RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

Part N Ships Carrying Liquefied Gases in Bulk

2019 AMENDMENT NO.1

Rule No.39 14 June 2019

Resolved by Technical Committee on 30 January 2019

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

Rule No.39 14 June 2019
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 N SHIPS CARRYING LIQUEFIED GASES IN BULK

Chapter 5 PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR, AND PRESSURE PIPING SYSTEMS

Title of Section 5.7 has been amended as follows.

5.7 Installation Requirements (Related to *IGC Code* 5.7)

Paragraph 5.7.4 has been amended as follows.

5.7.4 Bonding*

1 Where tanks or cargo piping and piping equipment are separated from the ship's structure by thermal isolation, provision is to be made for electrically bonding both the piping and the tanks. All gasketed pipe joints and hose connections are to be electrically bonded. Except where bonding straps are used, it is to be demonstrated that the electrical resistance of each joint or connection is less than 1 *MΩ*.

2 In addition to **-1** above, cargo tanks and cargo piping systems are to comply with the requirements specified in **14.2.2-7, Part D of the Rules** (in this case the term "cargo oil" is to be read as "cargo").

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 14 June 2019.
2. Notwithstanding the amendments to the Rules, the current requirements apply to ships other than ships for which the application for Classification Survey during Construction is submitted to the Society on or after the effective date.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE

Part N Ships Carrying Liquefied Gases in Bulk

2019 AMENDMENT NO.1

Notice No.26 14 June 2019
Resolved by Technical Committee on 1 August 2018 / 30 January 2019

Notice No.26 14 June 2019
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 N SHIPS CARRYING LIQUEFIED GASES IN BULK

Amendment 1-1

N16 USE OF CARGO AS FUEL

N16.1 General

Paragraph N16.1.1 has been amended as follows.

N16.1.1 General

1 The requirements for gas fuel diesel engines ~~and~~, gas fuel boilers and gas combustion units are to be in accordance with **Annex 3** "**GUIDANCE FOR HIGH PRESSURE DUAL FUEL DIESEL ENGINES**" or **Annex 4** "**GUIDANCE FOR LOW PRESSURE DUAL FUEL DIESEL ENGINES**" ~~and~~, **Annex 2** "**GUIDANCE FOR DUAL FUEL BOILERS**" and **Annex 2A** "**GUIDANCE FOR GAS COMBUSTION UNITS**" respectively. In addition, gas fuel turbines are to be as deemed appropriate by the Society.

2 ~~The requirements for gas turbines are to be subject to the special consideration of the Society.~~ Notwithstanding the requirements **-1** above, if other cargo gases are used as fuel in accordance with **16.9.1, Part N of the Rules**, gas fuel boilers, gas combustion units, gas fuel reciprocating internal combustion engines and gas turbines are to be approved by the Administration.

Annex 2 GUIDANCE FOR DUAL FUEL BOILERS

Chapter 2 CONSTRUCTION AND EQUIPMENTS OF DF BOILER

2.1 General

Sub-paragraph -2 has been amended as follows.

2 Burners of DF boiler are to be capable of ensuring stable burning under all conditions of combustion including the following **(1)** through **(5)** according to types of burners, and are, in principle, to be of the type that has passed prototype tests specified in ~~5~~**4.1**.
((1) to (5) are omitted.)

Chapter 3 has been deleted.

~~Chapter 3 GAS FUEL SUPPLY SYSTEMS~~

~~3.1 Gas Fuel Make-up Plants~~

~~3.1.1 General~~

~~**1** Equipment of gas fuel make-up plant and oil fuel supply systems for DF boilers is to be such that a failure of any one of the systems normally used will not cause adverse effects on steam supplies for ordinary consumption of steam for normal navigation and general shipboard use.~~

~~**2** Gas fuel supply compressors and heat exchangers forming the gas fuel make-up plant are to comply with the requirements of **Chapter 2** and **Chapter 4 of Annex 1 "GUIDANCE FOR EQUIPMENT AND FITTING OF SHIPS CARRYING LIQUEFIED GASES IN BULK"** respectively.~~

~~**3** Pressure vessels and piping systems composing the gas fuel make-up plant are to comply with the requirements of **Chapter 5, Part N of the Rules.**~~

~~**4** If the heating medium of gas fuel heat exchangers returns to spaces other than cargo spaces, it is to be so arranged that the heating medium is returned through degassing tanks located in cargo spaces. The degassing tanks are to be provided with a gas detecting system to issue alarms on detecting gas leaks. Vent outlets of the degassing tanks are to be provided with flame screens and the openings are to be located at safe positions.~~

~~3.2 Gas Fuel Supply Piping Systems~~

~~3.2.1 General~~

~~**1** Gas fuel supply piping systems are to comply with the relevant requirements of **16.4.1-2, Part N of the Rules.**~~

~~**2** Protection against gas fuel leaks from gas fuel supply piping systems located in other than cargo spaces is to comply with the relevant requirements of **16.4, Part N of the Rules.**~~

Chapters 4 and 5 have been amended as follows.

Chapter ~~4~~3 CONTROL SYSTEMS AND SAFETY SYSTEMS

~~4~~3.1 Control Systems

~~4~~3.1.1 Gas Burning Control System

Control systems for gas fuel burning are to comply with the following requirements **(1)** through **(7)**, in addition to the requirements of **18.4.1** and **18.4.2, Part D of the Rules**.
((1) to (5) are omitted.)

~~4~~3.2 Safety Systems

~~4~~3.2.1 Safety Systems and Alarm Systems of DF Boilers

1 The safety system and alarm system of DF boilers are to comply with the following requirements **(1)** to **(3)**, in addition to the requirements of **9.9.10,** and **18.4.4** and **18.4.5, Part D of the Rules**.

(1) Safety systems are to be provided so that the gas fuel supplies to all burners are cut off to stop the operation of DF boilers when the following abnormalities **(a)** through **(g)** occur during gas burning or burning. The automatic double block and bleed valves specified in **16.4.5, Part N of the Rules** may be used as the automatic cut off valve used for this purpose.
   (a) When all flame detectors specified in **2.3-4** issue flame-fail signals (in this case, it is to be able to stop the supply within 4 *seconds* after flame-fail).
   (b) When water level falls
   (c) When combustion air supply stops
   (d) When gas fuel supply pressure falls
   (e) When the automatic double block and bleed valve specified in **16.4.5, Part N of the Rules** fails
   (f) When the master gas fuel valve specified in **16.4.6, Part N of the Rules** closes
   (g) When considered necessary by the Society

((2) to (4) are omitted.)

2 DF boilers of ships **to** which the requirements in **1.1.1 of the Rules for Automatic and Remote Control Systems** apply are to comply with the requirements of **3.2** and ~~**3.6**~~ **3.3.3** of the said Rules and **-1** above and to be provided with alarm devices activated on the event of any abnormalities specified in **(1)** through **(10)** given below.
((1) to (6) are omitted.)

(7) Activation of automatic double block and bleed valves specified in **16.4.5, Part N of the Rules**

((8) to (10) are omitted.)

~~4~~3.2.2 Safety System for Gas Fuel Make-up Plants

1 Gas compressors for gas fuel make-up plants are to be equipped with the following safety systems:
((1) to (4) are omitted.)

2 Gas fuel supply **compressors** of ships to which the requirements in **1.1.1 of the Rules for Automatic and Remote Control Systems** apply are to be provided with safety systems and alarm

systems such as the following **(1)** through **(8)**.
((1) to (7) are omitted.)
(8) Safety systems and alarm systems specified in ~~**3.9**~~**3.3.6 of the Rules for Automatic and Remote Control Systems**, when the gas compressors are driven by steam turbines
(-3 is omitted.)

Chapter ~~5~~4 TESTS

~~5~~4.1 Prototype Tests

Burners of DF boilers are to be subjected to prototype tests using the gas fuel in accordance with a test plan approved by the Society to demonstrate the designed performance. However, sufficient records with performance data submitted may be substituted for prototype tests when deemed appropriate by the Society.

~~5~~4.2 Shop Tests

1 Tests of DF boilers are to be carried out according to the requirements in **9.10.1, Part D of the Rules**.
2 Operating tests of burners are to be conducted using the gas fuel. However, when the burners are of the same type of prototype burners specified in **~~5~~4.1** or of the similar products, shop tests using only the oil fuel may be accepted when deemed appropriate by the Society.
3 Tests specified in **-2** above may be substituted with the tests specified in **~~5~~4.3** when deemed appropriate by the Society.

~~5~~4.3 Tests after Installation On Board

1 DF boilers are to be tested in accordance with the requirements of **9.10.2, Part D of the Rules**.
2 Automatic control systems and remote control systems of equipment handling the gas fuel on DF boilers and gas fuel make-up plants are to be tested using the gas fuel in normal service conditions before the first cargo loading.
3 Part or all of the tests specified in **-2** above may be conducted during sea trials specified in **~~5~~4.4**.

~~5~~4.4 Sea Trials

1 The control systems of DF boilers and related equipment installed in ships subject to **1.1.1 of the Rules for Automatic and Remote Control Systems** are to be verified the control performance of operations using the oil fuel in accordance with the requirements in ~~**18.7.4-2, Part D of the Rules and**~~ **2.2.5 of the Rules for Automatic and Remote Control Systems** ~~according to the kind of Installations Characters~~. In addition, tests are to be carried out to verify the control performance using the gas fuel correspondingly in accordance with ~~these~~ the requirements.
(-2 is omitted.)

Annex 2A has been added as follows.

Annex 2A GUIDANCE FOR GAS COMBUSTION UNITS

Chapter 1 GENERAL

1.1 Scope

1 This annex applies to gas combustion units burning methane (boil-off gases and cargo vapour) (hereinafter referred to as "*GCU*") in accordance with the requirements in **16.1.1, Part N of the Rules**.
2 *GCU*s are to be in accordance with relevant requirements in **Part D** and **Part N of the Rules**, in addition to the requirements of this annex, **Chapter 7** and **16, Part N of the Rules**.

1.2 Equivalency

*GCU*s not in accordance 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) General arrangement
  (b) Items specified in **18.1.3(1)**, **(3)** and, **(5)** and **(6), Part D of the Rules**
  (c) Operating instructions for the automatic control devices and remote control devices (including sequential control, combustion control and safety devices).
  (d) Diagrams for automatic combustion control devices of *GCU*
  (e) Gas fuel burning devices
  (f) Gas leak protection devices for connections between *GCU*s and gas fuel supply piping systems
  (g) Gas fuel supply piping systems (including details of valves and pipe fittings) and devices to protect surrounding areas, etc. from gas leakages
  (h) Automatic control and remote control systems for gas fuel supply systems
  (i) Prototype test plans for gas fuel burning devices and test results
  (j) Onboard test plans
  (k) Test plans of gas trials specified in **4.20.3, Part N of the Rules**
  (l) Other drawings and data deemed necessary by the Society depending upon the type of *GCU*
(2) Plans and documents for reference
  (a) Instruction manuals (including guidance for onboard maintenance, inspection and overhaul)
  (b) Other drawings and data deemed necessary by the Society

Chapter 2 CONSTRUCTION AND EQUIPMENT OF *GCU*

2.1 General

1 When the maintaining by disposing as thermal oxidation of cargo vapours specified in **1.1.4(47)** and **16.2, Part N of the Rules**, following **(1)** to **(4)** are to be complied with:

(1) *GCU*s are to exhibit no externally visible flame;

(2) the uptake exhaust temperature is to be maintained below 535℃;

(3) arrangement of spaces where *GCU*s are located are to comply with **16.3** and supply systems are to comply with **16.4**;

(4) if waste gases coming from any other system are to be burnt, *GCU*s are to be designed to accommodate all anticipated feed gas compositions.

2 *GCU* burners are to be capable of ensuring stable igniting and burning under all conditions of combustion including the following **(1)** to **(5)** according to the type of burner. In addition, they are, in principle, to be of the type that has passed the prototype tests specified in **4.1**.

(1) Igniting condition and purging condition the fuel supply systems with inert gas (when supplementary oil burning is continued)

(2) Rapid load fluctuations

(3) Minimum load conditions

(4) Free flow combusting condition (when *GCU* burners are designed to be able to do so)

(5) Other conditions as deemed necessary by the Society depending upon the type of burners

3 *GCU*s are to be capable of quickly gas-burning on the condition of igniting.

4 *GCU*s and its supporting auxiliary services are to be to comply with **7.8.1, Part N of the Rules**.

2.2 Construction and Arrangement

1 The construction of *GCU*s is to be such that a smooth combustion gas flow is ensured without stagnation of the gas fuel, and neither gas fuel nor combustion gases leak out of the *GCU*s.

2 The construction of *GCU*s is to be capable of effective ventilation by a smooth flow of purge gas and air when the combustion chamber is ventilated. The ventilating system is to be as deemed appropriate by the Society.

3 Uptakes of *GCU*s are to be independent through to the funnel top and the uptakes of other combustion systems or exhaust gas pipes of other equipment are not to be connected thereto.

4 Combustion air intakes of *GCU*s are to be independent and to have a dedicated forced draught system to ensure forced air supply.

2.3 Burners

1 Each burner is to be capable of maintaining of stable combustion under all design firing conditions.

2 Gas fuel supply pipes to burners are to be provided with manually operable shut-off valves. In addition, non-return valves and back-fire prevention devices are to be provided in a series.

3 Gas fuel supply pipes to burners are to be purged automatically with appropriate inert gases if the supply is interrupted or burners are extinguished.

4 Gas fuel burners are to be so arranged that they can be ignited individually only by flames of oil fuel burners. In such cases, oil fuel burners are to be large enough to instantly ignite the gas fuel

at any nozzle of gas fuel burners. In the case of direct ignition type gas fuel burners specified in **3.2**, this requirement may be dispensed with.

5 Burners using both gas fuel and oil fuel are to be provided with at least two flame detectors. If a self-diagnostic function capable of monitoring failures of own system as deemed appropriate by the Society is provided, however, a single detector may be accepted.

6 Gas fuel burners are to be provided with a means to ensure the cutting off of gas fuel supplies before dismounting.

7 Gas fuel burners are to be so arranged as not to be damaged by fire during pilot oil burning.

8 Fuel oil burners are to be so arranged as not to be burn-damaged when *GCU*s are operated under the oil burning mode.

9 Each burner is to have suitable devices and be arranged to ensure that gas flow to the burner is cut off unless satisfactory ignition has been established and maintained.

10 Each oxidation system is to have provision to manually isolate its gas fuel supply from a safely accessible position.

Chapter 3 CONTROL SYSTEMS AND SAFETY SYSTEMS

3.1 Control Systems

3.1.1 Gas Burning Control Systems

Control systems for gas fuel burning are to be in accordance with the requirements specified in the following **(1)** to **(5)**. In addition, the wording "boiler" specified in **18.4.1** and **18.4.2, Part D of the Rules** is to be interpreted to mean "*GCU*", the systems are to be applied the requirements.

(1) It is to be so arranged that gas fuel is not supplied to burners until the flames of pilot burners used for gas fuel ignition are established and secured. In cases where gas fuel supply is initiated manually, it is to be so arranged that the gas fuel supply is cut off automatically when gas fuel supply valves are opened before flame of pilot burners are established, or that the gas fuel supply valves are locked until the pilot burner flames are established.

(2) Control systems regulating oil/gas supply ratios are to be capable of maintaining combustion over the full range of loads approved for oil/gas burning with consideration given to ensuring sufficient supplies of combustion air.

(3) Combustion air supplies for gas burning or oil/gas burning are to be automatically controlled to ensure safe combustion within the possible combustible range.

(4) Combustion chambers of *GCU* are to be capable of automatic purging for the chambers with sufficient air volumes both before igniting base burners and after extinction of all burners. Arrangements deemed appropriate by the Society are to be made to enable *GCU*s to be manually purged.

(5) In the case of gas fuel supply rate control systems, it is to be so arranged that gas fuel supply rates are ensured not to be reduced less than predetermined minimum supply rates verified in advance by tests.

3.2 Safety Systems and Alarm Systems

3.2.1 Safety Systems and Alarm Systems of *GCU*

1 Safety systems and alarm systems of *GCU* are to be in accordance with the following **(1)** and **(2)** requirements.

(1) Safety systems are to be provided so that gas fuel supplies to all burners are cut off to stop the operation of *GCU*s when the following **(a)** to **(i)** occur during gas burning or oil/gas burning. The automatic double block and bleed valves specified in **16.4.5, Part N of the Rules** may be used as automatic cut off valves for this purpose:
   (a) when automatic ignition fails;
   (b) when all flame detectors specified in **2.3-5** issue flame-fail signals (in such cases, it is to be able to stop the supply within 4 *seconds* after flame-fail);
   (c) when a fan supplying air for either combustion or cooling stops (excluding cases where a standby fan automatically switches on when an operating fan stops);
   (d) when gas fuel supply pressure falls (excluding free flow combusting condition);
   (e) when oil fuel (pilot oil) supply pressure falls;
   (f) when the automatic double block and bleed valves specified in **16.4.5, Part N of the Rules** fail;
   (g) when the master gas fuel valves specified in **16.4.6, Part N of the Rules** close;
   (h) when the uptake exhaust gas reaches high temperature;

(i) when deemed necessary by the Society.

(2) Means are to be provided to issue alarms in the following **(a)** to **(g)** cases:
- (a) when one of the flame detectors specified in **2.3-5** issues a flame-fail signal;
- (b) when either the combustion or cooling air supply decreases, or the fan stops;
- (c) when gas fuel supply pressure falls (excluding free flow combusting condition);
- (d) when the power supply for burner control stops;
- (e) when gas detectors for the outer pipes of double wall pipes or ducts fail;
- (f) when ventilation fans of the protection ducts for gas fuel supply piping specified in **16.4.3, Part N of the Rules** stop or inert gas pressure in the space between concentric pipes falls;
- (g) when factors causing to activate detecting systems specified in **13.6, Part N of the Rules** occurs.

2 *GCU*s subject to the **1.1.1 of the Rules for Automatic and Remote Control Systems** are to be in accordance with the requirements **-1** above, following **(1)** and **(2)** requirements.

(1) Such *GCU*s are to be provided with devices which issue alarms in the event any of the abnormalities specified in the following **(a)** to **(e)** occurs:
- (a) abnormal gas fuel temperatures;
- (b) abnormal gas fuel supply pressures;
- (c) low inert gas supply pressures for purging gas fuel piping systems and burners;
- (d) low pressures of hydraulic or pneumatic power sources for burning control, or loss of electric power supplies;
- (e) others deemed necessary by the Society.

(2) Systems intended for automatic combustion control are to comply with the following **(a)** to **(d)** requirements:
- (a) Automatic combustion control systems are to comply with the following requirements:
  - i) The systems are to be able to obtain planned capacity and be able to secure stable combustion.
  - ii) Devices to control the fuel supply of *GCU* to adjust according to the load imposed and are to be capable of ensuring stable combustion in the controllable range of fuel supply.
  - iii) In cases where combustion control is carried out according to the pressure of the *GCU*, the upper limit of this pressure is to be lower than the set pressure of the safety valves.
- (b) The combustion control devices for intermittent operation are to comply with the following requirements and they are to operate according to a planned sequence:
  - i) Before ignition of the pilot burner or before ignition of the main burner if a pilot burner is not fitted, the combustion chamber and the flue are to be prepurged by air of not less than 4 times the volume of the combustion chamber and the flue up to the *GCU* uptake. For small *GCU*s with only one burner, a prepurge for not less than 30 *seconds* will be accepted.
  - ii) In cases where deemed appropriate by the Society and direct ignition, a method of ignition in which the main burner is fired by ignition spark is used, the opening of the fuel valve is not to precede the ignition spark.
  - iii) In cases where indirect ignition is used, a method of ignition in which the main burner is fired by a pilot burner, the opening of the fuel valve for the pilot burner (hereinafter referred to as ignition fuel valve in this part) is not to precede the ignition spark, and the opening of the fuel valve for the main burner (hereinafter referred to as main fuel valve in this part) is not to precede the opening of the ignition fuel valve.

iv) Firing is to definitely be carried out within the planned period. If the firing of the main burner has failed, main fuel valves are to be so designed as to close after being opened within 10 *seconds* in the case of direct ignition and 15 *seconds* in the case of indirect ignition.
v) Firing on the main burners is to be carried out at their low firing position.
vi) After closure of the automatic double block and bleed valves, post-purge is to be sufficiently carried out to completely burn off all remaining fuel oil between the valves and the burner nozzle.

(c) The combustion control devices for controlling the number of firing burners are to comply with the following requirements:
i) Each burner is to be fired and extinguished according to a planned sequence. However, the base burner may be fired by manual operation and other burners may be fired by a flame from burner(s) already lit.
ii) Any remaining fuel in extinguished burners is to be automatically burnt up in order not to interfere with any restarting of the burner. However, while the pilot burner is not ignited, any remaining fuel in the base burner is not to be removed by steam or air when the base burner is placed in *GCU*s.
iii) The burners for *GCU*s are to be capable of being fired and extinguished from main control stations or the main control station on the bridge, except for the firing of base burner.

(d) Other combustion control devices are to be deemed appropriate by the Society. They are also to comply with the relevant requirements in **(a)** to **(c)** above.

3.2.2 Safety System for Gas Fuel Make-up Plants

1 Gas compressors for gas fuel make-up plants are to be equipped with the following **(1)** through **(4)** safety systems:

(1) Remote stopping devices from readily accessible places and the position from which the *GCU*s is normally controlled.
(2) An automatic stopping device actuating when the suction pressure of boil-off gas drops to below the predetermined value according to the cargo tank construction system, before the pressure reaches the set pressure of negative pressure relief valves for cargo tanks.
(3) Emergency shut-down specified in **Table N18.1, Part N of the Rules**.
(4) Volumetric compressors are to be fitted with pressure relief valves discharging into the suction line of the compressor. The size of the pressure relief valves is to be determined in such away that, with the delivery valve kept close, the maximum pressure will not exceed the maximum working pressure by more than 10%.

2 Gas fuel supply compressors of ships to which the requirements in **1.1.1 of the Rules for Automatic and Remote Control Systems** apply are to be provided with safety systems and alarm systems such as the following **(1)** through **(8)**.

(1) Monitoring devices and protective devices specified in **2.4.2 of the Annex1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**"
(2) Emergency stop devices specified in **2.4.3 of the Annex1**, "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**"
(3) Automatic stop at over speed
(4) Automatic stop at low lubricating oil pressures
(5) Automatic stop at abnormal rise of discharge pressures
(6) Automatic stop at abnormally low temperature at boil-off gas heater outlet
(7) Device to avoid continuous operations in the barred speed range

(8) Safety systems and alarm systems specified in **3.3.6 of the Rules for Automatic and Remote Control Systems**, when the gas compressors are driven by steam turbines

3 The exit temperature and pressure (or flow-rates) of gas fuel at the gas fuel make-up plants are to be automatically controlled. Furthermore, visual and audible alarm devices are to be provided such as to be activated when the temperature and pressure exceed the preset range.

Chapter 4 TESTS AND INSPECTION

4.1 Prototype Tests

Burners of *GCU*s are to be subjected to prototype tests using gas fuel to demonstrate design performance in accordance with test plans approved by the Society. Such tests, however, may be substituted for by the submission of sufficient records of performance data in cases where deemed appropriate by the Society.

4.2 Shop Tests

1 Tests of welds in piping systems and auxiliaries of *GCU* are to comply with relevant requirements in **Chapter 11, Part D** and **Part N of the Rules**.
2 Tests of Auxiliaries and piping of *GCU* after manufacture are to comply with the requirements in **12.6, Part D of the Rules**.
3 Operating tests of burners are to be conducted using the gas fuel. Shop tests using only oil fuel, however, may be accepted in cases deemed appropriate by the Society when the burners are of the same or similar type as burners which have passed the prototype tests specified in **4.1**.
4 The tests specified in **-3** above may be substituted for with the tests specified in **4.3** in cases where deemed appropriate by the Society.

4.3 Tests after Installation On Board

1 Function tests for the safety devices and alarm devices of *GCU*s are to be carried out after the *GCU* has been installed on board.
2 Automatic control systems and remote control systems for equipment handling gas fuel of *GCU*s and gas fuel preparation plants are to be tested using gas fuel in normal service conditions before the first fuel loading.
3 Part or all of the tests specified in **-2** above may be conducted during the gas trials specified in **4.4**.

4.4 Gas Trials

1 For Gas trials of the control systems for *GCU*s and related equipment specified in **4.20.3, Part N of the Rules**, the wording “boiler” and “main boiler” specified in **2.2.5 of the Rules for Automatic and Remote Control Systems** are to be interpreted to mean “*GCU*”, the requirements are to apply depending upon their of installation characters to verify the control performance where only oil fuel is used. In addition, tests are to be carried out to verify the control performance where only gas fuel is used in accordance with the aforementioned requirements.
2 For Gas trials of *GCU*s and related equipment, the wording “Sea Trail” specified in **2.3.1, Part B of the Rules** is to be interpreted to mean “Gas Trail”, the requirements are to apply and the gas trials carried out using oil fuel only.
In addition, only the tests in **2.3.1, Part B of the Rules** deemed necessary by the Society are to be carried out during the gas trials for dual-fuel type engines and the gas-only type engines operating by gas burning or oil/gas burning.
3 The tests specified in **-1** and **-2** above may be conducted during the sea trials.

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

1. The effective date of the amendments is 14 June 2019.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to ships the keels of which were laid or which were at *a similar stage of construction* before the effective date.

(Note) The term "*a similar stage of construction*" means the stage at which the construction identifiable with a specific ship begins and the assembly of that ship has commenced comprising at least 50 *tonnes* or 1% of the estimated mass of all structural material, whichever is the less.

Amendment 1-2

N4 CARGO CONTAINMENT

N4.19 Materials

Paragraph N4.19.1 has been amended as follows.

N4.19.1 Materials Forming Ship Structure

1 For the purpose of the requirements in **4.19.1-1, Part N of the Rules**, the calculation conditions in computing the temperature of hull structures are to be in accordance with the following **(1)** through **(4)**:

((1) to (4) are omitted.)

(-2 and -3 are omitted.)

4 "Heating system" referred to in the requirements in **4.19.1-6, Part N of the Rules** is to be such that in the case of a single failure of a mechanical or electrical component in any part of the system, heating can be maintained at not less than 100% of the theoretical heat requirement. With respect to the requirement, the following **-5** and **-6** are to be complied with.

5 Where **-4** above are met by duplication of the system components, i.e., heaters, glycol circulation pumps, electrical control panel, auxiliary boilers etc., all electrical components of at least one of the systems are to be supplied from the emergency switchboard.

6 Where duplication of the primary source of heat, e.g., oil-fired boiler is not feasible, alternative proposals such as an electric heater capable of providing 100% of the theoretical heat requirement provided and supplied by an individual circuit arranged separately on the emergency switchboard. Other solutions may be considered towards satisfying the requirements of **4.19.1-6(1), Part N of the Rules** provided a suitable risk assessment is conducted to the satisfaction of the Administration. The requirement of **-5** above continues to apply to all other electrical components in the system.

N5 PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR, AND PRESSURE PIPING SYSTEMS

N5.13 Testing Requirements

Paragraph N5.13.1 has been amended as follows.

N5.13.1 Type Testing of Piping Components

1 For the purpose of **5.13.1-1, Part N of the Rules**, those valves which are relevant to the following **(1)** or **(2)** are to be approved in accordance with the requirements in **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

(1) All valves used for the cargo and process piping ~~with design temperatures lower than -55°C~~.

(2) ~~Those~~All valves used for accessory piping or instrumentation piping ~~with design temperatures lower than -55°C and outside diameters exceeding 25 *mm* which normally come into contact with the cargo~~.

2 **"**Emergency shutdown valves, with materials having melting temperatures lower than 925°C" referred to in the requirements in **5.13.1-1(4), Part N of the Rules** does not include an emergency shutdown valve in which components made of materials having melting temperatures lower than 925°C do not contribute to the shell or seat tightness of the valve.

~~2~~**3** For the purpose of **5.13.1-2, Part N of the Rules**, all bellows-type expansion joints provided for all cargo piping, including the cargo liquid/vapour piping, provided both inside and outside tanks as well as vent piping with open ends are to be approved in accordance with the requirements of the **Annex 1** "**GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK**".

N11 FIRE PROTECTION AND EXTINCTION

N11.3 Water Spray System

N11.3.1 Area to be Covered

Sub-paragraph -4 has been added as follows.

4 With respect to the requirements of **11.3.1(7), Part N of the Rules**, the survival crafts on board including remote survival crafts (ref. SOLAS III/Reg. 31.1.4) facing the cargo area are to be protected by a water-spray system taking into consideration cargo area extension for fire-fighting purposes as stated in **11.1.4, Part N of the Rules**. Remote liferafts located in areas covered by water-spray protection as required in **11.3.1(6), Part N of the Rules** may be considered as adequately protected.

Paragraph N11.3.3 has been added as follows.

N11.3.3 Capacity of Water Spray Pumps

The expression "two complete athwartship tank groupings" specified in the requirement of **11.3.3(1), Part N of the Rules** means any two groups of tanks where one group is defined as tanks located in transverse direction from ship side to ship side. Where there is only one cargo tank occupying a hold space from ship side to ship side, it will be considered as a "grouping" for the purpose of this interpretation. The expression "any two complete athwartship tank groupings" represents an area equal to the combined area of the two largest tank groupings including any gas process units within these areas.

Annex 1 GUIDANCE FOR EQUIPMENT AND FITTINGS OF SHIPS CARRYING LIQUEFIED GASES IN BULK

Chapter 5 VALVES

5.3 Tests and Inspection

5.3.1 Type Test

Sub-paragraph (8) has been amended as follows.

In the tests specified in the preceding **5.2-2**, the test and inspection specified in the following **(1)** to **(9)** are to be conducted in addition to the requirements of **5.3.1(1), Part N of the Rules**:

((1) to (7) are omitted.)

(8) Fire test:
For emergency shutdown valves, with materials having melting temperatures lower than 925°C (excluding an emergency shutdown valve in which components made of materials having melting temperatures lower than 925°C do not contribute to the shell or seat tightness of the valve), fire tests are to be conducted to a standard acceptable to the Society.

((9) is omitted.)

EFFECTIVE DATE AND APPLICATION (Amendment 1-2)

1. The effective date of the amendments is 1 July 2019.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to ships the keels of which were laid or which were at *a similar stage of construction* before the effective date.
(Note) The term "*a similar stage of construction*" means the stage at which the construction identifiable with a specific ship begins and the assembly of that ship has commenced comprising at least 50 *tonnes* or 1% of the estimated mass of all structural material, whichever is the less.

Amendment 1-3

Annex 3 GUIDANCE FOR HIGH PRESSURE DUAL FUEL DIESEL ENGINES

Chapter 1 GENERAL

1.1 Scope

Sub-paragraph -3 has been added as follows.

3 High pressure DFD engines are to be in accordance with those requirements for low pressure gas-fuelled engines specified in **Annex 4** which the Society deems appropriate.

Chapter 5 TESTS

5.2 Shop Test

Paragraph 5.2.2 has been amended as follows.

5.2.2 Shop Trials

~~**1**~~ High pressure DFD engines are~~, in principle, to be subjected to shop trials using the fuel gas before being installed in a ship. In the case of engines, however, which are of the same model of those conforming to the prototype test requirements specified in **5.1** or are similar engines, shop trials using the oil fuel only may be accepted~~ to be tested as specified in **D2.6.1-3, Part D of the Guidance**.

~~**2** Even when shop trials using the oil fuel only are approved under the requirements of **-1** above, satisfactory function of equipments related to the combustion of the gas fuel is to be verified by appropriate means as far as practicable.~~

Annex 4 GUIDANCE FOR LOW PRESSURE DUAL FUEL DIESEL ENGINES

Chapter 1 GENERAL

1.1 Scope

Sub-paragraph -1 has been amended as follows.

1 The Guidance applies to trunk-piston type diesel engines ~~so designed that methane (boil-off gases and cargo vapour), which is not compressed to high pressure, is directly injected into cylinders or the suction piping before the suction valve in the suction stroke of each cylinder and ignite for due combustion at the end compression stroke~~ supplied with low pressure natural gas as fuel (hereinafter referred to as "low pressure DFD engine") and gas fuel supply systems in accordance with the requirements of **16.1.1, Part N of the Rules**.

Section 1.4 has been added as follows.

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 valve* means valves which have the functionality specified in **16.4.5, Part N of the Rules**.
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 piping* means piping containing gas or air / gas mixtures, including venting pipes.
8 *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.
9 *Low pressure gas* means gas with a pressure up to 1 *MPa*.
10 *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.
11 *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.)

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

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

14 *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 5 TESTS

5.2 Shop Test

Paragraph 5.2.2 has been amended as follows.

5.2.2 Shop Trials

~~**1**~~ Low pressure DFD engines are~~, in principle, to be subjected to shop trials using the fuel gas before being installed in a ship. In the case of engines, however, which are of the same model of those conforming to the prototype test requirements specified in **5.1** or are similar engines, shop trials using the oil fuel only may be accepted when deemed appropriate by the Society~~ to be tested as specified in **D2.6.1-2, Part D of the Guidance**.

~~**2** Even in the event that shop trials using the oil fuel only are approved under the requirements of **-1** above, satisfactory function of equipments related to the combustion of the gas fuel is to be verified by appropriate means as far as practicable.~~

EFFECTIVE DATE AND APPLICATION (Amendment 1-3)

1. The effective date of the amendments is 1 July 2019.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to gas-fuelled engines for which the application for approval is submitted to the Society before the effective date.

Amendment 1-4

Annex 3 GUIDANCE FOR HIGH PRESSURE DUAL FUEL DIESEL ENGINES

Chapter 1 GENERAL

Section 1.3 has been amended as follows.

1.3 Drawings and Data

The drawings and data to be submitted are as follows.

(1) Drawings and data 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 pipe for actuating gas fuel injection valves with its shielding
- (e) Gas fuel injection pipe with its shielding
- (f) High pressure oil pipe for sealing gas fuel injection valves with its shielding
- (g) Arrangements of gas detectors
- (h) Combustion monitoring device
- (i) Gas fuel injection valve actuating device
- (j) Governor
- (k) Engine control system diagram (including monitor, safety and alarm devices) for gas fuel combustion operation
- (l) Gas leak protective device at connections between engines and gas fuel supply piping
- (m) Gas fuel make-up plant (including construction, equipment, and control systems)
- (n) Gas fuel supply piping system (including details of valves and pipe fittings) and protective device for gas leak from them
- (o) Automatic control and remote control systems for gas fuel supply system
- ~~(p) Prototype testing plan and test results~~
- ~~(q) Shop test plan~~
- ~~(r) Testing plan at sea~~
- ~~(s) Sea trial plan~~
- (~~t~~p) Other drawings and data as deemed necessary by the Society according to the type of high pressure DFD engines

((2) is omitted.)

Chapter 5 TESTS

Section 5.1 has been amended as follows.

5.1 ~~Prototype Test~~Approval of Use

~~1~~ For each type of ~~H~~high pressure DFD engines ~~are to be subjected to prototype tests using the gas fuel in accordance with a prototype test plan approved by the Society to demonstrate the designed performance. However, tests using one or more cylinders of a prototype engine or a similar engine for demonstration may be substituted for prototype tests when deemed appropriate by the Society~~, an approval of use is to be obtained by the engine designer (licensor) as specified in **Chapter 8, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

~~2 The parts and accessory equipments of high pressure DFD engines related to the supply and combustion of the gas fuel may be required to undergo tests, which are separate from tests specified in -1 above, to demonstrate individual performance when deemed to be necessary by the Society.~~

Annex 4 GUIDANCE FOR LOW PRESSURE DUAL FUEL DIESEL ENGINES

Chapter 1 GENERAL

1.1 Scope

Sub-paragraph -3 has been added as follows.

3 To low pressure DFD engines, the requirements specified in **Part GF of the Rules** referred to in the following requirements in this Annex apply regardless of type, size and trading area of the ship except where explicitly specified otherwise.
(1) **2.1-5(3)**
(2) **2.2.3-1**
(3) **2.4.4-4(2)**
(4) **2.4.4-4(3)(b)**
(5) **4.1-7**
(6) **8.3(4)(i), Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**

Section 1.3 has been amended as follows.

1.3 Drawings and Data

The drawings and data to be submitted are as follows.
(1) Drawings and data 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 actuating systems
  (d) Gas fuel injection pipe and shielding arrangements
  (e) Arrangement of gas detectors
  (f) Combustion monitoring device
  (g) Governor
  (h) Engine control system diagram (including monitor, safety and alarm systems) for gas fuel combustion operation
  (i) Gas leak protection system at connections between engines and gas fuel supply piping systems
  (j) Gas fuel make-up plant (including construction, equipment, and control systems)
  (k) Gas fuel supply piping system (including details of valves and pipe fittings) and protective device for gas leaks from them
  (l) Automatic control and remote control systems for gas fuel supply systems
  ~~(m) Prototype test plan and test results~~
  ~~(n) Shop test plan~~
  ~~(o) Testing plan at sea~~
  ~~(p) Sea trial plan~~
  (m) Schematic layout or other equivalent documents of gas system on the engine
  (n) Gas piping system (including double-walled arrangement where applicable)

(o) Parts for gas admission system
The documentation to contain specifications for pressures, pipe dimensions and materials.
(p) 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
(q) Schematic layout or other equivalent documents of fuel oil system (main and pilot fuel systems) on the engine
(r) Shielding of high pressure fuel pipes for pilot fuel system, assembly
(~~q~~s) Other drawings and data as deemed necessary by the Society according to the type of low pressure DFD engines

(2) Drawings and data 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)~~
(~~a~~b) Other drawings and data as deemed necessary by the Society

(3) Drawings and data for the purpose of inspection and testing of engines
Items specified in **2.1.3-1(3), Part D of the Rules**

Chapter 2 has been amended as follows.

Chapter 2 CONSTRUCTION AND EQUIPMENT OF LOW PRESSURE DFD ENGINES

2.1 General

1 Low pressure DFD engines are to have a dual fuel system for operating on oil fuel and gas fuel.

~~**2** Low pressure DFD engines are to be capable of supplying oil fuel to each cylinder, which is sufficient to maintain stable combustion of gas fuel under any making operations.~~

~~3~~2 Low pressure DFD engines are to be capable of maintaining stable operation even under any of the following conditions **(1)** to **(3)**.

(1) Transferring from one fuel to another

(2) Rapid load transient

(3) Minimum load condition during gas combustion

~~4~~3 The gas fuel supply pressure of low pressure DFD engines, at the supplying point of the gas fuel to the combustion chamber or the suction pipe before the suction valves is to be kept always higher than the suction air pressure to prevent the back-flow of the air to the gas fuel line.

~~**5** Only oil fuel is, in principle, to be used when the operation of a low pressure DFD engine is unstable.~~

~~**6** Low pressure DFD engines are to be capable of being transferred quickly from the mode of simultaneous combustion of gas and oil fuels to the mode of combustion of oil fuel only.~~

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) Minimise 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 have satisfactory operating characteristics and durability for the assumed service period.

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

3 The actuating systems of gas fuel valves are to have satisfactory operating characteristics and

reliability.

2.2.2 Cylinder Covers

1 The shape 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 leakage of gas fuel and unburnt gases in the 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 **16.7, Part N of the Rules** are to be applied.

2.3 Safety Systems

~~**2.3.1 Combustion Monitoring Device**~~

~~**1** The gas fuel supply to low pressure DFD engines is to be automatically cut off in case of any abnormal conditions concerning the following **(1)** through **(4)** are detected.~~

~~(1) Function of gas fuel valves~~

~~(2) Function of pilot oil fuel injection valves~~

~~(3) Function of suction valves and exhaust valves~~

~~(4) Exhaust gas temperatures at each cylinder outlet~~

~~**2** When low pressure DFD engines are operated on gas fuel, the following items are to be monitored as standard.~~

~~(1) Abnormalities in each cylinder pressure~~

~~(2) Blow-by through suction valves or exhaust valves~~

2.3.~~2~~1 Protection against Explosions

~~**1** Relief valves of an approved type are to be provided for the crankcase at least at every crankthrow, and for separate spaces on the crankcase such as gear case for camshaft or similar drives for protection against explosions.~~

~~**2**~~**1** Unless designed with the strength to withstand the worst case overpressure due to ignited gas leaks, suction manifolds and exhaust gas pipes are to be fitted with suitable pressure relief systems.

~~**3**~~**2** The pressure relief systems specified in the preceding ~~**2**~~**1** are not to continuously discharge exhaust gas into enclosed spaces. Venting due to activation of the system is to be led to a non-hazardous location, away from personnel.

~~**4**~~**3** The relief valves for cylinders installed in accordance with the requirements of **2.4.2, Part D of the Rules**, are to be provided with a system to monitor certain closing of the valves as far as practicable.

~~**5**~~**4** Each gas fuel injection line is to be provided with a non-return valve~~, and if necessary, rupture disks are to be provided between the gas fuel injection line and the non-return valve to prevent the failure of the gas fuel injection lines due to abnormal pressure peak~~ or devices which have capabilities equivalent to those of the valves.

~~**6**~~**5** When gas is supplied in a mixture with air through a common manifold, flame arrestors are to be installed before each cylinder head.

~~7~~6 Effective gas detecting systems to detect gas fuel leaks are to be fitted at the following locations **(1)** and **(2)**.

(1) Crankcases. In this case, the sensors may be required at more than one location depending on the shape of the crankcase; and

(2) Other locations considered necessary by the Society.

2.3.~~3~~2 Governors

1 The governors of low pressure DFD engines are to be functional in either the simultaneous combustion mode of gas and oil fuel (or pilot oil) and the combustion mode of oil fuel.

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

3 Operations on gas fuel are to be performed by either of the following modes of operation **(1)** to **(3)**.

(1) An operation mode controlling gas fuel supply with fixed oil fuel supply (pilot oil).

(2) An operation mode controlling oil fuel (pilot oil) supply with fixed gas fuel supply.

(3) An operation mode in which both gas fuel and oil fuel supplies are controlled.

2.4 Accessory Equipment

2.4.1 Charge Air Systems

1 The charge air system on the low pressure DFD 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.~~1~~2 Exhaust Gas Systems

1 The exhaust gas system on the low pressure DFD 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.

~~The exhaust gas pipes of low pressure DFD engines are not to be connected to the exhaust gas pipes or the exhaust pipes of other engines or systems.~~

2.4.~~2~~3 Starting Systems

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

2.4.~~3~~4 Gas Fuel Injection Pipes

1 Except where specifically approved by the Society, gas fuel injection pipes is to be provided with effective shielding against gas fuel bursting due to failures of pipes.

2 Spaces between the gas fuel injection pipes and the shielding is to be provided with means according to the requirements in **3.2.2-2**.

3 When flexible tubes are used as the shielding, they are to be of an approved type.

4 For piping attached to low pressure DFD engines, the following **(1)** to **(5)** also apply.

(1) Requirements of **5.1** to **5.9** and **Chapter 16, Part GF of the Rules** are applied.

(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 DFD engine are applied the requirements of **16.4.3, Part N 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 applied the provisions of **16.4.3(2), Part N 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 in cases where the requirements of **Part N of the Rules** permit (e.g. **16.4.4-1, Part N of the Rules**).

(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 shall therefore 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 shall 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 shall be documented that they are suitable for that zone. Documentation and analysis is to be based on *IEC* 60079-10-1 or *IEC* 60092-502.

2.4.4~~5~~5 Cylinder Lubrication

Cylinder lubricating systems for low pressure DFD engines are to be capable of maintaining adequate alkali values and cylinder oil feeding rates according to the mode of operation on oil fuel only and also the modes of operation specified in **2.3.~~3~~2-3(1)** to **(3)** as standard.

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 DFD 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 DFD 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 Pre-mixed Engine

Inlet manifold, turbocharger, charge air cooler, etc. are to be regarded as parts of the fuel gas supply system. Failures of those components likely to result in a gas leakage are to be considered in the risk analysis (see **8.3, Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**).

Title of Chapter 4 has been amended as follows.

Chapter 4 CONTROL ~~SYSTEMS~~, ALARM AND SAFETY SYSTEMS

Section 4.1 has been amended as follows.

4.1 General

1 Control systems for operating low pressure DFD engines using gas fuel are to comply with the requirements in **18.1** to **18.3** and **18.7, Part D of the Rules**.

2 Gas fuel supply compressors in the gas fuel make-up plant are to be provided with the following safety systems:

(1) Remote stopping devices from readily accessible places and the position from which station of the main engine is normally controlled.

(2) Automatic stopping devices actuated when the suction pressure of boil-off gases drops to below the predetermined value according to the cargo tank construction system, before the tank pressure reaches the set pressure of negative pressure relief valves for cargo tanks.

(3) Emergency shut-down specified in **Table N18.1, Part N of the Rules**.

(4) Volumetric compressors are to be fitted with pressure relief valves discharging into the suction line of the compressor. The size of the pressure relief valves is to be determined in such away that, with the delivery valve kept close, the maximum pressure will not exceed the maximum working pressure by more than 10%.

3 The exit temperature and pressure or flow rate of the gas fuel at the gas fuel make-up plant are to be automatically controlled. Visual and audible alarm device are also to be provided such as to be activated when the temperature and pressure exceed the preset ranges.

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

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

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

7 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**.

8 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.

9 Unless the risk analysis required by **8.3, Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use** proves that risk is within the acceptable range, alarm and safety system functions are to be provided in accordance with **Table 4.1**. However, even if the risk analysis proves that risk is within the acceptable range, the alarm and safety system functions specified in **Part N of the Rules** are still to be provided.

Table 4.1 Alarm and Safety System Functions for Dual Fuel Engines

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

2) 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.

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

Section 4.2 has been amended as follows.

4.2 Low Pressure DFD Engines of Ships to which the Rules for Automatic Remote Control Systems Apply

Low pressure DFD engines of ships to which the requirement **1.1.1, of Rules for Automatic and Remote Control Systems** apply are to comply with the requirements of **3.2**, **3.5**, **4.1** and **4.2** of the same Rules, in addition to the following requirements **(1)** and **(2)**.

(1) Low pressure DFD engines are to be provided with safety systems which automatically cut off the gas fuel supply, and in addition, automatically transfer the mode of operation to oil fuel alone or stop the engines when abnormalities **(a)** to **(c)** given below occur. However, automatic cut off of the gas fuel supply with the automatic double block and bleed valves specified in **16.4.5, Part N of the Rules** may be accepted.

(a) When operating on gas fuel, abnormalities ~~specified~~are detected in ~~**2.3.1-1 or -2 are detected.**~~the following:

i) gas fuel valve function

ii) pilot oil fuel injection valve 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 to double wall pipes or void spaces of ducts specified in **3.2.2-2** are detected.
(c) Others as deemed necessary by the Society.

((2) is omitted.)

Chapter 5 TESTS

Section 5.1 has been amended as follows.

5.1 ~~Prototype Tests~~ Approval of Use

~~1~~ For each type of ~~L~~low pressure DFD engines ~~are to be subjected to prototype tests using the gas fuel in accordance with a prototype test plan approved by the Society to demonstrate the design performance. However, tests using one or more cylinders of a prototype engine or a similar engine for demonstration may be substituted for prototype tests when deemed appropriate by the Society,~~ an approval of use is to be obtained by the engine designer (licensor) as specified in **Chapter 8, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

~~2 The parts and accessory equipments of low pressure DFD engines related to the supply and combustion of the gas fuel may be required to undergo tests, which are separate from tests specified in -1 above, to demonstrate individual performance when deemed to be necessary by the Society.~~

EFFECTIVE DATE AND APPLICATION (Amendment 1-4)

1. The effective date of the amendments is 1 July 2019.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to the same type of gas-fuelled engine as that for which the application for approval of use is submitted to the Society before the effective date.

3. Notwithstanding the provision of preceding **2**, the amendments to the Guidance applies to gas-fuelled engines for which the application for renewal of approval of use is submitted on or after the effective date.