RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part GF Ships Using Low-Flashpoint Fuels

Rules for the Survey and Construction of Steel Ships
Part GF 2023 AMENDMENT NO.1
Guidance for the Survey and Construction of Steel Ships
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Rule No.29 / Notice No.28 30 June 2023
Resolved by Technical Committee on 25 January 2023

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NIPPON KAIJI KYOKAI

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

Part GF Ships Using Low-Flashpoint Fuels

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An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

Rule No.29 30 June 2023
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part GF SHIPS USING LOW-FLASHPOINT FUELS

Amendment 1-1

Chapter 1 GENERAL

1.1 General (*IGF Code* 2.1)

Paragraph 1.1.3 has been amended as follows.

1.1.3 Approval of Systems and Equipment, etc.*

1 For ships using natural gas as fuel, the systems and equipment following **(1)** to **(21)** that are provided to use the gas fuel are to be approved as specified separately by the Society.

((1) to (21) are omitted)

2 In addition to the requirements specified in **-1**, reciprocating engines designed to directly inject natural gas pre-compressed to a high pressure into cylinders and ignite with appropriate sources of ignition for due combustion at the termination of compression strokes (hereinafter referred to as "high pressure gas-fuelled engines"), and to gas fuel supply systems are to be in accordance with **Annex 1.1.3-2**.

3 In addition to the requirements specified in **-1**, trunk piston reciprocating engines supplied with low pressure natural gas as fuel (hereinafter referred to as "low pressure gas-fuelled engines"), and gas fuel supply systems are to be in accordance with **Annex 1.1.3-3**.

~~**2**~~**4** For ships that use low-flashpoint fuels other than natural gas, systems and equipment specified in **-1(1)** to **(2~~0~~1)** above provided for the purpose of using the low-flashpoint fuels are to be those deemed appropriate by the Society.

~~**3**~~**5** Boilers and internal combustion engines of piston type that are multi-fuel engines, and gas turbines are to be those deemed appropriate by the Society.

Annex 1.1.3-2 has been added as follows.

Annex 1.1.3-2 HIGH PRESSURE GAS-FUELLED ENGINES

Chapter 1 GENERAL

1.1 Scope

1 This annex applies to reciprocating engines designed to directly inject natural gas pre-compressed to a high pressure into cylinders and ignite with appropriate sources of ignition for due combustion (hereinafter referred to as "high pressure gas-fuelled engines"), and to gas fuel supply systems in accordance with the requirements in **1.1.3-2, Part GF of the Rules**.

2 High pressure gas-fuelled engines and gas fuel supply systems are to be in accordance with requirements related to reciprocating internal combustion engines and gas fuel supply system specified in **Part D** and **Part GF of the Rules**, in addition to the requirements of this annex.

3 High pressure gas-fuelled engines are to be in accordance with those requirements for low pressure gas-fuelled engines specified in **Annex 1.1.3-3** which the Society deems appropriate.

1.2 Equivalency

High pressure gas-fuelled engines which do not comply with the requirements of this annex may be accepted provided that they are deemed to be equivalent by the Society to those approved in accordance with this annex.

1.3 Submission of Plans and Documents

The plans and documents to be submitted are as follows.

(1) Plans and documents for approval
- (a) Drawings and data specified in **2.1.3-1(1), Part D of the Rules**
- (b) Drawings and data specified in **18.1.3(1)(a)**, **(b)** and **(e), Part D of the Rules**
- (c) Gas fuel injection valves
- (d) High pressure oil pipes for actuating gas fuel injection valves and associated protective shielding
- (e) Gas fuel injection pipes and associated protective shielding
- (f) High pressure oil pipes for sealing gas fuel injection valves and associated protective shielding
- (g) Arrangements of gas detectors
- (h) Combustion monitoring devices
- (i) Gas fuel injection valve actuating devices
- (j) Governors
- (k) Engine control system diagrams (including monitor, safety and alarm devices) for gas fuel combustion operations
- (l) Gas leak protective devices at connections between engines and gas fuel supply piping
- (m) Gas fuel supply piping systems (including details of valves and pipe fittings) and protective devices for gas leaks from said systems
- (n) Other drawings and data as deemed necessary by the Society according to the type of high pressure gas-fuelled engine

(2) Plans and documents for reference

(a) Drawings and data specified in **2.1.3-1(2), Part D of the Rules**

(b) Instruction manuals (including procedures for onboard maintenance, inspection and overhaul)

(c) Other drawings and data deemed necessary by the Society

(3) Drawings and data for the purpose of inspecting and testing engines

Items specified in **2.1.3-1, Part D of the Rules**, which are intended for inspection and testing (indicated by "○" in **Table D2.1(1)** and **Table D2.1(2), Part D of the Rules**).

Chapter 2 CONSTRUCTION AND EQUIPMENT OF HIGH PRESSURE GAS-FUELLED ENGINES

2.1 General

1 High pressure gas-fuelled engines are to be dual fuel system types capable of operating on oil fuel and gas fuel, or gas-only system types.

2 High pressure gas-fuelled dual fuel engines are to be capable of supplying oil fuel to each cylinder in amounts sufficient for maintaining stable combustion of gas fuel under any conditions.

3 High pressure gas-fuelled engines are to be capable of maintaining stable operations even under any of the following **(1)** to **(3)** conditions:

(1) switching from one fuel to another (in the cases of dual fuel engines),

(2) rapid load fluctuations, and

(3) minimum load conditions during gas combustion.

4 Only oil fuel is, in principle, to be used when operation of high pressure gas-fuelled dual fuel engines is unstable.

5 High pressure gas-fuelled dual fuel engines are to be capable of quickly switching from gas combustion mode to oil fuel only combustion mode.

2.2 Construction and Strength

2.2.1 Gas Fuel Injection Valves

1 Gas fuel injection valves are to possess satisfactory operating characteristics and durability for the assumed service period.

2 Gas fuel injection valves are to be provided with sealing systems to effectively prevent gas fuel from leaking through spaces around valve spindles.

3 Gas fuel injection valves are to be provided with effective cooling systems.

2.2.2 Gas Fuel Injection Valve Actuating Systems

1 Gas fuel injection valve actuating systems are to be reliably functional and operational.

2 When operating gas fuel injection valves equipped with actuating oil piping systems and sealing oil piping systems, the high pressure sections of such systems fitted to engine bodies are to be protected from actuating oil splashing in accordance with the requirements in **2.5.4, Part D of the Rules**.

3 Appropriate means are to be provided in cases where gas fuel injection valve actuating oil is required to be kept clean.

2.2.3 Cylinder Covers

1 The shapes of combustion chambers and the arrangements of gas fuel injection valves and oil fuel (or pilot oil) injection valves are to be such that reliable ignition and combustion of gas fuel are ensured.

2 The portions of cylinder covers where gas fuel injection valves and oil fuel injection valves are fitted are to be so constructed as to prevent leakages of gas fuels and unburnt gases into cylinders.

2.3 Safety Systems

2.3.1 Combustion Monitoring Devices

1 When high pressure gas-fuelled engines are operated on gas fuel, the items specified in the following **(1)** to **(4)** are, in principle, to be monitored and gas fuel supplies to engines are to be

automatically cut off in cases where any abnormalities are detected:
(1) gas fuel injection valve function,
(2) pilot oil fuel injection valve function (in the case of dual fuel engines),
(3) exhaust gas valves function, and
(4) exhaust gas temperatures at cylinder outlets.

2 When high pressure gas-fuelled engines are operated on gas fuel, the following items are, in general, to be monitored:
(1) abnormalities in cylinder pressure, and
(2) blow-by through exhaust valves.

2.3.2 Protection Against Explosions

1 Relief valves approved in accordance with **2.4.3, Part D of the Rules** are to be provided for crankcases.

2 Scavenge spaces and exhaust systems are to be fitted with suitable pressure relief systems in accordance with **10.2.2** and **10.3.1-1, Part GF of the Rules** unless designed to withstand the worst case overpressure due to ignited gas leaks.

3 Relief valves for cylinders installed in accordance with the requirements of **2.4.2, Part D of the Rules** are to be provided, as far as practicable, with monitoring systems to verify valve closing.

4 Engines having spaces under pistons that directly lead to crankcases are also to be in accordance with **10.3.1-2, Part GF of the Rules**.

2.3.3 Governors

1 Governors for high pressure gas-fuelled engines are to be capable of being operated during gas fuel combustion mode. In the case of dual fuel engines, governors are additionally to be capable of being operated either during gas and oil fuel (or pilot oil) combustion mode, and/or oil fuel only combustion mode.

2 The governors in **-1** above are to be in accordance with the requirements in **2.4.1-1, Part D of the Rules** for each mode of operation.

3 High pressure gas-fuelled dual fuel engines are to be operated in any one of the modes specified in the following **(1)** to **(3)**:
(1) controllable gas fuel supply and fixed oil fuel (pilot oil) supply,
(2) controllable oil fuel (pilot oil) supply and fixed gas fuel supply, or
(3) controllable gas fuel and oil fuel supplies.

2.4 Accessory Equipment

2.4.1 Exhaust Gas Systems

Exhaust gas pipes of high pressure gas-fuelled engines are not to be connected to the exhaust gas pipes or the exhaust pipes of other engines or systems.

2.4.2 Starting Systems

Starting air branch pipes to cylinders are to be provided with effective flame arresters.

2.4.3 Gas Fuel Pipes

1 Gas fuel pipes (only those attached to engines) are to be provided with effective protective shielding against gas fuel bursting due to pipe failure.

2 Spaces between gas fuel pipes (only those attached to engines) and protective shielding are to be in accordance with the requirements in **9.6, Part GF of the Rules**: relevant requirements are to be applied mutatis mutandis.

3 Only approved type flexible tubes are to be used as protective shielding.

4 Gas fuel pipes are to be provided with systems for inerting and gas-freeing.

5 Expansion joints provided for gas fuel pipes (only those attached to engines) are to be approved as specified separately by the Society.

2.4.4 Cylinder Lubrication

Cylinder lubricating systems for high pressure gas-fuelled engines are, in general, to be capable of maintaining adequate alkali values and cylinder oil feeding rates for oil fuel only operation as well as the modes of operation specified in **2.3.3-3(1)** to **(3)**.

Chapter 3 CONTROL SYSTEMS AND SAFETY SYSTEMS

3.1 General

1 Control systems for operating high pressure gas-fuelled engines using gas fuel are to be in accordance with the requirements in **18.1** to **18.3** and **18.7, Part D of the Rules**: relevant requirements are to be applied mutatis mutandis.

2 Temperatures and pressures of gas fuel supplied to high pressure gas-fuelled engines are to be automatically controlled. In addition, visual and audible alarm devices which activate when temperatures and pressures exceed preset ranges are to be provided.

3.2 High Pressure Gas-fuelled Engines of Ships Subject to the Rules for Automatic and Remote Control Systems

High pressure gas-fuelled engines of ships subject to the application of the **Rules for Automatic and Remote Control Systems** are be in accordance with the requirements in **3.2**, **3.3** and **4.2** of the said rules. In addition, such engines are to be in accordance with the following **(1)** and **(2)** requirements:

(1) High pressure gas-fuelled engines are to be provided with safety systems which automatically cut off gas fuel supply when **(a)** or **(b)** given below occur. In addition, in the case of dual fuel engines, such systems are to automatically switch the mode of operation to oil fuel only or are to stop the engines. Automatic cut off of gas fuel supplies with the double block and bleed valves specified in **9.4.4, Part GF of the Rules**, however, may be accepted.
   (a) When the abnormalities specified in **2.3.1-1** are detected.
   (b) Other cases deemed necessary by the Society.

(2) High pressure gas-fuelled engines are to be provided with systems which automatically reduce speed or switches the mode of operation to oil fuel only, and which issue alarms in the event any of the abnormalities specified in the following **(a)** to **(d)** occurs:
   (a) abnormal gas fuel temperatures;
   (b) abnormal gas fuel supply pressures;
   (c) low pressures of hydraulic pneumatic sources, or loss of electric power supplies for gas fuel combustion control; or
   (d) others deemed necessary by the Society.

Chapter 4 TESTS

4.1 Approval of Use

For each type of high pressure gas-fuelled engine, approval of use is to be obtained by the engine designer (licensor) in accordance with requirements specified separately by the Society.

4.2 Shop Tests

4.2.1 Hydraulic Tests

Pressure parts and accessory equipment with pressure parts of high pressure gas-fuelled engines are to be subjected to hydraulic tests in accordance with the requirements of **2.6.1, Part D of the Rules** and **16.7.3, Part GF of the Rules**: relevant requirements are to be applied mutatis mutandis.

4.2.2 Shop Trials

High pressure gas-fuelled engines are to be tested as specified in **2.6.1-4, Part D of the Rules**. To implement surveys of tests, in lieu of traditional ordinary surveys where the Surveyor is in attendance, the Society may approve survey methods which it considers to be able to obtain information equivalent to that obtained through traditional ordinary surveys.

4.3 Tests after Installation On Board

Control systems of high pressure gas-fuelled engines and related equipment are to be tested depending upon their installation characters in accordance with the requirements of **18.7.3, Part D of the Rules** or the requirements of **2.2.4 of the Rules for Automatic and Remote Control Systems**: relevant requirements are to be applied mutatis mutandis.

4.4 Sea Trials

1 Performance of control systems of high pressure gas-fuelled engines and related equipment is to be verified during operations using gas fuel depending upon their installation characters in accordance with the requirements of **2.2.5 of the Rules for Automatic and Remote Control Systems**: relevant requirements are to be applied mutatis mutandis.

2 The seal trials specified in **2.3.1, Part B of the Rules** are to be carried out using gas fuel only. Some of the aforementioned tests, however, may be omitted in cases where deemed to be appropriate the Society.

Annex 1.1.3-3 has been added as follows.

Annex 1.1.3-3 LOW PRESSURE GAS-FUELLED ENGINES

Chapter 1 GENERAL

1.1 Scope

1 This annex applies to trunk piston reciprocating engines supplied with low pressure natural gas as fuel (hereinafter referred to as "low pressure gas-fuelled engines"), and gas fuel supply systems in accordance with the requirements of **1.1.3-3, Part GF of the Rules**.

2 Low pressure gas-fuelled engines and gas fuel supply systems are to be in accordance with requirements related to reciprocating internal combustion engines and gas supply systems specified in **Part D** and **Part GF of the Rules**, in addition to the requirements of this annex.

3 The following requirements specified in **Part GF of the Rules** as well as other requirements specified separately by the Society apply to low pressure gas-fuelled engines regardless of ship type, ship size and ship service area. However, **1.1.1-2, Part GF of the Rules** does not apply except where explicitly specified otherwise.

(1) **2.1-5(3)**
(2) **2.2.3-1**
(3) **2.2.4**
(4) **2.4.4-5(1)**
(5) **2.4.4-5(2)**
(6) **2.4.4-5(3)(a)** to **(c)**
(7) **2.4.4-5(4)(a)**
(8) **3.1-6**

1.2 Equivalency

Low pressure gas-fuelled engines which do not comply with the requirements of this annex may be accepted provided that they are deemed to be equivalent by the Society to those approved in accordance with this annex.

1.3 Submission of Plans and Documents

The plans and documents to be submitted are as follows.

(1) Plans and documents for approval
  (a) Drawings and data specified in **2.1.3-1(1), Part D of the Rules**
  (b) Drawings and data specified in **18.1.3(1)(a)**, **(b)** and **(e), Part D of the Rules**
  (c) Gas fuel injection valves and associated actuating systems
  (d) Gas fuel injection pipes and associated protective shielding
  (e) Arrangements of gas detectors
  (f) Combustion monitoring devices
  (g) Governors
  (h) Engine control system diagrams (including monitor, safety and alarm systems) for gas fuel combustion operations
  (i) Gas leak protection systems at connections between engines and gas fuel supply piping systems

(j) Gas fuel supply piping systems (including details of valves and pipe fittings) and protective devices for gas leaks from such systems
(k) Pilot oil fuel injection devices or ignition systems
(l) Schematic layout or other equivalent documents of gas system on the engine
(m) Gas piping system (including double-walled arrangement where applicable)
(n) Parts for gas admission system
The documentation to contain specifications for pressures, pipe dimensions and materials.
(o) Arrangement of explosion relief valves for crankcase (if required by **2.4.3, Part D of the Rules**), charge air manifold and exhaust gas manifold, as applicable
(p) Schematic layout or other equivalent documents of fuel oil system (main and pilot fuel systems) on the engine (only for dual fuel engines)
(q) Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for dual fuel engines)
(r) Ignition system (only for gas only engines)
(s) Other drawings and data deemed necessary by the Society according to the type of low pressure gas-fuelled engine

(2) Plans and documents for reference
(a) Drawings and data specified in **2.1.3-1(2), Part D of the Rules**
(b) Other drawings and data deemed necessary by the Society

(3) Drawings and data for the purpose of inspecting and testing engines
Items specified in **2.1.3-1, Part D of the Rules**, which are intended for inspection and testing (indicated by "○" in **Table D2.1(1)** and **Table D2.1(2), Part D of the Rules**).

1.4 Terms

1 *Certified safe type* means electrical equipment that is certified in accordance with the recommendation published by the International Electrotechnical Commission (*IEC*), in particular publication *IEC* 60092-502:1999, or with recognized standards at least equivalent. The certification of electrical equipment is to correspond to the category and group for methane gas.

2 *Double block and bleed valves* means a set of two valves in series in a pipe and a third valve enabling the pressure release from the pipe between those two valves, specified in **2.2.1-9, Part GF of the Rules**. The arrangement may also consist of a two-way valve and a closing valve instead of three separate valves. The valves are to be in accordance with **9.4.4** to **9.4.6**.

3 *Dual fuel engine* means an engine that can burn natural gas as fuel simultaneously with liquid fuel, either as pilot oil or bigger amount of liquid fuel (gas mode), and also has the capability of running on liquid diesel fuel oil only (diesel mode).

4 *Engine room* is a machinery space or enclosure containing gas fuelled engine(s).

5 *Gas means* a fluid having a vapour pressure exceeding 0.28 *MPa* absolute at a temperature of 37.8℃.

6 *Gas admission valve* is a valve or injector on the engine, which controls gas supply to the cylinder(s) according to the cylinder(s) actual gas demand.

7 *Gas only engine* means an engine capable of operating on gas fuel only and not able to switch over to oil fuel operation.

8 *Gas piping* means piping containing gas or air / gas mixtures, including venting pipes.

9 *Gas Valve Unit* (*GVU*) is a set of manual shutoff valves, actuated shut-off and venting valves, gas pressure sensors and transmitters, gas temperature sensors and transmitters, gas pressure control valve and gas filter used to control the gas supply to each gas consumer. It also includes a connection for inert gas purging.

10 *Low pressure gas* means gas with a pressure up to 1 *MPa*.

11 *Lower Heating Value* (*LHV*) means the amount of heat produced from the complete combustion of a specific amount of fuel, excluding latent heat of vaporization of water.

12 *Methane Number* is a measure of resistance of a gas fuel to knock, which is assigned to a test fuel based upon operation in knock testing unit at the same standard knock intensity. (Pure methane is used as the knock resistant reference fuel, that is, methane number of pure methane is 100, and pure hydrogen is used as the knock sensitive reference fuel, methane number of pure hydrogen is 0.)

13 *Pilot fuel* means the fuel oil that is injected into the cylinder to ignite the main gas-air mixture on Gas-fuelled engines.

14 *Pre-mixed engine* means an engine where gas is supplied in a mixture with air before the turbocharger.

15 *Safety Concept* is a document describing the safety philosophy with regard to gas as fuel. It describes how risks associated with this type of fuel are controlled under reasonably foreseeable abnormal conditions as well as possible failure scenarios and their control measures. A detailed evaluation regarding the hazard potential of injury from a possible explosion is to be carried out and reflected in the safety concept of the engine.

Chapter 2 CONSTRUCTION AND EQUIPMENT OF LOW PRESSURE GAS-FUELLED ENGINES

2.1 General

1 Low pressure gas-fuelled engines are to be dual fuel system types capable of operating on oil fuel and gas fuel, or gas-only system types.

2 Low pressure gas-fuelled engines are to be capable of maintaining stable operation even under any of the following **(1)** to **(3)** conditions:

(1) switching from one fuel to another (in the cases of dual fuel engines),

(2) rapid load fluctuations, and

(3) minimum load conditions during gas combustion.

3 Gas fuel supply pressures for low pressure gas-fuelled engines are to always be kept higher than suction air pressures at the supply points of gas fuel to combustion chambers or the suction pipes before suction valves in order to prevent any back-flow of air into gas fuel lines.

4 The manufacturer is to declare the allowable gas composition limits for the engine and the minimum and (if applicable) maximum methane number.

5 Components containing or likely to contain gas are to be designed in accordance with the following **(1)** to **(5)**.

(1) Minimize the risk of fire and explosion so as to demonstrate an appropriate level of safety commensurate with that of an oil-fuelled engine

(2) Mitigate the consequences of a possible explosion to a level providing a tolerable degree of residual risk, due to the strength of the component(s) or the fitting of suitable pressure relief devices of an approved type

(3) Refer to **10.2** and **10.3, Part GF of the Rules**

(4) Discharge from pressure relief devices is to prevent the passage of flame to the machinery space and be arranged such that the discharge does not endanger personnel or damage other engine components or systems

(5) Relief devices are to be fitted with a flame arrester

2.2 Construction and Strength

2.2.1 Gas Fuel Valves and Actuating Systems

1 Gas fuel valves are to possess satisfactory operating characteristics and durability for the assumed service period.

2 Gas fuel valves are to be provided with sealing systems to effectively prevent gas fuel from leaking through spaces around valve spindles.

3 Actuating systems of gas fuel valves are to possess satisfactory operating characteristics and reliability.

2.2.2 Cylinder Covers

1 The shapes of combustion chambers and the arrangements of gas fuel valves are to be such that reliable ignition and combustion of gas fuel are ensured.

2 The portions of cylinder covers where gas fuel valves and oil fuel injection valves are fitted are to be so constructed as to prevent the leakages of gas fuels and unburnt gases into cylinders.

2.2.3 Crankcase

1 Crankcase explosion relief valves are to be installed in accordance with **2.4.3, Part D of the Rules**. Refer also to **10.3.1-2, Part GF of the Rules**.

2 For maintenance purposes, a connection, or other means, are to be provided for crankcase inerting and ventilating and gas concentration measuring.

2.2.4 Gas Ignition in Cylinder

For gas ignition in the cylinder, the requirements of **10.3, Part GF of the Rules** are to be applied.

2.3 Safety Systems

2.3.1 Protection Against Explosions

1 Suction manifolds and exhaust gas pipes are to be fitted with suitable pressure relief systems in accordance with the requirements of **10.2.2** and **10.3.1-1, Part GF of the Rules**.

2 Relief valves for cylinders installed in accordance with the requirements of **2.4.2, Part D of the Rules** are to be provided, as far as practicable, with monitoring systems to verify valve closing.

3 Gas fuel injection lines are to be provided with non-return valves or devices which have capabilities equivalent to those of the valves.

4 Flame arrestors are to be installed before cylinder heads in cases where gas is supplied in mixtures with air through common manifolds.

2.3.2 Governors

1 Governors for low pressure gas-fuelled engines are to be capable of being operated during gas fuel combustion mode. In the case of dual fuel engines, the governors are additionally to be capable of being operated either during gas and oil fuel (or pilot oil) combustion mode, and/or oil fuel only combustion mode.

2 The governors of **-1** above are to be in accordance with the requirements in **2.4.1-1, Part D of the Rules** in each mode of operation.

3 Low pressure gas-fuelled dual fuel engines are to be operated in any one of the modes specified in the following **(1)** to **(3)**:

(1) controllable gas fuel supply and fixed oil fuel (pilot oil) supply,

(2) controllable oil fuel (pilot oil) supply and fixed gas fuel supply, or

(3) controllable gas fuel and oil fuel supplies.

2.4 Accessory Equipment

2.4.1 Charge Air Systems

1 The charge air system on the low pressure gas-fuelled engine is to be designed in accordance with **2.1-5**.

2 In case of a single engine installation, the engine is to be capable of operating at sufficient load to maintain power to essential consumers after opening of the pressure relief devices caused by an explosion event. Sufficient power for propulsion capability is to be maintained.

3 Load reduction is to be considered on a case-by-case basis, depending upon engine configuration (single or multiple) and type of relief mechanism (self-closing valve or bursting disk).

2.4.2 Exhaust Gas Systems

1 The exhaust gas system on the low pressure gas-fuelled engine is to be designed in accordance with **2.1-5**.

2 In case of a single engine installation, the engine is to be capable of operating at sufficient load to maintain power to essential consumers after opening of the pressure relief devices caused by an explosion event. Sufficient power for propulsion capability is to be maintained.

3 Continuous relief of exhaust gas (through open rupture disc) into the engine room or other enclosed spaces is not acceptable.

2.4.3 Starting Systems

Starting air branch pipes to cylinders are to be provided with effective flame arresters.

2.4.4 Gas Fuel Pipes

1 Gas fuel pipes are to be provided with effective protective shielding against gas fuel bursting due to pipe failure, except where deemed appropriate by the Society.

2 Only approved type flexible tubes are to be used as protective shielding.

3 Gas fuel pipes are to be provided with systems for inerting and gas-freeing.

4 Expansion joints provided for gas fuel pipes (only those attached to engines) are to be approved as specified separately by the Society.

5 For piping attached to low pressure gas-fuelled engines, the following **(1)** to **(5)** also apply.

(1) The piping is to be designed in accordance with the criteria for gas piping (design pressure, wall thickness, materials, piping fabrication and joining details etc.) as given in **Chapter 7, Part GF of the Rules**.

(2) Arrangement of the gas piping system on the engine

Pipes and equipment containing fuel gas are defined as hazardous area zone 0 (refer to **12.5.1, Part GF of the Rules**). The space between the gas fuel piping and the wall of the outer pipe or duct is defined as hazardous area zone 1 (refer to **12.5.2(6), Part GF of the Rules**).

(3) Normal "double wall" arrangement

(a) The gas piping system on the low pressure gas-fuelled engine is to be arranged according to the principles and requirements of **9.6, Part GF of the Rules**.

(b) The design criteria for the double pipe or duct are given in the **9.8** and **7.4.1-4, Part GF of the Rules**.

(c) In case of a ventilated double wall, the ventilation inlet is to be located in accordance with the provisions of **13.8.3, Part GF of the Rules**.

(d) The pipe or duct is to be pressure tested in accordance with **12.6.1-2** to **-4, Part D of the Rules** to ensure gas tight integrity and to show that it can withstand the expected maximum pressure at gas pipe rupture.

(4) Alternative arrangement

(a) Single walled gas piping is only acceptable:

i) for engines installed in *ESD* protected machinery spaces, as defined in **5.4.1(2), Part GF of the Rules** and in compliance with other relevant parts of **Part GF of the Rules** (e.g. **5.6, Part GF of the Rules**);

ii) when complying with requirements specified separately by the Society.

(b) In case of gas leakage in an *ESD*-protected machinery space, which would result in the shutdown of the engine(s) in that space, a sufficient propulsion and manoeuvring capability including essential and safety systems is to be maintained. Therefore the safety concept of the engine is to clearly indicate application of the "double wall" or "alternative" arrangement. The minimum power to be maintained is to be assessed on a case-by-case basis in consideration of the operational characteristics of the ship.

(5) Gas admission valves

Gas admission valves are to be certified safe as follows:

(a) The inside of the valve contains gas and therefore it is to be certified for zone 0.

(b) When the valve is located within a pipe or duct in accordance with **(3)**, the outside of the valve is to be certified for zone 1.

(c) When the valve is arranged without enclosure in accordance with the "*ESD*-protected machinery space" (see **(4)**) concept, no certification is required for the outside of the valve, provided that the valve is de-energized upon gas detection in the space.

(d) However, if they are not rated for the zone they are intended for, it is to be documented that they are suitable for that zone. Documentation and analysis is to be based on *IEC*

60079-10-1:2015 or *IEC* 60092-502:1999.

2.4.5 Cylinder Lubrication

Cylinder lubricating systems for low pressure gas-fuelled dual fuel engines are, in general, to be capable of maintaining adequate alkali values and cylinder oil feeding rates for oil fuel only operation as well as the modes of operation specified in **2.3.2-3(1)** to **(3)**.

2.5 Design Requirements for Each Kind of Engines

2.5.1 Dual Fuel Engine

1 General

(1) The maximum continuous power that a dual fuel engine can develop in gas mode may be lower than the approved MCR of the engine (i.e. in oil fuel mode), depending in particular on the gas quality. This maximum power available in gas mode and the corresponding conditions are to be stated by the engine manufacturer and demonstrated during the type test.

(2) Low pressure gas-fuelled dual fuel engines are to be capable of supplying oil fuel to each cylinder in amounts sufficient for maintaining stable combustion of gas fuel under any conditions.

(3) Only oil fuel is, in principle, to be used when operation of low pressure gas-fuelled dual fuel engines are unstable.

2 Starting, changeover and stopping

(1) Dual fuel engines are to be arranged to use either oil fuel or gas fuel for the main fuel charge and with pilot oil fuel for ignition. The engines are to be arranged for rapid changeover from gas use to fuel oil use. In the case of changeover to either fuel supply, the engines are to be capable of continuous operation using the alternative fuel supply without interruption to the power supply.

(2) Changeover to gas fuel operation is to be only possible at a power level and under conditions where it can be done with acceptable reliability and safety as demonstrated through testing.

(3) Changeover from gas fuel operation mode to oil fuel operation mode is to be possible at all situations and power levels.

(4) The changeover process itself from and to gas operation is to be automatic but manual interruption is to be possible in all cases.

(5) In case of shut-off of the gas supply, the engines are to be capable of continuous operation by oil fuel only.

3 Gas supply to the combustion chamber is not to be possible without operation of the pilot oil injection. In addition, pilot injection is to be monitored for example by fuel oil pressure and combustion parameters.

2.5.2 Gas Only Engine

In case of failure of the spark ignition, the engine is to be shut down except when the following **(1)** to **(3)** are satisfied:

(1) the failure is limited to one cylinder;

(2) the gas supply to the failed cylinder is immediately shut off; and

(3) safe operation of the engine is substantiated by risk analysis and tests.

2.5.3 Pre-mixed Engine

Inlet manifolds, turbochargers, charge air coolers, etc. are to be regarded as parts of the fuel gas supply system, and failures of such components likely to result in gas leakages are to be considered in risk analysis by a method deemed appropriate by the Society.

Chapter 3 CONTROL, ALARM AND SAFETY SYSTEMS

3.1 General

1 Control systems for operating low pressure gas-fuelled engines using gas fuel are to be in accordance the requirements in **18.1** to **18.3** and **18.7, Part D of the Rules**: relevant requirements are to be applied mutatis mutandis.

2 Temperatures and pressures (or flow rates) of gas fuel supplied to low-pressure gas-fuelled engines are to be automatically controlled. In addition, visual and audible alarm devices which activate when temperatures and pressures exceed preset ranges are to be provided.

3 The engine control system is to be independent and separate from the safety system.

4 The gas supply valves are to be controlled by the engine control system or by the engine gas demand.

5 Combustion is to be monitored on an individual cylinder basis.

6 In the event that poor combustion is detected on an individual cylinder, gas operation may be allowed in the conditions specified in **10.3.1-6, Part GF of the Rules**.

7 Regardless of **-5**, if monitoring of combustion for each individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted.

8 Unless risk analysis by a method deemed appropriate by the Society otherwise proves that risk is within the acceptable range otherwise, alarm and safety system functions for dual fuel or gas only engines are to be provided in accordance with **Table 3.1** (for dual fuel engines, **Table 3.1** applies only to the gas mode). However, even if risk analysis proves that risk is within the acceptable range, the alarm and safety system functions specified in **Part GF of the Rules** are still to be provided.

3.2 Low Pressure Gas-fuelled Engines of Ships Subject to the Rules for Automatic Remote Control Systems

Low pressure gas-fuelled engines of ships subject to the application of the **Rules for Automatic and Remote Control Systems** are to be in accordance with the requirements in **3.2**, **3.3** and **4.2** of said rules. In addition, such engines are to be in accordance with the following **(1)** and **(2)** requirements:

(1) Low pressure gas-fuelled engines are to be provided with safety systems which automatically cut off the gas fuel supplies when any one of **(a)**, **(b)** or **(c)** given below occur. In addition, in the case of dual fuel engines, such systems are to automatically switch the mode of operation to oil fuel only or are to stop the engines. Automatic cut off of the gas fuel supplies with the double block and bleed valves specified in **9.4.4, Part GF of the Rules**, however, may be accepted.
   (a) When operating on gas fuel, abnormalities are detected in the following:
      i) gas fuel valve function
      ii) pilot oil fuel injection valve (in the cases of dual fuel engines) or ignition system (in the cases of gas-only engines) function
      iii) suction valve and exhaust valve function,
      iv) exhaust gas temperatures at cylinder outlets
      v) pressure in cylinder
      vi) blow-by through suction valves or exhaust valves
   (b) When gas leaks in the air space between the gas fuel piping and the wall of the outer pipe or duct specified in **9.6.1, Part GF of the Rules** are detected.
   (c) Others deemed necessary by the Society.

(2) Low pressure engines are to be provided with systems which automatically reduce speed or

switches the mode of operation to oil fuel only, and which issues alarms in the event any of the abnormalities specified in the following **(a)** to **(d)** occurs:

(a) abnormal gas fuel temperatures;

(b) abnormal gas fuel supply pressures;

(c) low pressures of hydraulic and pneumatic sources, or loss of electric power supply for gas fuel combustion control; or

(d) others deemed necessary by the Society.

Table 3.1 Alarm and Safety System Functions for Dual Fuel and Gas Only Engines

Parameter	Alarm	Automatic activation of the double block and bleed valves	Automatic switching over to oil fuel mode[1)]	Engine shutdown
1. Abnormal pressures in the gas fuel supply line	X	X	X	X [5)]
2. Gas fuel supply systems - malfunction	X	X	X	X [5)]
3. Pilot fuel injection or spark ignition systems - malfunction	X	X [2)]	X	X [2)5)]
4. Exhaust gas temperature after each cylinder - high	X	X [2)]	X	X [2)5)]
5. Exhaust gas temperature after each cylinder - low[3)]	X	X [2)]	X	X [2)5)]
6. Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion	X	X [2)4)]	X [4)]	X [2)4)5)]
7. Oil mist concentration in crankcase or bearing temperature[6)] - high	X	X	-	X
8. Pressure in the crankcase - high[4)]	X	X	X	-
9. Engine stops - any cause	X	X	-	-
10. Failure of the control-actuating medium of the block and bleed valves	X	X	X	-

Notes:

1) Dual fuel engine only, when running in gas mode

2) For gas only engines, the double block and bleed valves and the engine shutdown may not be activated in case of specific failures affecting only one cylinder, provided that the concerned cylinder can be individually shutoff and the safe operation of the engine in such conditions is demonstrated by the risk analysis.

3) Required only if necessary for the detection of misfiring. In addition, deviation from average is to be used for the operation setting of each function.

4) In the case where the failure can be corrected by an automatic mitigation action, only the alarm may be activated. If the failure persists after a given time, the safety actions are to be activated.

5) Gas only engine only

6) Where required by **2.4.5, Part D of the Rules**

Chapter 4 TESTS

4.1 Approval of Use

For each type of low pressure gas-fuelled engine, approval of use is to be obtained by the engine designer (licensor) in accordance with requirements specified separately by the Society.

4.2 Shop Tests

4.2.1 Hydraulic Tests

Pressure parts and accessory equipment with pressure parts of low pressure gas-fuelled engines are to be subjected to hydraulic tests in accordance with the requirements of **2.6.1, Part D of the Rules** and **16.7.3, Part GF of the Rules**: relevant requirements are to be applied mutatis mutandis.

4.2.2 Shop Trials

Low pressure gas-fuelled engines are to be tested as specified in **2.6.1-3, Part D of the Rules**. To implement surveys of tests, in lieu of traditional ordinary surveys where the Surveyor is in attendance, the Society may approve survey methods which it considers to be able to obtain information equivalent to that obtained through traditional ordinary surveys.

4.3 Tests after Installation On Board

Control systems of low pressure gas-fuelled engines and related equipment are to be tested depending upon their installation characters in accordance with the requirements of **18.7.3, Part D of the Rules** or the requirements of **2.2.4 of the Rules for Automatic and Remote Control Systems**: relevant requirements are to be applied mutatis mutandis.

4.4 Sea Trials

1 Performance of control systems of low pressure gas-fuelled engines and related equipment is to be verified during operations using the gas fuel depending upon their installation characters in accordance with the requirements of **2.2.5 of the Rules for Automatic and Remote Control Systems**: relevant requirements are to be applied mutatis mutandis.

2 The sea trials specified in **2.3.1, Part B of the Rules** are to be carried out using gas fuel only. Some of the aforementioned tests, however, may be omitted in cases where deemed appropriate by the Society.

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

1. The effective date of the amendments is 30 June 2023.
2. Notwithstanding the amendments to the Rules, the current requirements apply to the surveys for which the application is submitted to the Society before the effective date.

Amendment 1-2

Chapter 2 DEFINITIONS

2.2 Definitions (*IGF Code* 2.2)

2.2.1 Terms*

Sub-paragraph -2 has been amended as follows.

2 *Breadth (B')* means the greatest moulded breadth of the ship at or below the deepest subdivision draught (summer load line draught) (refer to ~~**4.1.2(3),**~~ **2.3.1.2(11), Part 1, Part C**).

Chapter 5 SHIP DESIGN AND ARRANGEMENT

5.3 General Requirements (*IGF Code* 5.3)

5.3.4 Alternative Fuel Tank Locations

Sub-paragraph (2) has been amended as follows.

As an alternative to **5.3.3(1)** above, the following calculation method may be used to determine the acceptable location of the fuel tanks:

(1) (Omitted)

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

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

where:

f_l: calculated by use of the formulations for factor *p* contained in ~~**4.2.2-2, Part C of the Rules**~~ **2.3.2.2-2., Part 1, Part C**. The value of *x*1 is to correspond to the distance from the aft terminal to the aftmost boundary of the fuel tank and the value of *x*2 is to correspond to the distance from the aft terminal to the foremost boundary of the fuel tank.

f_t: calculated by use of the formulations for factor *r* contained in ~~**4.2.2-3, Part C of the Rules**~~ **2.3.2.2-3., Part 1, Part C**, and reflects the probability that the damage penetrates beyond the outer boundary of the fuel tank. The formulation is follows. 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.

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

f_v: calculated by following formulation:

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

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

where:

H: the distance from baseline, in metres, to the lowermost boundary of the fuel tank

d: the deepest draught (summer load line draught)

((3) to (8) are omitted.)

5.12 Airlocks (*IGF Code* 5.12)

Paragraph 5.12.1 has been amended as follows.

5.12.1 Structure

An airlock is a space enclosed by gastight bulkheads with two substantially gastight doors spaced at least 1.5 *m* and not more than 2.5 *m* apart. Unless subject to the requirements of the ~~**Chapters 18, 19**~~**11.3.2, 11.3.3, 11.4.6** and ~~**20,**~~ **11.4.7, Part 1, Part C**, the door sill is not to be less than 300 *mm* in height. The doors are to be self-closing without any holding back arrangements.

Chapter 6 FUEL CONTAINMENT SYSTEM

6.4 Liquefied Gas Fuel Containment (*IGF Code* 6.4)

6.4.15 Tank Types*

Sub-paragraphs -1(1) and (3) have been amended as follows.

1 Type *A* independent tanks

(1) Design basis

(a) Type *A* independent tanks are tanks primarily designed using classical ship-structural analysis procedures in accordance with ~~the requirements in **Chapter 14, Part C of the Rules**~~ recognized standards. Where such tanks are primarily constructed of plane surfaces, the design vapour pressure P_0 is to be less than 0.07 *MPa*.

(b) A complete secondary barrier is required as defined in **6.4.3**. The secondary barrier is to be designed in accordance with **6.4.4**.

(2) (Omitted)

(3) Ultimate design condition

(a) For tanks primarily constructed of plane surfaces, the nominal membrane stresses for primary and secondary members (stiffeners, web frames, stringers, girders), when calculated by classical analysis procedures, are to not exceed the lower of $R_m/2.66$ or $R_e/1.33$ for nickel steels, carbon-manganese steels, austenitic steels and aluminium alloys, where R_m and R_e are defined in **6.4.12(1)(a)iii)**. However, if detailed calculations are carried out for the primary members, the equivalent stress σ_C, as defined in **6.4.12(1)(a)iv)**, may be increased over that indicated above to a stress acceptable to the Society. Calculations are to take into account the effects of bending, shear, axial and torsional deformation as well as the hull/liquefied gas fuel tank interaction forces due to the deflection of the hull structure and liquefied gas fuel tank bottoms.

(b) Tank boundary scantlings are to meet at least the requirements in ~~**Chapter 14, Part C of the Rules**~~**Chapter 6, Part 2-9, Part C** for deep tanks taking into account the internal pressure as indicated in **6.4.9-3(3)(a)** and any corrosion allowance required by **6.4.1-7**.

(c) The liquefied gas fuel tank structure is to be reviewed against potential buckling.

(4) (Omitted)

Sub-paragraph -4(5) has been amended as follows.

4 Membrane tanks

(5) Ultimate design condition

(a) The structural resistance of every critical component, sub-system, or assembly, is to be established, in accordance with **6.4.15-4(1)(b)**, for in-service conditions.

(b) The choice of strength acceptance criteria for the failure modes of the liquefied gas fuel containment system, its attachments to the hull structure and internal tank structures, is to reflect the consequences associated with the considered mode of failure.

(c) The inner hull scantlings are to meet the requirements in ~~**Chapter 14**~~ **Chapter 6, Part 1, Part C**, taking into account the internal pressure as indicated in **6.4.9-3(3)(a)** and the specified appropriate regulations for sloshing load as defined in **6.4.9-4(1)(c)**.

EFFECTIVE DATE AND APPLICATION (Amendment 1-2)

1. The effective date of the amendments is 1 July 2023.

2. Notwithstanding the amendments to the Rules, the current requirements apply to the following ships:

(1) ships for which the date of contract for construction is before the effective date; or

(2) sister ships of ships subject to the current requirements for which the date of contract for construction is before 1 January 2025.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE

Part GF Ships Using Low-Flashpoint Fuels

2023 AMENDMENT NO.1

Notice No.28 30 June 2023
Resolved by Technical Committee on 25 January 2023

Notice No.28 30 June 2023
AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

Part GF SHIPS USING LOW-FLASHPOINT FUELS

Amendment 1-1

GF1 GENERAL

GF1.1 General

Paragraph GF1.1.3 has been amended as follows.

GF1.1.3 Approval of Systems and Equipment, etc.

1 The wording "to be approved as specified separately by the Society" specified in **1.1.3-1, Part GF of the Rules** means that an approval is to be obtained in accordance with **Annexes 1** to **4**.

2 In applying **1.1.3, Part GF of the Rules**, **Annex 1.1.3-2, Part GF of the Rules** is to be dealt with as follows:

(1) The wording "specified separately by the Society" specified in **2.4.3-5, Annex 1.1.3-2, Part GF of the Rules** refers to **Annex 1**.

(2) The wording "specified separately by the Society" specified in **4.1, Annex 1.1.3-2, Part GF of the Rules** refers to **Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

3 In applying **1.1.3, Part GF of the Rules**, **Annex 1.1.3-3, Part GF of the Rules** is to be dealt with as follows:

(1) The wording "specified separately by the Society" specified in **1.1-3, Annex 1.1.3-3, Part GF of the Rules** refers to **8.3(4)(i), Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

(2) The wording "specified separately by the Society" specified in **2.4.4-4, Annex 1.1.3-3, Part GF of the Rules** refers to **Annex 1**.

(3) The wording "specified separately by the Society" specified in **2.4.4-5(4)(a)ii), Annex 1.1.3-3, Part GF of the Rules** refers to **GF9.6.2**.

(4) The wording "deemed appropriate by the Society" specified in **2.5.3** and **3.1-8, Annex 1.1.3-3, Part GF of the Rules** refers to **8.3, Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

(5) The wording "specified separately by the Society" specified in **4.1, Annex 1.1.3-3, Part GF of the Rules** refers to **Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

Annex 3 has been deleted.

~~**Annex 3 GUIDANCE FOR HIGH PRESSURE GAS-FUELLED ENGINES**~~

~~**(Omitted)**~~

Annex 4 has been deleted.

~~**Annex 4 GUIDANCE FOR LOW PRESSURE GAS-FUELLED ENGINES**~~

~~**(Omitted)**~~

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

1. The effective date of the amendments is 30 June 2023.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to the surveys for which the application is submitted to the Society before the effective date.

Amendment 1-2

GF16 MANUFACTURE, WORKMANSHIP AND TESTING

GF16.3 Welding of Metallic Materials and Non-destructive Testing for the Fuel Containment System

GF16.3.5 Production Weld Tests

Sub-paragraph -1 has been amended as follows.

1 Production weld tests are to be in accordance with the requirements specified in **16.3.5**, **Part GF** and **Chapter 11**, **Part D of the Rules** and are also to comply with the following requirements:

~~(1) Application~~

~~When welding is made for independent tanks of ships carrying liquefied gases in bulk, the production weld tests are to be carried out for each position of welding in accordance with the following requirements, in addition to the welding procedure qualification tests specified in **Part M of the Rules**.~~

~~(a) Type *A* independent tanks~~

~~The production weld test is to be carried out on at least one test sample for every 50 *m* of welding length of butt joints of principal structural members. However, consideration may be given for reduction of the number of test sample or omission of the production weld test taking into account the past records and the actual state of quality control system of the manufacturer.~~

~~(b) Type *B* independent tanks~~

~~The production weld tests are to be carried out on at least one test sample for every 50 *m* of welding length of butt joints of principal structural members. However, the number of test sample may be reduced to one test sample for every 100 *m* of welding length taking into account the past records and the actual state of quality control system of the manufacturer. In this case, however, at least one or more test specimens are to be selected for one tank.~~

~~(c) Type *C* independent tanks~~

~~The production weld tests are to be carried out on at least one test sample for every 30 *m* of welding length of butt joints of principal structural members. However, the number of test sample may be reduced to one test sample for every 50 *m* of welding length taking into account the past records and the actual state of quality control system of the manufacturer.~~

(~~2~~1) Test procedure

(a) The production weld tests are to be carried out ~~for every welding length specified in the above **(1)**~~ for welded joints made under the same welding procedure, welding position and welding conditions.

(b) Test sample are, in principle, to be located on the same line as the welded joints of the body and to be welded at the same time of welding of the body.

(~~3~~2) Kind of test

Kinds of the test are to be as given in **Table GF16.3.5-1**.

(~~4~~3) Test assemblies

The shape and size of test assemblies are to be as shown in **Fig. GF16.3.5-1**. In cases of Type

A and Type *B* independent tanks, tensile test may not be required.

(~~5~~4) Test specimens

(a) The shape and size of tensile test specimens are to be of the *U*2*A* or *U*2*B* test specimen specified in **Table M3.1**, **Part M of the Rules**.

(b) The shape and size of bend test specimens are to be of the *UB*-1, *UB*-2 and *UB*-3 test specimens specified in **Table M3.2**, **Part M of the Rules**. For test specimens with a thickness exceeding 20 *mm*, side bend test specimens are to be substituted for face bend and root bend test specimens.

(c) Impact test specimens are to be the *U*4 test specimen specified in **Table K2.5**, **Part K of the Rules**. In the impact test, one set of test specimens comprising three pieces are to be taken from every test assembly.

The test specimens are to be taken alternately from the position *A* and from a position among *B* through *E* where the lowest value is recorded in the welding procedure qualification test, shows in **Fig. M4.4**, **Part M of the Rules**. This means that one set of three test specimens are taken from a test assembly at the position *A*, thence other set of three test specimens are taken in the subsequent test assembly from the position among *B* through *E* where the lowest value is recorded, and this procedure is repeated.

(~~6~~5) Tensile test

The tensile strength of weld metal is to be more than the specified value of the base metal. However, the tensile strength of weld metal which has lower tensile strength than that of the parent metal is to be complied with the requirements in **4.2.5**, **Part M of the Rules**.

(~~7~~6) Bend test

(a) The bend test specimen is to be bent up to an angle of 180 degrees by a test jig with an inner radius of double the thickness of the test specimen.

(b) The results of the bend test are to be as free from cracks exceeding 3 *mm* in length in any direction on the outer bent surface and from other significant defects.

(~~8~~7) Impact test

The specified value for the impact test are to be the value prescribed for the base material being joined. However, test temperature may be determined in accordance with the requirements in **GF6.4.13-2**.

EFFECTIVE DATE AND APPLICATION (Amendment 1-2)

1. The effective date of the amendments is 30 June 2023.

2. Notwithstanding the amendments to the Guidance, the current requirements may apply to ships for which the date of contract for construction is before the effective date.

Amendment 1-3

GF16 MANUFACTURE, WORKMANSHIP AND TESTING

GF16.3 Welding of Metallic Materials and Non-destructive Testing for the Fuel Containment System

Paragraph GF16.3.5 has been amended as follows.

GF16.3.5 Production Weld Tests

1 Production weld tests are to ~~be in accordance with the requirements specified in **16.3.5, Part GF** and **Chapter 11, Part D of the Rules** and are also to~~ comply with the following ~~requirements~~:

(1) Application

When welding is made for independent tanks of ships carrying liquefied gases in bulk, the production weld tests are to be carried out for each position of welding in accordance with the following requirements, in addition to the welding procedure qualification tests specified in **Part M of the Rules**.

(a) Type *A* independent tanks

The production weld test is to be carried out on at least one test sample for every 50 *m* of welding length of butt joints of principal structural members. However, consideration may be given for reduction of the number of test sample or omission of the production weld test taking into account the past records and the actual state of quality control system of the manufacturer.

(b) Type *B* independent tanks

The production weld tests are to be carried out on at least one test sample for every 50 *m* of welding length of butt joints of principal structural members. However, the number of test sample may be reduced to one test sample for every 100 *m* of welding length taking into account the past records and the actual state of quality control system of the manufacturer. In this case, however, at least one or more test specimens are to be selected for one tank.

(c) Type *C* independent tanks

The production weld tests are to be carried out on at least one test sample for every 30 *m* of welding length of butt joints of principal structural members. However, the number of test sample may be reduced to one test sample for every 50 *m* of welding length taking into account the past records and the actual state of quality control system of the manufacturer.

(2) Test procedures

(a) The production weld tests are to be carried out for every welding length specified in the above **(1)** for welded joints made under the same welding procedure, welding position and welding conditions.

(b) Test ~~sample~~ assemblies are, in principle, to be located on the same line as the welded joints of the body and to be welded at the same time of welding of the body.

(3) Kind of test

The ~~K~~kind~~s~~ of the test is ~~are~~ to be as given in **Table GF16.3.5-1**. In the case of Type *A* and Type *B* independent tanks, tensile tests need not be carried out.

(4) Test assemblies

The shape and size of test assemblies are to be as shown in **Fig. GF16.3.5-1**. ~~In cases of Type~~

~~*A* and Type *B* independent tanks, tensile test may not be required.~~

(5) Test specimens

(a) The shape and size of tensile test specimens are to be of the *U*2*A* or *U*2*B* test specimen specified in **Table M3.1**, **Part M of the Rules**.

(b) The shape and size of bend test specimens are to be of the *UB*-1, *UB*-2 and ~~*UB*-3~~10 test specimens specified in **Table M3.2**, **Part M of the Rules**. For test specimens with a thickness ~~exceeding 20~~ not less than 12 *mm*, side bend test specimens ~~are to~~ may be substituted for face bend and root bend test specimens.

(c) Impact test specimens are to be the *U*4 test specimen specified in **Table K2.5**, **Part K of the Rules**. In the impact test, one set of test specimens comprising three pieces are to be taken from every test assembly.

The test specimens are to be taken alternately from the position *A* and from a position among *B* through *E* where the lowest value is recorded in the welding procedure qualification test, shows in **Fig. M4.4**, **Part M of the Rules**. This means that one set of three test specimens are taken from a test assembly at the position *A*, thence other set of three test specimens are taken in the subsequent test assembly from the position among *B* through *E* where the lowest value is recorded, and this procedure is repeated.

(6) Tensile tests

The tensile strength of weld metal is to be more than the specified value of the base metal. However, the tensile strength of weld metal which has lower tensile strength than that of the parent metal is to be complied with ~~the requirements in~~ **4.2.5**, **Part M of the Rules**.

(7) Bend tests

(a) The bend test specimen is to be bent up to an angle of 180 degrees by a test jig with an inner radius of double the thickness of the test specimen.

(b) The results of the bend test are to be as free from cracks exceeding 3 *mm* in length in any direction on the outer bent surface and from other significant defects.

(8) Impact tests

(a) ~~The specified value for the impact test~~ Minimum average energy values are to be the value prescribed for the base material being joined. However, test temperature may be determined in accordance with ~~the requirements in~~ **GF6.4.13-2**.

(b) Minimum single energy values are to be in accordance with **16.3.3-5(3)**, **Part GF of the Rules**.

(c) For type *C* independent tanks and process pressure vessels, notwithstanding the preceding **(b)**, minimum single energy values are to be in accordance with **11.5.4-1 (3)(b)**, **Part D of the Rules**.

2 For the purpose of ~~the requirements in~~ **16.3.5-1**, **Part GF of the Rules**, the number of test specimens for production weld tests of secondary barriers may be reduced to the extent as deemed appropriate by the Society considering the experience of same welding procedures in past, workmanship and quality control. In general, intervals of production tests for secondary barriers may be approximately 200 *m* of butt weld joints and the tests are to be representative of each welding position.

3 For the purpose of ~~the requirements in~~ **16.3.5-5**, **Part GF of the Rules**, production weld tests for membrane tanks are left to the discretion of the Society depending on the construction system of the tank.

4 Procedures for additional tests before rejection are to comply with the following:

(1) Tensile tests

The requirements in **11.5.4-3**, **Part D of the Rules** are to be complied with.

(2) Bend test

(a) The requirements in **4.2.12-2**, **Part M of the Rules** are to be complied with.

(b) For type *C* independent tanks and process pressure vessels, notwithstanding the preceding **(a)**, bend tests are to be in accordance with **11.5.4-3**, **Part D of the Rules**.

(3) Impact tests

(a) The requirements in **16.2.2-4**, **Part GF of the Rules** are to be complied with.

(b) For type *C* independent tanks and process pressure vessels, notwithstanding the preceding **(a)**, impact tests are to be in accordance with **11.5.4-3**, **Part D of the Rules**.

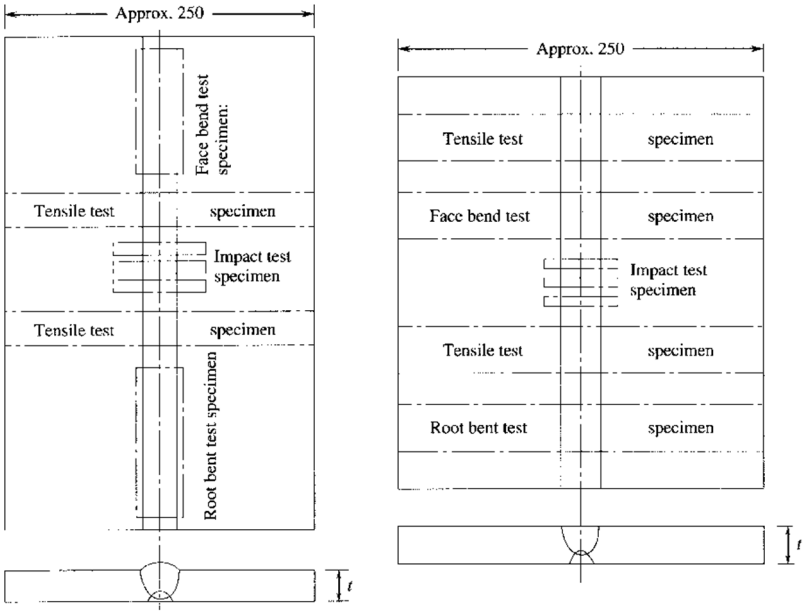
Table GF16.3.5-1 Kinds of Tests

Material	Kind of test
9 *% Ni* steel	Tensile test, bend test and impact test
Austenitic stainless steel	Tensile test, and bend test
Aluminium alloy(1)	Tensile test, and bend test
~~Steel for low temperature service (excluding 9% *Ni* steel)~~ Others	Tensile test, bend test and impact test

Note:

(1) For aluminium alloys other than type 5083, additional tests may be required to verify the toughness of the material.

Fig. GF16.3.5-1 Test Assemblies for Production Weld Tests (units: *mm*, *t*: thickness)



(a) For 9% *Ni* steel (b) For materials other than (a)

Note:

(1) In the case of Type *A* and Type *B* independent tanks, tensile tests need not be carried out.

EFFECTIVE DATE AND APPLICATION (Amendment 1-3)

1. The effective date of the amendments is 30 June 2023.

Amendment 1-4

GF6 FUEL CONTAINMENT SYSTEM

GF6.4 Liquefied Gas Fuel Containment

GF6.4.6 Supporting Arrangements

Sub-paragraph -2(2) has been amended as follows.

2 The analysis of supporting structures against the load conditions specified in the requirements in **6.4.9-3(3)(h)** and **6.4.9-4(1)(a)**, **Part GF of the Rules** is to be done while giving considerations to the following conditions **(1)** and **(2)**:

(1) A condition where, at a static heel angle of 30°, static load by the weight of liquefied gas fuel tank containing the liquefied gas fuel and the static sea water pressure without dynamic pressure due to waves is imposed.

(2) A condition where load by the weight of liquefied gas fuel tank containing the liquefied gas fuel with the acceleration caused by ship motions specified in the requirements in **6.4.9-4(1)(a)**, **Part GF of the Rules** and the dynamic sea water pressure due to waves are imposed. Such dynamic sea water pressure due to waves may be determined by the requirements in ~~**C31.1.3, Part C of the Guidance**~~**4.3, Part 2-9, Part C of the Rules**.

GF6.4 Liquefied Gas Fuel Containment

Paragraph 6.4.15 has been amended as follows.

GF6.4.15 Tank Types

1 (Omitted)

2 The "classical analysis procedures" referred to in the requirements in **6.4.15-1(3)(a)**, **Part GF of the Rules** means ~~the beam theory where the type of stress to be assessed is the combined stress of bending stress and axial stress~~ to meet the requirements in **Chapter 6, Part 2-9, Part C of the Rules**.

3 (Omitted)

4 For the purpose of the requirements in **6.4.15-1(3)(b)**, **Part GF of the Rules**, in structures where the membrane or axial force due to internal pressure can not be neglected, the calculation equation specified in ~~**Chapter 14,**~~ **Chapter 6, Part 2-9, Part C of the Rules** may be used after suitable modification.

~~**5** For the purpose of the requirements in **6.4.15-1(3)(b)**, **Part GF of the Rules**, in case where no corrosion allowance specified in **6.4.1-7**, **Part GF of the Rules** is required, stiffeners may have section modulus more than 1/1.2 of one required in **14.2.3, Part C of the Rules**.~~

Table GF6.4.15 Allowable Stresses for the Primary Equivalent Stress

Ferrite steels	Austenic steels	Aluminium alloys
$0.79R_e$	$0.84R_e$	$0.79R_e$
$0.53R_m$	$0.42R_m$	$0.42R_m$

Note:

For each member, the smaller of the above values is to be used with R_e and R_m as specified in **6.4.12-1(1)(c), Part GF of the Rules**.

~~6~~**5** (Omitted)

~~7~~**6** (Omitted)

~~8~~**7** (Omitted)

~~9~~**8** The "calculations using accepted pressure vessel buckling theory" referred to in the requirements in **6.4.15-3(3)(b)**, **Part GF of the Rules** means calculations based on standards such as *JIS*, *ASME*, etc. P_4 among design external pressure P_e is to be the value computed by applying the requirements in **10.2~~,~~18.2****4.4.2.7, 4.4.2.8** and ~~**19.2,**~~ **4.9.2.2, Part 1, Part C of the Rules** corresponding to the location of the tanks.

~~10~~**9** (Omitted)

~~11~~**10** (Omitted)

~~12~~**11** In the assessments referred to in the preceding **-~~11~~0**, verification is to be made through fatigue tests on a model combining the elements of the tank, second barrier, insulation structure and tank supporting structure considering the dimensional effects on real tank and the effects of dispersions in materials and fabrication accuracy as an integral part of the test specified in **16.5.5-1(1)**, **Part GF of the Rules**.

~~13~~**12** (Omitted)

~~14~~**13** For the purpose of the requirements in **6.4.15-4(4)(b)**, **Part GF of the Rules**, the hull structure adjacent to membrane tanks is to comply with the requirements in ~~**Chapter 14,**~~ **Chapter 6, Part 1, Part C of the Rules** and, in addition, the stress in the hull structure is to be restricted in consideration of the structural strength of membrane tanks, if necessary. The allowable stresses of the membrane, membrane supporting structures and insulation materials are to be determined in each case according to the mechanical properties of materials, records of construction, product specifications and levels of product quality control practice.

EFFECTIVE DATE AND APPLICATION (Amendment 1-4)

1. The effective date of the amendments is 1 July 2023.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to the following ships:

(1) ships for which the date of contract for construction is before the effective date; or

(2) sister ships of ships subject to the current requirements for which the date of contract for construction is before 1 January 2025.

Amendment 1-5

GF9 FUEL SUPPLY TO CONSUMERS

Section GF9.2 has been added as follows.

GF9.2 Functional Requirements

GF9.2.2 Additional Requirements

1 In applying **9.2.2-2, 9.6.1** and **7.3.6-3, Part GF of the Rules**, two independent safety barriers are to be in place, while, as far as practicable, using a minimum of flange connections. There is to be no single common flange or other component where a single failure itself may overcome both primary and secondary barriers and may result in a gas leak into the surrounding area causing danger to the ship itself, any persons on board, or the environment.

2 Notwithstanding **-1** above, a single common flange (with two sealing systems) may be accepted at fuel connections to gas consumers (including *GCU*s, boilers and components on the engine, such as gas regulating units).

EFFECTIVE DATE AND APPLICATION (Amendment 1-5)

1. The effective date of the amendments is 1 July 2023.

2. Notwithstanding the amendments to the Guidance, the current requirements may apply to ships for which the date of contract for construction* is before the effective date.

*"contract for construction" is defined in the latest version of IACS Procedural Requirement(PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
(1) such alterations do not affect matters related to classification, or
(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Note:
This Procedural Requirement applies from 1 July 2009.

Amendment 1-6

Annex 1 GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS USING LOW-FLASHPOINT FUELS

Chapter 16 FIXED DRY CHEMICAL FIRE-EXTINGUISHING EQUIPMENT

16.1 General

16.1.1 Application

Sub-paragraph -2 has been amended as follows.

1 The requirements in this chapter apply to fixed dry chemical fire-extinguishing equipment in accordance with the requirements in **1.1.3-1**, **Part GF of the Rules**.
2 Fixed dry chemical fire-extinguishing systems specified in **11.6.1-1**, **Part GF of the Rules**, are to conform to the requirements in **11.6.1-1**, **Part GF of the Rules**, and in addition ~~they are to comply with the~~ "*Guidelines for the approval of fixed dry chemical powder fire-extinguishing systems for the protection of ships carrying liquefied gases in bulk*" (*MSC*.1/*Circ*.1315/Rev.1) apply correspondingly.

EFFECTIVE DATE AND APPLICATION (Amendment 1-6)

1. The effective date of the amendments is 1 July 2023.
2. Notwithstanding the amendments to the Guidance, the current requirements apply to fixed dry chemical powder fire-extinguishing systems for which the contractual delivery date(In the absence of a contractual delivery date, systems for which the actual delivery date) to the ship is before the effective date.