintenance

1. Maintenance and repair procedures should include considerations with respect to the fuel containment system and adjacent spaces. Special consideration should be given to the toxicity of fuel.
2. The procedures and information should include maintenance of electrical equipment that is installed in explosion hazardous spaces and areas. The inspection and maintenance of electrical installations in explosion hazardous spaces should be performed in accordance with recognized standards.

Section 4 Bunkering Operations

401. Responsibilities

1. Before any bunkering operation commences, the master of the receiving ship or their representative and the representative of the bunkering source (persons in charge, PIC) should:
   (1) agree in writing the transfer procedure including the maximum transfer rate at all stages and volume to be transferred;
   (2) agree in writing action to be taken in an emergency; and
   (3) complete and sign the bunker safety checklist.
2. Upon completion of bunkering operations, the ship PIC should receive and sign documentation containing a description of the product and the quantity delivered.

402. Control, automation and safety systems

1. The fuel handling manual required by 1702. 3 should include but not be limited to:
   (1) overall operation of the ship from dry-dock to dry-dock, including procedures for bunker loading and, where appropriate, discharging, sampling, inerting and gas freeing;
   (2) operation of inert gas systems;
   (3) fire-fighting and emergency procedures: operation and maintenance of fire-fighting systems and use of extinguishing agents;
   (4) specific fuel properties and special equipment needed for the safe handling of the particular fuel;
   (5) fixed and portable gas detection operation and maintenance of equipment;
   (6) emergency shutdown systems, where fitted; and
   (7) a description of the procedural actions to take in an emergency situation, such as leakage, fire or poisoning.
2. A fuel system schematic/piping and instrumentation diagram (P&ID) should be reproduced and permanently displayed in the ship's bunker control station and at the bunker station.

403. Pre-bunkering verification

1. Prior to conducting bunkering operations, pre-bunkering verification including, but not limited to the following, should be carried out and documented in the bunker safety checklist:
   (1) all communications methods, including ship shore link (SSL), if fitted;
   (2) operation of fixed fire detection equipment;
   (3) operation of portable gas detection equipment;
   (4) readiness of fixed and portable fire-fighting systems and appliances;
   (5) operation of remote-controlled valves; and
   (6) inspection of hoses and couplings.
2. Documentation of successful verification should be indicated by the mutually agreed and executed bunkering safety checklist signed by both PICs.

404. Ship bunkering source communications

1. Communications should be maintained between the ship PIC and the bunkering source PIC at all times during the bunkering operation. In the event that communications cannot be maintained, bunkering should stop and not resume until communications are restored.
2. Communication devices used in bunkering should comply with recognized standards for such devices acceptable to the Society.
3. PICs should have direct and immediate communication with all personnel involved in the bunkering operation.
4. The SSL or equivalent means to a bunkering source provided for automatic ESD communications, should be compatible with the receiving ship and the delivering facility ESD system. (Refer to ISO 28460)

405. Electrical bonding

Consideration should be given to the electrical insulation between ship and shore. ⚓

GUIDELINES FOR SHIPS USING LOW-FLASHPOINT FUELS (LPG & METHYL/ETHYL ALCOHOL)

Published by
KR
36, Myeongji ocean city 9-ro, Gangseo-gu,
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Website : http://www.krs.co.kr