2023

Provisional Guidance for Ships of Less Than 24 Meters Using Liquefied Petroleum Gas as Fuels

GC-43-E

KR

Introduction

As the IMO regulations enhanced on air pollutants discharged from ships are enforced, the transition from traditional ship fuel to eco-friendly ship fuel is accelerating. LNG was the first to enter into force as an international regulation (IGF Code) among eco-friendly alternative fuels. Although the demand for the use of LPG fuel as a ship fuel is emerging, concerns about safety coexist due to lack of experience and absence of domestic and foreign laws, so actual application of LPG as ships fuel has been hardly moving forward in actual application of LPG as ships fuel.

In response, Busan City started a project to demonstrate safety of LPG as ship's fuel by building a LPG fueled ship as a regulation-free special zone project, and proceeded with classification by KR to secure the safety of the ships subject to demonstration. For the requirements applied to the design and construction of the vessel to be demonstrated, it was decided to apply the interim guidelines for LPG fueled ships developed by IMO and alternative requirements were applied for unreasonable or unrealizable requirements in consideration of the vessel's purpose, operational characteristics, and size.

Based on the interim guidelines for LPG fueled ships developed by IMO, this provisional guidance was developed by a method of developing alternative requirements for unreasonable or unrealizable requirements identified in the registration inspection process during manufacturing of ships subject to demonstration of the Regulation Free Zone Project. This provisional guidance is developed in the shipbuilding stage, and will be issued as a guidance after confirming and reflecting the safety during the operation demonstration process of the ship subject to this project.

CONTENTS

CHAPTER 1 GENERAL

Section 1 General

101. Application

1. This guidance apply to vessels of less than 24 meters in length that use liquefied petroleum gas fuel and navigate within domestic coastal areas. However, it does not apply to passenger ships.
2. Other requirements not specified in this Guidance are, in principle, to be in accordance with relevant requirements in the **Rules for the Classification of Ships Using Low-flashpoint Fuels**.

102. Definitions

The definitions of terms are to be followed to **Rules for the Classification of Ships Using Low-flashpoint Fuels** unless otherwise specified in this Guidance.

1. **Fuel containment system** is the arrangement for the storage of fuel including tank connections. The spaces around the fuel tank are defined as follows:
   (1) Fuel storage hold space is the space enclosed by the ship's structure in which a fuel containment system is situated. If tank connections are located in the fuel storage hold space, it will also be a tank connection space;
   (2) Tank connection space is a space surrounding all tank connections and tank valves that is required for tanks with such connections in enclosed spaces.
2. **LPG** means liquefied petroleum gas. It is mainly composed of a mixture of propane (C3H8) and butane (C4H10) and may contain small amounts of other hydrocarbons and impurities. In this Guidance, petroleum gas either in its liquefied or gaseous state is referred to as LPG.
3. Fuel means LPG.
4. **Gas dispersion analysis** means the analysis of the dispersion behavior of gases performed using appropriate modeling techniques such as computational fluid dynamics (CFD) analysis.
5. **Ventilation analysis** means the analysis of the ventilation efficiency of a space using appropriate modelling techniques such as CFD analysis.
6. **Effectiveness of ventilation** refers to the effect of ventilation to control the diffusion and persistence of an explosive gas atmosphere due to gas leakage, depending on the degree and efficiency of ventilation (refer to IEC 60079-10-1, 6.5.4).
7. **The 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, medium and low (refer to IEC 60079-10-1, 6.5.4).

103. Alternative design

1. This Guidance contains functional requirements for all appliances and arrangements related to the usage of LPG Fuel.
2. Appliances and layout of the LPG fuel system may deviate from those set out in this Guidance. Such appliances and layout can be used provided that these meet the intent of the goal and functional requirements concerned and provide an equivalent level of safety of the relevant Chapters.
3. The equivalence of the alternative design is to be approved by the Society. However, the Society is not to allow operational methods or procedures to be applied as an alternative to a particular fitting, material, appliance, apparatus, item of equipment, or type thereof which is prescribed by this Guidance. ⚓

CHAPTER 2 GOAL AND FUNCTIONAL REQUIREMENTS

Section 1 Goal

101. Goal

The goal of this Chapter 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 liquefied petroleum gas.

Section 2 Functional Requirements

201. Functional requirements

In addition to **Ch 2, Sec 2 of Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;.

1. In applying the requirements in **Ch 2, 201. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, special consideration may be given to ships which can be rescued, i.e. ships operating only in smooth water areas or ships with less than 2 hours voyage from the port of departure to the port of arrival.
2. In applying the requirements in **Ch 2, 201. 11. of Rules for the Classification of Ships Using Low-flashpiont Fuels**, Machinery and components should be considered with properties of all possible composition of the fuel to be used. ⚓

CHAPTER 3 GENERAL REQUIREMENTS

Section 1 Goal

101. Goal

The goal of this Chapter is to ensure that necessary risk assessments have been conducted to eliminate or reduce adverse effects on people on board, the environment or the ship.

Section 2 Risk Assessment

201. Risk assessment

1. A risk assessment is to be carried out to ascertain whether the risks arising from the use of LPG fuel have been addressed to the personnel on board, to the environment, and to the structural strength or integrity of the ship. Consideration should be given to hazards associated with the physical arrangement, operation and maintenance of reasonably predictable failures.
2. For ships using LPG as fuel, the risk assessment required by **1** need only be conducted where explicitly required by **Ch 3, 201. of Rules for the Classification of Ships Using Low-flashpiont Fuels** and the followings :
   (1) **401. 1** of **Ch 5**
   (3) **301. 2** of **Ch 6**
   (4) **601. 2** of **Ch 13**
3. The risk should analyzed using an acceptable and certified risk analysis technique, and at least loss of function, damage to components, fire, explosion, and electric shock should considered in the analysis. Analysis should performed to eliminate hazards wherever possible. Risks that cannot be eliminated should minimized to the necessary level.
4. The details of the risk and the means of mitigation are to be documented to the Society's 2. satisfaction in accordance with Guidance for Approval of Risk-based Ship Design.

Section 3 Limitation of Explosion Consequences

301. Limitation of explosion consequences

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

CHAPTER 4 CLASSIFICATION AND SURVEYS

Section 1 General

101. General

1. The classification and surveys of units 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 notations

Ships which comply with this Guidance may be assigned with the following LFFS notations and datails are as follows.

1. LFFS(DF-LPG): Dual fuel engines using LPG as fuel are installed

2. LFFS(SF-LPG): Single fuel engines using LPG as fuel are installed

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 Guidance.

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 documents in **Ch 4, 203. 3 of Rules for the Classification of Ships Using Low-flashpoint Fuels** except those not applicable to design temperature and tank type specified in this Guidance, the following documents are to be submitted.

(1) Arrangement of ventilation ducts in hazardous areas
(2) Detailed arrangement of gas detector
(3) Arrangement of ventilation in/out and route of double pipe/duct containing fuel pipe.

4. Plans and documents for reference

In addition to **Ch 4, 203. 4 of Rules for the Classification of Ships Using Low-flashpoint Fuels** except those not applicable to design temperature and ttank type specified in this Guidance, the following documents are to be submitted.

(1) Ventilation analysis and distributed analysis data performed in accordance with the requirements

of this Guidance.
(2) Design vapor pressure calculation formula for pressure type fuel tanks without temperature control devices
(3) Data for a risk analysis according to Ch 3, 201.

Section 3 Periodical Surveys

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

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 systems, fuel supply equipment and refuelling systems.

Section 2 Functional Requirements

201. Functional requirements

In addition to **Ch 5, Sec 2** of **Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. For the application of **Ch 5, 201, 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, locations of the source of release are to be determined taking into consideration 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. For the application of **Ch 5, 201, 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, openings are to be arranged so that the released gas does not escape to openings in non-hazardous areas, taking into account the specific gravity and dispersion characteristics of LPG vapor.

3. For the application of **Ch 5, 201, 5. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, special consideration may be given to ships which can be rescued, i.e. ships operating only in smooth water areas or ships with less than 2 hours voyage from the port of departure to the port of arrival.

Section 3 Arrangement of Fuel Tanks

301. General requirements

1. Fuel storage tanks are to be protected against mechanical damage.

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

302. Location of fuel tanks

1. The fuel tanks are to be protected from external damage caused by collision or grounding in the following way(see **Fig 5.1**):
   (1) The fuel tanks are to be located at a minimum distance of B/5, whichever is less, measured inboard from the ship side at right angles to the centreline at the level of the summer load line draught;
   (2) The boundaries of each fuel tank are to be taken as the extreme outer longitudinal, transverse and vertical limits of the tank structure including its tank valves.
   (3) For independent tanks the protective distance is to be measured to the tank shell.
   (4) In no case is the boundary of the fuel tank is not to be less than 600 mm from the hull shell or aft end. However, this distance may be mitigated for ships where the collision analysis proves that the fuel tanks are protected from external damage due to collision or grounding.
   (5) The lowermost boundary of the fuel tanks is to be located above the minimum distance of B/15, measured from the moulded line of the bottom shell plating at the centreline. However, this distance may be mitigated for ships where the collision analysis proves that the fuel tanks are protected from external damage due to collision or grounding.

(8) For ships with a hull structure providing higher collision and/or grounding resistance or proving that the fuel tank is protected from external damage due to collision or grounding through collision analysis, fuel tank location regulations may be specially considered in accordance with **Ch 1, 103.**

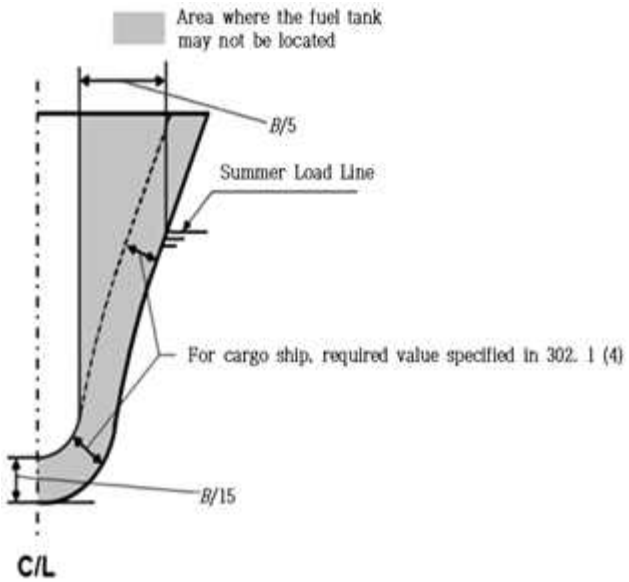

Fig 5.1 Location of Fuel Tank

2. As an alternative to **1.** (1) above, the following calculation method may be used to determine the acceptable location of the fuel tanks:

(1) The value f_{CN} calculated as described in the following is to be less than 0.04 for cargo ships. The value f_{CN} accounts for collision damages that may occur within a zone limited by the longitudinal projected boundaries of the fuel tank only, and cannot be considered or used as the probability for the fuel tank to become damaged given a collision. The real probability will be higher when accounting for longer damages that include zones forward and aft of the fuel tank.

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

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

where:

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

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

$$f_t = 1 - r(x1, x2, b)$$

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

f_v = the calculated value by use of the formulations for factor v contained in **SOLAS II-1/7-2.6.1.1** and reflects the probability that the damage is extending vertically above

the lowermost boundary of the fuel tank. The formulations to be used are:

$f_v = 1.0 - 0.8 \cdot ((H-d)/7.8)$, if $(H-d)$ is less than or equal to 7.8 m, f_v is not to be taken greater than 1.

$f_v = 0.2 - (0.2 \cdot ((H-d)-7.8)/4.7)$, in all other cases f_v is not be taken less than 0.

where:

H is the distance from baseline, in metres, to the lowermost boundary of the fuel tank; and

d is the deepest draught (summer load line draught).

(3) The boundaries of each fuel tank are to be taken as the extreme outer longitudinal, transverse and vertical limits of the tank structure including its tank valves.

(4) For independent tanks the protective distance is to be measured to the tank shell.

(5) In no case is the boundary of the fuel tank should be at least 600 mm from the hull shell or aft end. However, this distance may be mitigated for ships where the collision analysis proves that the fuel tanks are protected from external damage due to collision or grounding.

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

(7) In case the fuel tank arrangement is unsymmetrical about the centreline of the ship, the calculations of f_{CN} is to be calculated on both starboard and port side and the average value is to be used for the assessment. The minimum distance as set forth in (5) is to be met on both sides.

(8) For ships with a hull structure providing higher collision and/or grounding resistance, fuel tank location regulations may be specially considered in accordance with Ch 1, 103.

Section 4 Machinery Space Concepts

401. Machinery space concepts

In addition to Ch 5, 401. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the followings are to be applied;

1. Explosion-safe machinery spaces: The arrangements for machinery spaces are to be such that, under normal conditions, machinery spaces are non-hazardous. In addition, the gas concentration in machinery spaces should not reach 20% of the LEL as a result of a single damage to the liquefied petroleum gas fuel system by means of the following, and should be confirmed through a risk assessment:

(1) In machinery spaces, sources of gas leakage are to be minimized and effectiveness of ventilation is to be ensured.

(2) The fuel supply to the machinery space is to be shut off if gas is detected in the machinery space or if the machinery space ventilation fails.

Unless an alternative power source or alternative fuel supply source is secured in preparation for such fuel supply shut off specified in above (2), explosion safety machinery space is only applied to ships which can be rescued, i.e. ships operating only in smooth water areas or ships with less than 2 hours voyage from the port of departure to the port of arrival.

Section 5 Gas Safe Machinery Space

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

Section 6 ESD-Protected Machinery Spaces

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

Section 7 Explosion-safe machinery spaces

701. Explosion-safe machinery spaces

1. Measures are to applied prevent gas concentrations from reaching 20% of the LEL in machinery spaces The following arrangement is to be provided but may not be limited to:
   (1) Restriction of sources of gas leakage,
   (2) Gas detector,
   (3) Fuel supply shut-off valve, and
   (4) Efficient ventilation
2. Gas supply pipes within machinery spaces may be accepted without gastight external enclosure on the following conditions:
   (1) A single failure of the fuel system is not to lead to a gas concentration in machinery spaces exceeding 20% of the lower explosion limit.
   (2) In gas machinery spaces, gas leakage sources such as valves or joints are not to be installed except in unavoidable cases.
   (3) A fixed gas detection system is to be installed to automatically shut off the gas supply. The gas detection system should automatically cut off the gas supply when the detection concentration of the gas is 20% of the lower explosion limit.
   (4) An excess flow prevention valve is to be installed outside machinery spaces, and in case of abnormal flow due to damage to fuel pipes or joints, the overflow prevention valve is to be shut off. This anti-overflow valve can be functionally combined with a master gas valve.
3. Ventilation systems for explosion-safe machinery spaces are to be provided in accordance with **Ch 13, 501.**
4. Explosion-safe machinery spaces are to be designed to be well ventilated without geometrically accumulating gases or forming gas pockets.

Section 8 Location and Protection of Fuel Piping

801. Location and protection of fuel piping

In addition to **Ch 5, 701. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. For the application of **Ch 5, 701. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, fuel pipes are to not be located less than 600 mm from the ship's side. However, this distance may be mitigated for ships where the collision analysis proves that the fuel tanks are protected from external damage due to collision or grounding.
2. For the application of **Ch 5, 701, 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, gas fuel pipes in ESD protected machinery spaces and explosion-safe machinery spaces should be located as far as practicable from electrical installations and tanks containing flammable liquids.
3. For the application of **Ch 5, 701, 5. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, ESD protected machinery spaces and explosion-safe machinery spaces are to be protected against mechanical damage.
4. Double barriers around the fuel supply systems in a gas safe machinery space are to be continuous and not to have openings in machinery spaces. Where a gas valve unit are located in a gas safety machinery space, the means of access to the gas valve unit is permissible only though bolted hatch which can withstand the maximum leakage pressure.

Section 9 Fuel Preparation Room

901. Fuel preparation room

In addition to **Ch 5, 801. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. The fuel supply equipment may be installed in the tank connection space. Where potential sources of ignition such as compressors and pumps are installed in the tank connection space, both requirements for the tank connection space and the fuel preparation room are to be applied.

Section 10 Bilge Systems

1001. Bilge systems

1. Bilge systems installed in areas where fuel covered by this guidance applies can be present are to be separated from bilge systems in spaces where fuel cannot present.
2. Bilge in hazardous areas is to be constructed independently for each area and discharged overboard or led to a closed tank fitted with a gas detector. If bilges in one hazardous space are connected to bilges in other hazardous spaces, means are to be provided to prevent gas leaking from one space from entering other spaces through the connected bilge pipes.

Section 11 Drip Trays

1101. Drip trays

1. Drip trays are to be fitted where leakage may occur which can cause damage to the ship structure or where limitation of the area which is effected from a spill is necessary.
2. Drip trays are to be made of suitable material.
3. Each tray is to be fitted with a drain valve to enable rain water to be drained over the ship's side.
4. Each tray is to have a sufficient capacity to ensure that the maximum amount of spill according to the risk assessment can be handled.

Section 12 Arrangement of Entrances and Other Openings in Enclosed Spaces

1201. Arrangement of entrances and other openings in enclosed spaces

Other requirements not specified in this Guidance are to be in accordance with **Ch 5, 1101. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 5, 1101, 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, If the access to an ESD-protected machinery space and explosion-safe machinery spaces is from another enclosed space in the ship, the entrances are to be arranged with an airlock which complies with **Ch 5, Sec 13.**

Section 13 Airlocks

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

Section 14 Outlet of vent pipe and pressure relief pipe

1401. Outlet of vent pipe and pressure relief pipe

1. The following LPG vapor discharge pipes shall be connected to the tank vent pipe.
   (1) Tank pressure relief valve

(2) Vent pipe and bleed line of gas fuel supply pipe

2. The following liquefied petroleum gas liquid discharge lines should be connected to the fuel tank. However, in unavoidable cases, it can be connected to the tank vent pipe, but leakage of liquefied petroleum gas liquid from the vent outlet is not allowed.

(1) Pressure relief valve of liquid fuel supply pipe
(2) Vent pipe and bleed line of liquid fuel supply pipe
(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 **Ch 6, 201. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. For the application of **Ch 6, 201. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, special consideration may be given to ships which can be rescued, i.e. ships operating only in smooth water areas or ships with less than 2 hours voyage from the port of departure to the port of arrival.
2. The fuel containment system is to be designed considering the characteristics of the constituents of the fuel to be used.

Section 3 General Requirements

301. General requirements

In addition to **Ch 6, 301. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, the followings are to be applied;

1. **Ch 6, 301. 1. and 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels** are not apply.
2. For the application of **Ch 6, 301. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, even if the tank connection is on the open deck, if leaked liquefied petroleum gas is likely to accumulate or spread to non-hazardous spaces such as accommodation spaces and machinery spaces according to the risk assessment in accordance with **Ch 3, 201. 4**, tank connection spaces are to be installed and exhaust ventilation outlets are to be installed in safe locations.

Section 4 Liquefied Gas Fuel Containment

401. General

Other requirements not specified in this Guidance are to be in accordance with **Ch 6, 401. of Rules for the Classification of Ships Using Low-flashpoint Fuels.**

1. For the application of **Ch 6, 401. 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, Liquefied gas fuel containment systems are to be designed based on the sea conditions of the voyage area.
2. For the application of **Ch 6, 401. 4.** (10) **of Rules for the Classification of Ships Using Low-flashpoint Fuels**, Ultimate Design Condition – The structure of the liquefied gas fuel containment system and its structural elements must be able to withstand without loss of structural integrity the loads that may occur during construction, testing and foreseeable operation. The design should consider appropriate combinations of the following loads.

   (A) Internal pressure
   (B) External pressure

(C) Dynamic loads due to hull behavior in all load conditions
(D) Weight of fuel and tank on support structure
(E) Test load

402. Liquefied gas fuel containment safety principles

1. Secondary barriers are not required for liquefied fuel containment systems where the probability of structural failure and leakage through the primary barrier is extremely low and negligible, such as for independent tank type C.

403. Supporting arrangements

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

404. Associated structure and equipment

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

405. Thermal insulation

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

406. Design loads

1. General

Ch 6, 409. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

2. Permanent loads

Ch 6, 409. 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

3. Functional loads

Requirements not specified in this paragraph are to comply with Ch 6, 409. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels

(1) For the application of Ch 6, 409. 3. (3) of Rules for the Classification of Ships Using Low-flashpoint Fuels, When determining the functional loads, at least the effects from the following criteria are to be considered, and (C) and (G) are not apply.
internal pressure/
external pressure/
thermally induced loads/
vibration/
interaction loads/
loads associated with construction and installation/
test loads/
static heel loads/
weight of liquefied gas fuel/

4. Environmental loads

Requirements not specified in this paragraph are to comply with Ch 6, 409. 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

(1) Ch 6, 409. 4. (1) (C) to (H) of Rules for the Classification of Ships Using Low-flashpoint Fuels are not applicable.

5. Accidental loads

Accidental loads are defined as loads that are imposed on a liquefied gas fuel containment system and it's supporting arrangements under abnormal and unplanned conditions.

(1) Collision load
The collision load is to be determined based on the fuel containment system under fully loaded condition with an inertial force corresponding to design acceleration(a) in forward direction and "

$a/2$" in the aft direction, where design acceleration(a) is twice the gravitational acceleration("g"). However, special consideration is to be given to ships with Froude Number($Fn = V/\sqrt{gL}$, $g = 9.81\mathrm{m/s^2}$) > 0.4.

(2) Loads due to flooding on ship
For independent tanks, loads caused by the buoyancy of a fully submerged empty tank are to be considered in the design of anti-flotation chocks and the supporting structure in both the adjacent hull and tank structure.

407. Structural integrity

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

408. Structural analysis

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

409. Design conditions

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

410. Materials

1. Materials forming ship structure

(1) Requirements not specified in this paragraph are to comply with Ch 6, 413. 1. (1) of Rules for the Classification of Ships Using Low-flashpoint Fuels.
(A) Ch 6, 413. 1. (1) (B), (F) and (G) of Rules for the Classification of Ships Using Low-flashpoint Fuels are not applicable.

(2) Table 7.5 is given for all other hull structural materials where the temperature calculated from design conditions due to the influence of liquefied gas fuel is less than 0°C. This includes hull structures supporting liquefied gas fuel tanks, double bottom plating, longitudinal bulkhead plating, transverse bulkhead plating, floors, webs, stringers and all attached stiffeners.

(3) Ch 6, 413. 1. (3) and (4) of Rules for the Classification of Ships Using Low-flashpoint Fuels are not applicable.

2. Materials of primary and secondary barriers

Requirements not specified in this paragraph are to comply with Ch 6, 413. 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

(1) For the application of Ch 6, 410. 2. (1) of Rules for the Classification of Ships Using Low-flashpoint Fuels, Metallic materials used in the construction of primary barriers not forming the hull, is to be suitable for the design loads that they may be subjected to, and be in accordance with Table 7.1 or 7.2.

(2) For the application of Ch 6, 410. 2. (2) of Rules for the Classification of Ships Using Low-flashpoint Fuels, Materials, either non-metallic or metallic but not covered by Table 7.1, or 7.2, used in the primary barriers may be approved by the Society considering the design loads that they may be subjected to, their properties and their intended use.

(3) Where applicable, are to be tested for the range between the expected maximum temperature in service and 5 °C below the minimum design temperature, but not lower than minus 196 °C.

(4) Ch 6, 410. 2. (3), (5) and (6) of Rules for the Classification of Ships Using Low-flashpoint Fuels are not apply.

3. Thermal insulation and other materials used in liquefied gas fuel containment systems

Requirements not specified in this paragraph are to comply with Ch 6, 413. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

(1) For the application of Ch 6, 413. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels, if applicable, The above characteristics should be tested between the highest predicted temperature during use and a temperature 5°C lower than the lowest design temperature.

411. Construction processes

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

412. Tank types

Ch 6, 415. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied, and Ch 6, 415. 1, 2 and 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels are not applicable.

413. 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

501. Portable liquefied gas fuel tanks

Requirements not specified in below are to comply with Ch 6, 501. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

1. For the application of Ch 6, 501. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels, The design of the tank should be in accordance with Ch 6, 415. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels, or the portable fuel tank should have passed the inspection in accordance with the 'High Pressure Gas Safety Management Act' including accessories. The tank support structure (container frame or truck chassis) should be designed for its intended purpose.

Section 6 Pressure Relief System

601. General

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

602. Pressure relief systems for liquefied gas fuel tanks

In addition to Ch 6, 702. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the followings are to be applied;.

1. For the application of Ch 6, 702. 6. (2) of Rules for the Classification of Ships Using Low-flashpoint Fuels, The procedure shall make it possible to close only one of the pressure relief valves installed on the liquefied petroleum gas fuel tank and include a physical interlock for this purpose. However, a physical interlocking device may be replaced by a locking device so that the emergency separation means is normally kept open and a warning plate prohibiting the emergency separation means from being closed during operation.
2. For the application of Ch 6, 702. 7. of Rules for the Classification of Ships Using Low-flashpoint Fuels, (1) is a structure in which discharge is directed downwards overboard without obstruction, and item (3) does not applicable.
3. For the application of Ch 6, 702. 8. of Rules for the Classification of Ships Using Low-flashpoint Fuels, The discharge port of the pressure relief valve should be located as far away as possible from the following places, and the following should be confirmed through gas dispersion analysis.
   (1) Released gases do not enter air inlets, outlets or openings leading to accommodation, service and control areas and other non-hazardous areas.
   (2) The released gases do not create a flammable atmosphere at the exhaust vents of the machinery and other sources of ignition.
   (3) Released gases do not accumulate on open deck

603. Sizing of pressure relieving system

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

Section 7 Loading Limit for Liquefied Gas Fuel Tanks

701. Loading limit

In addition to Ch 6, 801. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the followings are to be applied.

1. Notwithstanding the requirements of Ch 6, 801. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels, in the case of pressurized independent tank type C, the loading limit may be 80% of the total tank volume in terms of volume.

Section 8 Maintaining of Fuel Storage Condition

801. Control of tank pressure and temperature

1. Liquefied gas fuel tanks should be designed to withstand the maximum gauge vapor pressure of the fuel corresponding to the upper limit temperature of the fuel inside the tank under the upper limit of the ambient design temperature.
2. Venting of fuel vapor to the atmosphere for tank pressure control is not permitted except in emergency situations.

802. Design of systems

1. The upper limits of the ambient design temperature are 45°C for air and 32°C for seawater. In particular, when sailing in hot or cold regions, this temperature is to be increased or decreased as deemed appropriate by the Society. Also, if the tank is installed on an open deck and exposed to the solar, the temperature rise inside the tank due to solar radiation should be considered as 65 °C.
2. Tanks are to be designed so that fuel vapors do not escape to the atmosphere even at the maximum pressure in the tank.

Section 9 Atmosphere 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 10 Inerting

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

Section 11 Inert Gas Production and Storage on Board

1101. Inert gas production and storage on board

1. The inert gas should not exceed 5% oxygen concentration (by volume).
2. Where a nitrogen storage facilities are installed in a separate compartment outside of the engine-room, the separate compartment is to be fitted with an independent mechanical extraction ventilation system, providing a minimum of 6 air changes per hour. A low oxygen alarm is to be

fitted.

3. Nitrogen pipes are to only be led through well ventilated spaces. Nitrogen pipes in enclosed spaces is to:
   (1) be fully welded;
   (2) have only a minimum of flange connections as needed for fitting of valves; and
   (3) be as short as possible. ⚓

CHAPTER 7 MATERIAL AND GENERAL PIPE DESIGN

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

201. Functional requirements

This section is additional requirements to **Ch 7, 201. of Rules for the Classification of Ships Using Low-flashpoint Fuels.**

1. **Ch 7, 201. 3. Rules for the Classification of Ships Using Low-flashpoint Fuels** does not apply.

Section 3 Pipe Design

301. General

Ch 7, 301. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

302. Wall thickness

Ch 7, 302. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

303. Design condition

Ch 7, 303. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

304. Allowable stress

Requirements not specified in below are to comply with **Ch 7, 304. of Rules for the Classification of Ships Using Low-flashpoint Fuels.**

1. **Ch 7, 304. 5. Rules for the Classification of Ships Using Low-flashpoint Fuels** does not apply.

305. Flexibility of piping

Ch 7, 305. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

306. Piping fabrication and joining details

Requirements not specified in below are to comply with **Ch 7, 306. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 7, 306. 4.** (1) (B) **of Rules for the Classification of Ships Using Low-flashpoint Fuels**, (a) does not apply.

Section 4 Materials

401. Metallic materials

Ch 7, 306. 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 piping systems are to be suitable for the temperature, pressure and composition of all LPG used on board.
2. If there is no means to control the vapor generated from the fuel tank during bunkering, a vapor collection connection should be installed on the manifold.

Section 3 Bunkering Station

301. General requirements

Requirements not specified in below are to comply with Ch 8, 301. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

1. For the application of Ch 8, 301. 6. of Rules for the Classification of Ships Using Low-flashpoint Fuels, During bunkering operations, the bunkering manifold area should be visible from the bunkering control station with the naked eye or CCTV.

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

401. Manifold

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

Section 5 Bunkering System

501. Bunkering system

Requirements not specified in below are to comply with Ch 8, 501. of Rules for the Classification of Ships Using Low-flashpoint Fuels. .

1. For the application of Ch 8, 501. 7. of Rules for the Classification of Ships Using Low-flashpoint Fuels, Means should be provided for communication with the bunker supplier during automatic and manual emergency shutdown (ESD). ⚓

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. The fuel supply system should be capable of supplying the required pressure, temperature and flow rate.

2. For the fuel supply piping system supplying LPG liquid, measures for purging, drain, vent and leakage should be specially considered to ensure safety equal to or higher than that for gas.

Section 3 Redundancy of Fuel Supply

301. Redundancy of fuel supply

In addition to Ch 9, 301. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the followings are to be applied.

1. For the application of Sec 3, special consideration may be given to ships which can be rescued, i.e. ships operating only in smooth water areas or ships with less than 2 hours voyage from the port of departure to the port of arrival.

Section 4 Safety Functions of Gas Supply System

401. Safety functions of gas supply system

Requirements not specified in below are to comply with Ch 9, 401. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

1. For the application of Ch 9, 401. 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels, each gas consuming device shall be equipped with a fuel shut-off valve with one manual shut-off valve and one automatic shut-off valve in series or a combination of manual and automatic valves. This valve is to be of the fail-to-close type. This valve is to close automatically when the safety devices required in Ch 15, 201. 2. are operated, and are also to be used for normal engine shutdown.

2. Ch 9, 401. 5, 6, 7 and 8. of Rules for the Classification of Ships Using Low-flashpoint Fuels are not applicable.

3. For the application of Ch 9, 401. 9. of Rules for the Classification of Ships Using Low-flashpoint Fuels, for single engine systems and multiple engine systems, where a separate master valve is provided for each engine, functions of the master gas fuel valve and the fuel shut-off valve in paragraph 1 can be combined.

4. For the application of Ch 9, 401. 10. of Rules for the Classification of Ships Using Low-flashpoint Fuels, for each main gas supply line entering ESD protected machinery space and explosion-safe machinery spaces and each gas supply line to high pressure installations, means is to be provided for rapid detection of a rupture in the gas line in the engine-room. When rupture is detected a valve is to be automatically shut off. This valve is to be located in the gas supply line before it en-

ters the engine-room or as close as possible to the point of entry inside the engine-room. It can be a separate valve or combined with other functions, e.g. the master valve.

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

601. Fuel supply to consumers in gas-safe machinery spaces

Requirements not specified in below are to comply with Ch 9, 601. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

1. Ch 9, 601. 1. (1) of Rules for the Classification of Ships Using Low-flashpoint Fuels does not apply.

1. For the application of Ch 9, 601. 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels, The connection of the duct to the gas pipe to the gas injection valve must be completely protected by the duct. This arrangement should allow replacement or disassembly of the injection valve and cylinder cover. In addition, all gas pipes of the engine itself until the gas is injected into the combustion chamber must be double ducted. Double ducts in the intake piping may be omitted if, during intake to the cylinders of a low-pressure engine, gas is supplied directly to each individual cylinder intake and no fuel gas release into the machinery space occurs due to a single failure. In addition, when the fuel supply pipe from the fuel inlet to the injection valve of the engine is composed of a cast block rather than a double pipe structure, a detailed evaluation of the potential risk of fuel leakage into the engine space due to a single damage is performed, and should be reflected in safety concept of the engine.

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

701. Fuel supply to consumers in ESD-protected machinery spaces or Explosion-safe Machinery Spaces

1. The pressure in the gas fuel supply system is not to exceed 1.0 MPa.

2. The gas fuel supply lines are to have a design pressure not less than 1.0 MPa.

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

801. The 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. High-pressure fuel piping the design pressure of the ducting

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

1. For the application of Ch 9, 802. 1. (2) of Rules for the Classification of Ships Using Low-flashpoint Fuels, For the k value, the most stringent value should be applied considering the usable composition ratio of the fuel.

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. The fuel consumption device should be designed to be suitable for operation with the characteristics of the components of the fuel to be used.

Section 3 Internal Combustion Engines of Piston Type

Ch 10, Sec 3 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied. ⚓

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 natural gas as ship fuel.

Section 2 Functional Requirements

201. 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. Fuel preparation rooms are to be separated into A-60 class from machinery spaces of category A and areas of high fire risk.

2. This section is additional requirements to Ch 11, 301. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels. A fuel storage hold area of independent tank type C may be considered as a cofferdam if the following requirements are met:
   (1) Independent tanks of type C are not to be located directly above machinery spaces or other spaces with a high fire risk.
   (2) The minimum distance from the boundary of an independent tank type C shell plating or tank junction area to the A-60 class boundary shall not be less than 900 mm.

Section 4 Water Spray Systems

401. Water spray systems

Requirements not specified in below are to comply with Ch 11, 501. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

1. For the application of Ch 11, 501. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels, the water spraying system is to protect the boundaries of superstructures, compressor rooms, pump rooms, bunkering control stations, bunkering stations and normally occupied accommodation at a distance of not more than 5m from fuel storage tanks on open decks and facing tanks.

2. For the application of Ch 11, 501. 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels, In order to isolate the damaged part, stop valves should be installed at appropriate intervals or the system should be divided into two or more independently operated parts. However, the necessary controls shall be located in an easily accessible location without becoming inaccessible in the event of a fire in the area to be protected.

3. Ch 11, 501. 6. of Rules for the Classification of Ships Using Low-flashpoint Fuels does not applicable.

Section 5 Dry Chemical Powder Fire-extinguishing System

501. Dry chemical powder fire-extinguishing system

1. Two portable powder fire extinguishers with a capacity of at least 10 kg must be kept near the bunker station, additional portable fire extinguishers may be required by the requirements of other IMO documents.

Section 6 Fire Detection and Alarm System

601. Fire detection and alarm system

Ch 11, 701. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 7 Fuel Preparation Room Fire- extinguishing Systems

701. Fuel preparation room fire-extinguishing systems

The fuel preparation room is to be equipped with a fixed fire extinguishing system that complies with Pt 8, Ch 8, Sec 3 of Rules for the Classification of Steel Ships, and the concentration and application rate required to extinguish a liquefied petroleum gas fire are to be considered. ⚓

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

201. 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

301. General requirements

Requirements not specified in below are to comply with **Ch 12, 301. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 12, 301. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, Hazardous areas on open decks and other spaces not defined in this chapter are to be determined based on IEC 60079-10-1. Electrical installations installed in hazardous areas should comply with the standards.
2. For the application of **Ch 12, 301. 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, electrical installations and cables should in principle not be installed in hazardous areas, except those essential for operational purposes based on IEC 60079-14:2007 and IEC 60079-10-1:2008.
3. Electrical installations in explosion-safe machinery spaces should satisfy the following requirements.
   (1) in addition to fire and gas hydrocarbon detectors and fire and gas alarms, lighting equipment and ventilation fans should be certified safe for zone 1.
   (2) all electrical equipment in a machinery space containing gas-fuelled engines, and not certified for zone 1 is to be automatically disconnected, if gas concentration above 20 % LEL is detected by two detectors in the space containing gas-fuelled consumers.

Section 4 Area Classification

Ch 12, Sec 4 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 5 Hazardous Area Zones

501. Zone “0”

Zone "0" includes, but is not limited to:

1. The interiors of fuel tanks
2. Pipes and equipment containing fuel
3. Any pipe work of pressure-relief or other venting systems for fuel tanks

502. Zone "1"

Requirements not specified in below are to comply with **Ch 12, 502. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 12, 502. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, fuel tank outlets, gas or steam outlets, bunkering manifold valves, other fuel valves, fuel pipe flanges, fuel preparation room ventilation exhausts, and boundaries of dangerous spaces, semi-enclosed spaces or spaces on deck around gas tank openings for pressure relief of small amounts of gas or vapor mixtures that may be caused by temperature changes are in accordance with IEC 60079-10-1:2008.
2. For the application of **Ch 12, 502. 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, the boundaries of open deck or semi-enclosed spaces on decks around fuel preparation room entrances, fuel preparation room ventilation intakes and other openings in space "1", hazardous areas are to be in accordance with IEC 60079-10-1:2008.
3. For the application of **Ch 12, 502. 5. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, areas on open decks within leak-tight coamings around gas bunkering manifold valves and around these areas according to IEC 60079-10-1:2008.
4. For the application of **Ch 12, 502. 7. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, explosion-safe machinery spaces are considered non-hazardous spaces during normal operation, but equipment which remains to operate after detection of a gas leak should be suitable for zone "1".
5. For the application of **Ch 12, 502. 9. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, around the outer surfaces of fuel containment systems (other than independent tank type C) if they are exposed. The limit of the dangerous zone is in accordance with IEC 60079-10-1:2008.
7. Around ventilation outlets of fuel tanks that emit large amounts of gas or vapor. The limit of the dangerous zone is in accordance with IEC 60079-10-1:2008.

503. Zone "2"

Requirements not specified in below are to comply with **Ch 12, 503. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 12, 503. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, an area within 1.5 mm around an open or semi-enclosed area of Zone "1". The lmit of the danger zone is in accordance with IEC 60079-10-1:2008.
2. For the application of **Ch 12, 503. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, The area within the distance according to IEC 60079-10-1:2008 from the area defined in **Ch 12, 502. 7**.
3. Airlock to protect non-hazardous area from Zone "1". ⚓

CHAPTER 13 VENTILATION

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

201. Functional requirements

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

1. In particular, the capacity and arrangement of the ventilation system should be designed to secure the ventilation effect in consideration of the specific gravity of the liquefied petroleum gas vapor.

Section 3 General Requirements

301. Ventilation of hazardous spaces

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

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/non-hazardous enclosed spaces

Air inlets for hazardous enclosed spaces are to be taken from areas that, in the absence of the considered inlet, would be non-hazardous. Air inlets for non-hazardous enclosed spaces are to be taken from non-hazardous areas at least 0.5 m away from the boundaries of any hazardous area. Where the inlet duct passes through a more hazardous space, the duct is to be gas-tight and have over-pressure relative to this space. Arrangements are to be made so that gases exhausted from the air outlets of the hazardous area are not recirculated through the air intakes. A gas dispersion analysis is to be conducted as necessary to confirm the satisfaction of these arrangements.

306. Air outlets from non-hazardous spaces

Ch 13, Sec 3, 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, Sec 3, 307. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be

applied.

308. Required capacity of the ventilation plant

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.

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

Ch 13, Sec 3, 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, Sec 3, 310. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

311. Number and location of ventilation inlets

The number and location of ventilation intakes in each zone should be determined considering the size and arrangement of the zone. If the structure of the floor is complicated, ventilation analysis should be conducted to determine whether the ventilation capacity and duct arrangement are appropriate.

312. Suction duct in hazardous area

At least one intake duct within the hazardous zone should extend down to a height of 1/3 of the machinery space level to remove sub-floor gases and facilitate the circulation of outside air. Ventilation inlets are to be located above the normal water level of the bilge.

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

501. Machinery Spaces

Requirements not specified in below are to comply with **Ch 13, 501. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 13, 501. 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, explosion-safe machinery spaces are to be provided with continuous ventilation of the negative pressure type with ventilation capacity given in KS V ISO 11105:2012. Ventilation systems are to provide good air circulation in all spaces and are to be particularly capable of detecting the formation of gas pockets in those spaces.
2. For the application of **Ch 13, 501. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, Machinery spaces protected by emergency shut-offs are to be provided with a high level of ventilation as defined by a standard recognized by the Society.
3. For the application of **Ch 13, 501. 4. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, even if one ventilator having a circuit separated from the main switchboard or emergency switchboard or a group of ventilators having a common circuit from the main switchboard or emergency switchboard does not operate, the number and output of ventilation fans for machinery spaces protected by emergency shut-off and explosion-safe machinery spaces and double pipe ventilation fans for gas-safe machinery spaces are to maintain at least 50% of the total ventilation

capacity.

4. The ventilation fan is to be operated 4 minutes before starting the engine. Physical interlocks are to be included to this effect.

Section 6 Fuel Preparation Room

601. Fuel preparation room

1. The fuel preparation room is to be equipped with an effective mechanical ventilation system of negative pressure type with a ventilation capacity of at least 30 ventilations per hour. Ventilation systems are to be operated at least 4 minutes prior to starting compressors and pumps.

2. The power of the ventilation fans in machinery spaces is to be provided with a means of supplying, in addition to the main source of electrical power, the power required to run the ventilation fans for 4 minutes as required by Par 4.

3. The number and power of the ventilation fans are to be such that the capacity is not reduced by more than 50 %, if a fan with a separate circuit from the main switchboard or emergency switchboard or a group of fans with common circuit from the main switchboard or emergency switchboard, is inoperable. Single ventilation fan may accepted where spare parts are provided comprising a motor, starter spares and complete rotating element, including bearings of each type.

4. Ventilation systems for fuel preparation rooms, are to be in operation when pumps or compressors are working.

5. Approved automatic fail-safe fire dampers are to be installed in ventilation trunks in fuel staging rooms or in spaces deemed necessary by risk assessment.

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

Ch 13, Sec 8 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

CHAPTER 14 ELECTRICAL INSTALLATIONS

Section 1 Goal

101. Goal

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

Section 2 Functional Requirements

201. Functional requirements

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

Section 3 Electrical installations

301. General requirements

1. For the application of Ch 14, 301. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels, electrical equipment installed in hazardous areas should be of approved safety type suitable for the composition of LPG according to IEC 60079-20. IEC 60079-20 classifies butane and propane, the main components of LPG, into the following temperature classes and equipment groups.

Table 14.1 Temperature and equipment group

	Temperature grade	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 Guidance.

Section 2 Functional Requirements

201. Functional requirements

Requirements not specified in below are to comply with **Ch 15, 201. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 15, 201. 3. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, for ESD protected machinery spaces or explosion-safe machinery spaces, safety devices are to shut off the gas supply in case of gas leakage and, in addition, shut off all non-explosion-proof electrical installations in the machinery spaces.

Section 3 General Requirements

301. General requirements

Requirements not specified in below are to comply with **Ch 15, 301. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 15, 301. 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, level indicators are to be provided in the bilge wells in each tank connection space of independent liquefied gas storage tanks. In addition, if the fuel in the tank is low temperature, a temperature sensor should be installed. An alarm should be activated at the high level of the bilge well. If a temperature sensor is installed, a safety device should operate when a low temperature is detected.

Section 4 Bunkering and Liquefied Gas Fuel Tank Monitoring

401. Level indicators for liquefied gas fuel tanks

Ch 15, 401. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

402. Overflow control

Ch 15, 402. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 5 Bunkering Control

501. Bunkering control

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

Section 6 Gas Engine Monitoring

601. Gas engine monitoring

Ch 15, 701. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 7 Gas Detection

701. Gas detection

Requirements not specified in below are to comply with Ch 15, 801. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

1. For the application of Ch 15, 801. 1. (10) of Rules for the Classification of Ships Using Low-flashpoint Fuels, all ventilation inlets in accommodation and machinery spaces
2. For the application of Ch 15, 801. 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels, in each ESD-protected machinery space and explosion-safe machinery spaces, redundant gas detection systems are to be provided.
3. For the application of Ch 15, 801. 6. of Rules for the Classification of Ships Using Low-flashpoint Fuels, safety devices in explosion-safe machinery spaces are to be activated at a vapor concentration of 20 % of the LEL on both detectors.

Section 8 Fire Detection

801. Fire detection

Required safety actions at fire detection in the machinery space containing gas-fuelled engines and rooms containing independent tanks for fuel storage hold spaces are given in Table 15.1 below.

Table 15.1 Monitoring of gas supply system to engines

Parameter	Alarm	Automatic shutdown of main tank valve	Automatic shutdown of gas supply to machinery space containing gas-fuelled engines	Remarks
Gas detection in tank connection space at 20 % LEL	X			
Gas detection on two detectors[1] tank connection space at 40 % LEL	X	X		
Fire detection in fuel storage hold space	X			
Fire detection in ventilation trunk to the tank connection space and in the tank connection space	X			
Bilge well high level in tank connection space	X			
Bilge well low temperature in tank connection space	X	X		
Gas detection in duct between tank and machinery space containing gas-fuelled engines at 20 % LEL	X			
Gas detection on two detectors[1] in duct between tank and machinery space containing gas-fuelled engines at 40 % LEL	X	X[2]		
Gas detection in fuel preparation room at 20 % LEL	X			
Gas detection on two detectors[1] in fuel preparation room at 40 % LEL	X	X[2]		
Gas detection in duct inside machinery space containing gas-fuelled engines at 30 % LEL	X			If double pipe fitted in machinery space containing gas-fuelled engines
Gas detection on two detectors[1] in duct inside machinery space and explosion-safe machinery space containing gas-fuelled engines at 60 % LEL	X		X[3]	If double pipe fitted in machinery space containing gas-fuelled engines
Gas detection in ESD protected machinery space containing gasfuelled engines at 20 % LEL	X			
Gas detection of 20% LEL in explosion-safe machinery spaces where gas-fired engines are installed	X			
Gas detection at 20% LEL on two detectors[1] in explosion-safe machinery spaces with gas-fired engines	X		X	It is also to disconnect non certified safe electrical equipment in machinery space containing gas-fuelled engines

Table 15.1 Monitoring of gas supply system to engines (continued)

Parameter	Alarm	Automatic shutdown of main tank valve	Automatic shutdown of gas supply to machinery space containing gas-fuelled engines	Remarks
Gas detection on two detectors[1] in ESD protected machinery space containing gas-fuelled engines at 40 % LEL	X		X	It is also to disconnect non certified safe electrical equipment in machinery space containing gas-fuelled engines
Loss of ventilation in duct between tank and machinery space containing gas-fuelled engines	X		X[2]	
Loss of ventilation in duct inside machinery space containing gas-fuelled engines[5]	X		X[3]	If double pipe fitted in machinery space containing gas-fuelled engines
Loss of ventilation in ESD protected machinery space containing gas-fuelled engines	X		X	
Fire detection in machinery space containing gas-fuelled engines	X			
Abnormal gas pressure in gas supply pipe	X			
Failure of valve control actuating medium	X		X[4]	Time delayed as found necessary
Automatic shutdown of engine (engine failure)	X		X[4]	
Manually activated emergency shutdown of engine	X		X	

Note :

1) Two independent gas detectors located close to each other are required for redundancy reasons.
2) If the tank is supplying gas to more than one engine and the different supply pipes are completely separated and fitted in separate ducts and with the master valves fitted outside of the duct, only the master valve on the supply pipe leading into the duct where gas or loss of ventilation is detected is to close.
3) If the gas is supplied to more than one engine and the different supply pipes are completely separated and fitted in separate ducts and with the master valves fitted outside of the duct and outside of the machinery space containing gas-fuelled engines, only the master valve on the supply pipe leading into the duct where gas or loss of ventilation is detected is to close.
4) Only fuel shut-off valve to be activated.
5) If the duct is protected by inert gas (See Ch 9, 601. 1) then loss of inert gas overpressure is to lead to the same actions as given in this table.
6) Valves referred to in Ch 9, 401.

Section 9 Ventilation

901. Ventilation

Requirements not specified in below are to comply with Ch 15, 1001. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

1. For the application of Ch 15, 1001. 2. of Rules for the Classification of Ships Using Low-flashpoint Fuels, for machinery spaces protected by emergency shut-offs and explosion-safe machinery spaces, safety devices are to operate in the event of engine room ventilation failure.

Section 10 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

Section 1 General

101. General

Ch 16, 101. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 2 General Test Regulations and Specifications

Ch 16, Sec 2 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 3 Welding of Metallic Materials and Non-destructive Testing for the Fuel Containment System

Ch 16, Sec 3 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 4 Other Regulations for Construction in Metallic Materials

401. General

Ch 16, 401. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

402. Independent tank

Ch 16, 402. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 5 Testing

501. Testing and inspections during construction

Requirements not specified in below are to comply with Ch 15, 1001. of Rules for the Classification of Ships Using Low-flashpoint Fuels.

1. Ch 15, 501. 4, 6, 7 and 8. of Rules for the Classification of Ships Using Low-flashpoint Fuels are not apply.

502. Type C independent tanks and other pressure vessels 【See Guidance】

Ch 16, 504. of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 6 Welding, Post-weld Heat Treatment and Non-destructive Testing

Ch 16, Sec 6 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

Section 7 Testing Regulations

Ch 16, Sec 7 of Rules for the Classification of Ships Using Low-flashpoint Fuels is to be applied.

CHAPTER 17 DRILLS AND EMERGENCY EXERCISES

Section 1 General

101. General

Requirements not specified in below are to comply with **Ch 17, 101. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. **Ch 17, 101. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels** is not applicalbe.

102. Drill

1. The goal of this chapter is to ensure that seafarers on board ships to which this standard applies have appropriate qualifications, training and experience.
2. The company should ensure that crew members of ships using liquefied petroleum gas complete training in accordance with the laws specified in Article 42-2 of the Enforcement Rule of the Seafarers Act so that they can have the appropriate ability to board. ⚓

CHAPTER 18 OPERATION

Section 1 Goal

101. General

The goal of this chapter is to ensure that operational procedures for the loading, storage, operation, maintenance, and inspection of systems for gas or low-flashpoint fuels minimize the risk to personnel, the ship and the environment and that are consistent with practices for a conventional oil fuelled ship whilst taking into account the nature of the liquid or gaseous fuel.

Section 2 Functional Requirements

201. Functional Requirements

Requirements not specified in below are to comply with **Ch 18, 201. of Rules for the Classification of Ships Using Low-flashpoint Fuels**.

1. For the application of **Ch 18, 201. 1. of Rules for the Classification of Ships Using Low-flashpoint Fuels**, all ships subject to this **Guidance** should keep on board a copy of the flag state laws including this **Guidance**.

Section 3 Regulations for Maintenance

301. Regulations for maintenance

1. Maintenance and repair procedures shall include considerations with respect to the tank location and adjacent spaces (see **Ch 5**).
2. In-service survey, maintenance and testing of the fuel containment system are to be carried out in accordance with the inspection/survey plan required by **Ch 6 401. 8**.
3. The procedures and information shall 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 shall be performed in accordance with a recognized standard.

Section 4 Regulations for Bunkering Operations

401. Responsibilities

1. Before any bunkering operation commences, the master of the receiving ship or his representative and the representative of the bunkering source (Persons In Charge, PIC) shall:
   (1) agree in writing the transfer procedure and if necessary, gassing up; 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 check-list.
2. Upon completion of bunkering operations the ship PIC shall receive and sign a Bunker Delivery Note for the fuel delivered, completed and signed by the bunkering source PIC.

402. Overview of control, automation and safety systems

1. The fuel handling manual required by **201. 3** shall include but is not limited to:
   (1) overall operation of the ship from dry-dock to dry-dock, including procedures for system cool down and warm up, bunker loading and, where appropriate, discharging, sampling, inerting and

gas freeing;
(2) bunker temperature and pressure control, alarm and safety systems;
(3) system limitations, cool down rates and maximum fuel storage tank temperatures prior to bunkering, including minimum fuel temperatures, maximum tank pressures, transfer rates, filling limits and sloshing limitations;
(4) operation of inert gas systems;
(5) firefighting and emergency procedures: operation and maintenance of firefighting systems and use of extinguishing agents;
(6) specific fuel properties and special equipment needed for the safe handling of the particular fuel;
(7) fixed and portable gas detection operation and maintenance of equipment;
(8) emergency shutdown and emergency release systems, where fitted; and
(9) a description of the procedural actions to take in an emergency situation, such as leakage, fire or potential fuel stratification resulting in rollover.

2. A fuel system schematic/piping and instrumentation diagram (P&ID) shall be reproduced and permanently mounted 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, shall 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 gas and fire detection equipment;
(3) operation of portable gas detection equipment;
(4) operation of remote controlled valves; and
(5) inspection of hoses and couplings.

2. Documentation of successful verification shall be indicated by the mutually agreed and executed bunkering safety checklist signed by both PIC's.

404. Ship bunkering source communications

1. Communications shall 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 shall stop and not resume until communications are restored.

2. Communication devices used in bunkering shall comply with recognized standards for such devices acceptable to the Administration.

3. PIC's shall have direct and immediate communication with all personnel involved in the bunkering operation.

4. The ship shore link (SSL) or equivalent means to a bunkering source provided for automatic ESD communications, shall be compatible with the receiving ship and the delivering facility ESD system. (Refer to **ISO 28460**)

405. Electrical bonding

Hoses, transfer arms, piping and fittings provided by the delivering facility used for bunkering shall be electrically continuous, suitably insulated and shall provide a level of safety compliant with recognized standards (Refer to **API RP 2003** and **ISGOTT**).

406. Conditions for transfer

1. Warning signs shall be posted at the access points to the bunkering area listing fire safety precautions during fuel transfer.

2. During the transfer operation, personnel in the bunkering manifold area shall be limited to essential staff only. All staff engaged in duties or working in the vicinity of the operations shall wear appropriate personal protective equipment (PPE). A failure to maintain the required conditions for transfer shall be cause to stop operations and transfer shall not be resumed until all required conditions are met.

3. Where bunkering is to take place via the installation of portable tanks, the procedure shall provide

an equivalent level of safety as integrated fuel tanks and systems. Portable tanks shall be filled prior to loading on board the ship and shall be properly secured prior to connection to the fuel system.

4. For tanks not permanently installed in the ship, the connection of all necessary tank systems (piping, controls, safety system, relief system, etc.) to the fuel system of the ship is part of the "bunkering" process and shall be finished prior to ship departure from the bunkering source. Connecting and disconnecting of portable tanks during the sea voyage or manoeuvring is not permitted.

Section 5 Regulations for Enclosed Space Entry

501. Regulations for enclosed space entry

1. Under normal operational circumstances, personnel shall not enter fuel tanks, fuel storage hold spaces, void spaces, tank connection spaces or other enclosed spaces where gas or flammable vapours may accumulate, unless the gas content of the atmosphere in such space is determined by means of fixed or portable equipment to ensure oxygen sufficiency and absence of an explosive atmosphere (Refer to IMO MSC Res.A.1050(27)).
2. Personnel entering any space designated as a hazardous area shall not introduce any potential source of ignition into the space unless it has been certified gas-free and maintained in that condition.

Section 6 Regulations for Inerting and Purging of Fuel Systems

601. Regulations for inerting and purging of fuel systems

1. The primary objective in inerting and purging of fuel systems is to prevent the formation of a combustible atmosphere in, near or around fuel system piping, tanks, equipment and adjacent spaces.
2. Procedures for inerting and purging of fuel systems shall ensure that air is not introduced into piping or a tank containing gas atmospheres, and that gas is not introduced into air contained in enclosures or spaces adjacent to fuel systems.

Section 7 Regulations for Hot Work on or Near Fuel Systems

701. Regulations for hot work on or near fuel systems

Hot work in the vicinity of fuel tanks, fuel piping and insulation systems that may be flammable, contaminated with hydrocarbons, or that may give off toxic fumes as a product of combustion shall only be undertaken after the area has been secured and proven safe for hot work and all approvals have been obtained. ⚓

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