RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER	**No. 313-69-1220c**	dated 13.05.2019

Re:

amendments to the Rules for the Classification and Construction of Sea-Going Ships, 2019, ND No. 2-020101-114-E

Item(s) of supervision:

Internal Combustion Engines

Entry-into-force date:	~~Valid till:~~	~~Validity period extended till:~~
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Number of pages: 1+10

Appendices:

Appendix 1: information on amendments introduced by the Circular Letter

Appendix 2: text of amendments to Parts VII "Machinery Installations", VIII "Systems and Piping" and IX "Machinery"

Director General Konstantin G. Palnikov

Text of CL:

We hereby inform that the Rules for Classification and Construction of Sea-Going Ships have been amended as specified in Appendix 2 to the Circular Letter

It is necessary to do the following:

1. Apply the provisions of the Circular Letter during review and approval of technical documentation of machinery.
2. Bring the content of the Circular Letter to the notice of the RS surveyors and the interested persons in the area of RS Branch Offices' activity.

List of the amended and/or introduced paras/chapters/sections:

Part VII, Section 2: paras 2.1.13, 2.1.14; Part VIII, Section 13: paras 13.12.6, 13.12.11; Part IX, Section 1: para 1.2.3.1, Section 2: para 2.3.4.5, Section 9

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"Thesis" System No. 19-92815

Appendix 1 to Circular Letter
No. **313-69-1220c** dated 13.05.2019

Information on amendments introduced by the Circular Letter
(for inclusion in the Revision History to the RS Publication)

Nos.	Amended paras/chapters/sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
1	Part VII, para 2.1.13	New requirements for the minimum power of the gas engines have been introduced	313-69-1220c of 13.05.2019	01.07.2019
2	Part VII, para 2.1.14	The requirements for the minimum power of the gas engines determination have been introduces	313-69-1220c of 13.05.2019	01.07.2019
3	Part VIII, para 13.12.6	The reference has been specified	313-69-1220c of 13.05.2019	01.07.2019
4	Part VIII, para 13.12.11	The reference has been specified	313-69-1220c of 13.05.2019	01.07.2019
5	Part IX, para 1.2.3.1	The requirements for the scope of technical documentation of gas engines have been introduced	313-69-1220c of 13.05.2019	01.07.2019
6	Part IX, Table 1.2.3.2	The Table has been renumbered	313-69-1220c of 13.05.2019	01.07.2019
7	Part IX, Table 1.2.3.1-3	The Table with the list of documents for gas engines has been introduced	313-69-1220c	01.07.2019
8	Part IX, para 2.3.4.5	The reference has been specified	313-69-1220c of 13.05.2019	01.07.2019
9	Part IX, Section 9	The Section has been revised, new requirements for gas ICE have been introduced	313-69-1220c of 13.05.2019	01.07.2019

Appendix 2 to Circular Letter
No. **313-69-1220c** dated 13.05.2019

RULES OE THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2019, ND No. 2-020101-114-E

PART VII. MACHINERY INSTALLATIONS

1 New **Para 2.1.13** is introduced reading as follows:

"**2.1.13** For a ship with gas engines installed in an ESD (emergency shutdown devices)-protected machinery space, the minimum power of the main and auxiliary engines shall be assessed on a case-by-case basis from the operational characteristics of the ship, ensuring that the requirements of para 9.12.2.5, Part IX "Machinery" are met, taking into account the design and purpose.".

2 New **Para 2.1.14** is introduced reading as follows:

"**2.1.14** For a ship with a single gas engine, the requirements of paras 9.12.2.7 — 9.12.2.8, Part IX "Machinery" shall be met. The minimum power shall be determined to ensure that this requirement is fulfilled, taking into account the particular design and purpose of the ship.".

PART VIII. SYSTEMS AND PIPING

13 FUEL OIL SYSTEM

13.12 APPLICATION ON NATURAL GAS (METHANE) AS FUEL

3 **Para 13.12.6** is replaced by the following text:

"**13.12.6** The main gas valve shall be installed outside the engine room and be equipped with remote control to enable its closing from the engine room.
This valve shall be automatically closed in the following cases:
leakage of gas fuel;
violation of the conditions stated in 13.12.2 and 13.12.3;
actuation of oil mist concentration sensor in the engine crankcase or in the temperature control system of the engine bearings.
It is advisable, that the main gas valve is automatically closed at the actuation of interlocked gas valves (refer to Section 9, Part IX "Machinery").".

4 **Para 13.12.11** is replaced by the following text:

"**13.12.11** Gas supply to dual-fuel engines and gas turbines shall meet the requirements of 8.10 and 9, Part IX "Machinery".".

PART IX. MACHINERY

1 GENERAL

1.2 SCOPE OF SURVEYS

5 **Para 1.2.3.1** is replaced by the following text:

"**.1** on internal combustion engines:
for information – in compliance with Table 1.2.3.1-1;
for approval - in compliance with Table 1.2.3.1-2;
for gas engines the documents in compliance with Table 1.2.3.1-3 shall be submitted additionally.
Procedure for submission and review of technical documentation on internal combustion engines (refer to Appendix 2 "Procedure Documentation Flow" to Section 5 "Machinery", Part IV "Technical Supervision During Manufacture of Products" of the Rules for Technical Supervision During Construction of Ships and Manufacture of materials and Products for Ships).".

6 **Table 1.2.3.2** is renumbered 1.2.3.1-2.

7 New **Table 1.2.3.1-3** is introduced reading as follows:

"Table 1.2.3.1-3

The following documents shall be submitted **for the approval of Dual Fuel (DF) and Gas Fuel (GF) engines**[1]

1	Schematic layout or other equivalent documents of gas system on the engine
2	Gas piping system (including double-walled arrangement where applicable)
3	Parts for gas admission system (the documentation to contain specification of pressures, pipe dimensions and materials)
4	Arrangement of explosion relief valves (crankcase[1], charge air manifold, exhaust gas manifold) as applicable
5	List of certified safe equipment and evidence of relevant certification
6	Safety concept [2]
7	Report of the risk analysis [2]
8	Gas specification[2]
9	Schematic layout or other equivalent documents of fuel oil system (main and pilot fuel systems) on the engine. [3]
10	Shielding of high pressure fuel pipes for pilot fuel system, assembly [3]
11	High pressure parts for pilot fuel oil injection system (the documentation to contain specification of pressures, pipe dimensions and materials) [3]
12	Ignition system [4]
[1] – taking into account the design features of the engine, the Register may request the provision of additional documentation; [2] – for information; [3] – required for DF engine; [4] – required for GF engine.	

".

2 INTERNAL COMBUSTION ENGINES

2.3 ENGINE FRAME

8 Para **2.3.4.5** is replaced by the following text:

"**2.3.4.5** Ventilation of crankcase, and any arrangement which could produce a flow of external air within the crankcase, is in principle not permitted except for dual fuel engines where crankcase ventilation shall be provided in accordance with 9.5.2.".

9 DUAL-FUEL INTERNAL COMBUSTION ENGINES

9 **Section 9** is replaced by the following text:

"**9 GAS INTERNAL COMBUSTION ENGINES**"

9.1 GENERAL

9.1.1 The requirements of the present Section are applicable to dual-fuel internal combustion engines (DF engines) with ignition from compression, operated on liquid fuel and natural gas (methane) as well as to gas-fuel internal combustion engines (GF engines) operated on natural gas only.

The requirements of 9.2. — 9.11 are applicable to all crosshead-type engines as well as to trunk piston internal combustion engines operating on gas with a maximum working gas pressure of more than 1,0 MPa.

The requirements of 9.2, 9.3, 9.12, 9.13 are applicable to trunk piston internal combustion engines operating on gas with a maximum working gas pressure of 1,0 MPa and less. The gas can be ignited by the combustion of a certain amount of fuel (pilot injection) or by extraneous ignition (sparking plug).

Gas can be introduced as follows:

into the air inlet manifold, scavenge space, or cylinder air inlet channel port; or

mixed with air before the turbocharger ("pre-mixed engines").

Engines intended for installation on ships with distinguishing mark **GFS** in the class notation shall additionally meet the applicable requirements of Chapter 9.6 of Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships".

9.1.2 Individual requirements relevant to the application of the DF engines are given in 4.1 — 4.2, Part VII "Machinery Installations" and in 5.5.1 of the present Part.

9.2 DEFINITIONS AND EXPLANATIONS

9.2.1 In this Section the following definitions are accepted:

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.

Double block and bleed valves mean the set of valves referred to in:

IGC Code, 16.4.5;

IGF Code, 2.2.9 and 9.4.4 — 9.4.6.

Dual fuel engine ("DF 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).

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

Gas (Gas fuel) means a fluid having a vapour pressure exceeding 0,28 MPa absolute at a temperature of 37.8 ^{o}C.

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.

Gas engine means either a DF engine or a GF engine.

Gas fuel only engine ("GF engine") means an engine capable of operating on gas fuel only and not able to switch over to oil fuel operation.

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

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.

IGC Code means the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (as amended by IMO resolution MSC.370(93)).
IGF Code means the International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels (IMO resolution MSC.391(95)).
Low pressure gas means gas with a pressure up to 1,0 MPa.
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.
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).
Pilot fuel means the fuel oil that is injected into the cylinder to ignite the main gas-air mixture on DF engines.
Pre-mixed engine means an engine where gas is supplied in a mixture with air before the turbocharger.
Recognized standards mean applicable international or national standards acceptable by the Register or standards laid down and maintained by an organization which complies with the standards adopted by IMO and which are recognized by the Register.
Safety Concept is a document describing the safety philosophy with regard to gas as fuel, risks associated with this type of fuel, risk control under reasonably foreseeable abnormal conditions, possible failure scenarios and their control measures including a detailed evaluation regarding the hazard potential of injury from a possible explosion.

9.3 RISK ANALYSIS

9.3.1 Scope of the risk analysis.
The risk analysis is to address:
a failure or malfunction of any system or component involved in the gas operation of the engine;
a gas leakage downstream of the gas valve unit;
the safety of the engine in case of emergency shutdown or blackout, when running on gas;
the inter-actions between the gas fuel system and the engine.
With regard to the scope of the risk analysis it shall be noted that failures in systems external to the engine, such as fuel storage or fuel gas supply systems, may require action from the engine control and monitoring system in the event of an alarm or fault condition. Conversely failures in these external systems may, from the ship perspective, require additional safety actions from those required by the engine limited risk analysis.
9.3.2 Form of the risk analysis.
The risk analysis shall be carried out in accordance with international standard ISO 31010:2009: Risk management – Risk assessment techniques, or other recognized standards.
The required analysis shall be based on the single failure concept, which means that only one failure needs to be considered at the same time. Both detectable and non-detectable failures shall be considered. Consequences failures, i.e. failures of any component directly caused by a single failure of another component, are also to be considered.
9.3.3 Procedure for the risk analysis.
The risk analysis shall:
.1 identify all the possible failures in the concerned equipment and systems which could lead:
to the presence of gas in components or locations not designed for such purpose, and/or
to ignition, fire or explosion;
.2 evaluate the consequences;
.3 where necessary, identify the failure detection method;
.4 where the risk cannot be eliminated, identify the corrective measures in the system design (such as, redundancies safety devices, monitoring or alarm provisions which permit restricted operation of the system), in the system operation (such as initiation of the redundancy, activation of an alternative mode of operation).
The results of the risk analysis shall be documented.
9.3.4 Equipment and systems to be analysed.
The risk analysis required for engines shall cover at least the following aspects:

.1 failure of the gas-related systems or components, in particular:
gas piping and its enclosure, where provided;
cylinder gas supply valves.
Thus, failures of the gas supply components not located directly on the engine, such as block-and-bleed valves and other components of GVU, shall not be considered in the analysis;
.2 failure of the ignition system (oil fuel pilot injection or sparking plugs);
.3 failure of the air to fuel ratio control system (charge air by-pass, gas pressure control valve, etc.);
.4 for engines where gas is injected upstream of the turbocharger compressor, failure of a component likely to result in a source of ignition (hot spots);
.5 failure of the gas combustion or abnormal combustion (misfiring, knocking)
.6 failure of the engine monitoring, control and safety systems. Where engines incorporate electronic control systems, a failure mode and effects analysis shall be carried out in accordance with requirements of 9.3.4.1 — 9.3.4.3;
.7 abnormal presence of gas in engine components (e.g. air inlet manifold and exhaust manifold of DF or GF engines) and in the external systems connected to the engines
(e.g. exhaust duct);
.8 changes of operating modes for DF engines;
.9 hazard potential for crankcase fuel gas accumulation, for engines where the space below the piston is in direct communication with the crankcase, refer to 10.3.1.2 of the IGF Code.

9.4 CONDITIONS OF OPERATION ON TWO KINDS OF FUEL

9.4.1 When operated on two kinds of fuel DF engines shall be equipped with the arrangement for supply of starting fuel with further supply of gas fuel. The possibility of quick change-over from gas fuel to liquid fuel shall be provided.
Starting fuel shall be supplied to each cylinder in all operation modes of the DF engines.
9.4.2 Start of DF engines, astern operation shall be carried out on liquid fuel only.
9.4.3 When DF engine is run on variable modes, ships maneuvering, mooring operations, only liquid fuel shall be used.
9.4.4 In case of unexpected gas fuel cut off DF engine shall continue operation on liquid fuel without stop.
9.4.5 DF engines shall be provided with sensors for blocking simultaneous feed of gas fuel and complete supply of liquid fuel.

9.5 CRANKCASE PROTECTION

9.5.1 Crankcases of DF engines shall be fitted with safety valves in way of each crankshaft crank. Design and actuating pressure of the safety valves shall be specified with due regard to the possible explosion of gas fuel leakage accumulated in the crankcase.
9.5.2 When a trunk-piston engine is used as the DF engine, the crankcase shall be protected as follows:
.1 to prevent accumulation of gas fuel leakage, the ventilation of crankcases shall be provided. Air pipe ends shall be led to safety place and fitted with flame arresters;
.2 detectors of gas fuel leakage or any other equivalent equipment shall be installed. Device for automatic admission of inert gas is recommended for installation;
.3 mounting of oil mist concentration sensor in the crankcase shall be provided.
9.5.3 When a cross-head type engine is used as the DF engine, the engine crankcase shall be equipped with oil mist concentration sensor or temperature control system of the engine bearings.

9.6 PROTECTION OF SUB-BEARING SPACES OF THE CROSS-HEAD TYPE DF ENGINES

9.6.1 Sub-bearing spaces shall be provided with gas fuel leakage detectors or any other equivalent devices.

9.7 INTAKE AND EXHAUST GAS SYSTEMS

9.7.1 Intake piping and supercharging air receivers as well as exhaust gas collectors shall be fitted with safety valves or other protective devices. For engines operating on gas with a maximum working gas pressure of not more than 1,0 MPa, the use of other design solutions is allowed provided that proving calculations or experimental data are provided.

9.7.2 Exhaust gas pipelines from DF engines shall not be combined with exhaust gas piping from other engines, boilers or incinerators.

9.7.3 The exhaust gas piping shall be provided with effective means of blowing off.

9.8 STARTING AIR PIPING

9.8.1 Branch pipes of starting air piping laid to each cylinder shall be equipped in compliance with the requirements of 2.9.2.

9.9 COMBUSTION CONTROL

9.9.1 The range of combustion control shall be determined and presented for approval with due regard to the analysis of the origin of failures and their consequences for all the elements of DF engines affecting the combustion process.

The minimum range of control, types of automatic protection and parameter limit values are given in Table 9.9.1.

Table 9.9.1

No.	Controlled parameter or DF engine component	Measurement point or monitoring conditions	Parameter limit values (alarm) or fault symptoms	Automatic shut-off of the gas fuel supply valves	Indication in main machinery control room
1	Gas fuel injection valves and starting oil fuel injectors	Each cylinder	Seizing of gas fuel injection valve in open condition	X	Constantly
		At each cylinder outlet	Ignition failure		
2	Exhaust gas temperature	Deviation from average	max	X	Constantly
3	Combustion pressure	At each cylinder	max.	X	Constantly
		Deviation from average	max.	X	On call
4	Gas fuel supply pressure	At engine inlet	min	X	Constantly

9.10 GAS FUEL SUPPLY

9.10.1 At the inlet of gas fuel supply collector to the DF engine cylinders the flame arrester shall be fitted.

9.10.2 An arrangement for manual cut-off the gas fuel supply to the DF engine from the local control station shall be provided.

9.10.3 Gas fuel supply piping shall meet the requirements of 13.12, Part VIII "Systems and Piping".

9.10.4 The connection of the engine gas collector with the ship gas piping shall provide the necessary flexibility.

9.10.5 The connection of the gas fuel supply collector to the gas fuel injection valves shall provide complete coverage by the protection pipes or ducts.

9.11 GAS FUEL SUPPLY CUT-OFF

9.11.1 Gas fuel supply cut-off to DF engines by means of automatic closing of valves on the engine shall be performed when the DF engine has stopped due for any unknown reason or in cases stated in 9.5.2.2, 9.5.2.3, 9.5.3, 9.6.1, 9.9.1 of the present Part, and 13.12.2 or 13.12.3, Part VIII "Systems and Piping".

9.11.2 It is advisable that the main cut-off valve for gas fuel supply to the collector could be automatically closed at the failure of gas fuel feed valves to DF engine combustion chambers (refer to 9.9.1 of the present Part and 13.12.6, Part VIII "Systems and Piping").

9.11.3 Gas fuel supply to DF engines shall be automatically terminated when the concentration of gas in the engine room reaches 60 % of the lower inflammability level. The requirements of 9.4.4 shall be met.

9.12 DESIGN OF DF ENGINE AND GF ENGINE

9.12.1 General Design principles.

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

9.12.1.2 Components containing or likely to contain gas shall be designed to:

minimize the risk of fire and explosion so as to demonstrate an appropriate level of safety commensurate with that of an oil-fuelled engine;

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. Discharge from pressure relief devices shall 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. Relief devices shall be fitted with a flame arrester.

Also refer to the IGF Code 10.2 and 10.3.

9.12.2 Requirements for design and gas piping as an engine component.

9.12.2.1 The piping shall be designed in accordance with the criteria for gas piping (design pressure, wall thickness, materials, piping fabrication and joining details etc.) as given in the IGF Code chapter 7. For engines of gas carriers, IGC Code chapter 5.1 to 5.9 and 16 applies.

9.12.2.2 Pipes and equipment containing fuel gas are defined as hazardous area Zone 0 (refer to IGF Code 12.5.1).

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 IGF Code 12.5.2.6).

9.12.2.3 The "double wall" gas piping system on the engine shall be arranged according to the principles and requirements of the IGF Code 9.6. For engines of gas carriers, IGC Code 16.4.3 applies.

9.12.2.4 The design criteria for the double pipe or duct are given in the IGF Code 7.4.1.4 and 9.8.

In case of a ventilated double wall, the ventilation inlet shall be located in accordance with the provisions of IGF Code, regulation 13.8.3. For gas carriers, IGC Code 16.4.3.2 applies.

The pipe or duct shall be tested in accordance with 21.2.1 , Part VIII "Systems and Piping" to ensure gas tight integrity and to show that it can withstand the expected maximum pressure at gas pipe rupture.

9.12.2.5 Alternative arrangement.

Single walled gas piping is only acceptable:

for engines installed in ESD protected machinery spaces, as defined in IGF Code 5.4.1.2 and in compliance with other relevant parts of the IGF Code (e.g. 5.6);

in the case gas is supplied into the air inlet directly on each individual cylinder during air intake to the cylinder on a low pressure engine, such that a single failure will not lead to release of fuel gas into the machinery space.

For engines of gas carriers, the IGC Code applies.

In case of gas leakage in an ESD-protected machinery space, which result in the shutdown of the engine(s) in that space, a sufficient propulsion and manoeuvring capability including essential and safety systems shall be maintained (refer to 2.1.13, Part VII "Machinery installations").

9.12.2.6 The safety concept of the engine is to indicate application of the "double wall" or "alternative" arrangement.

9.12.2.7 Charge air system on the engine.

The charge air system on the engine shall be designed in accordance with 9.12.1.2.

In case of a single engine installation, the engine shall 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 shall be maintained.

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

9.12.2.8 Exhaust system on the engine.

The exhaust gas system on the engine shall be designed in accordance with 9.12.1.2.

In case of a single engine installation, the engine shall 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 shall be maintained.

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

9.12.2.9 Engine crankcase.

9.12.2.9.1 Crankcase explosion relief valves shall be installed in accordance with 2.3.5 (refer also to IGF Code 10.3.1.2).

9.12.2.9.2 Inerting.

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

9.12.2.10 Gas ignition in the cylinder.

Requirements of IGF Code 10.3 apply. For engines of gas carriers, IGC Code 16.7 applies.

9.12.2.11 Control, monitoring, alarm and safety systems.

The engine control system shall be independent and separate from the safety system.

The gas supply valves shall be controlled by the engine control system or by the engine gas demand.

Combustion shall be monitored on an individual cylinder basis.

In the event that poor combustion is detected on an individual cylinder, gas operation may be allowed in the conditions specified in IGF Code 10.3.1.6.

If monitoring of combustion for each individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted.

Unless the risk analysis required by 9.3 proves otherwise, the monitoring and safety system functions for DF or GF engines shall be provided in accordance with Table 9.12.2.11.

Table 9.12.2.11

Monitoring and Safety System Functions for DF (applies only to the gas mode) and GF Engines

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

Footnotes:

[1)] DF engine only, when running in gas mode.

[2)] For GF 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.

[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 shall be activated.

[5] GF engine only.
[6] Where required in compliance with 2.3.

9.12.2.12 Gas admission valves.
Gas admission valves shall be certified safe by a competent body as follows:
the inside of the valve contains gas and shall therefore be certified for Zone 0;
when the valve is located within a pipe or duct in accordance with 9.12.2.3 and 9.12.2.4, the outside of the valve shall be certified for Zone 1;
when the valve is arranged without enclosure in accordance with the ESD-protected machinery space (taking in account 9.12.2.5 and 9.12.2.6) concept, no certification is required for the outside of the valve, provided that the valve is de-energized upon gas detection in the space.
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 shall be based on IEC 60079-10-1:2013 or IEC 60092-502:1999.

9.13 SPECIFIC DESIGN REQUIREMENTS

9.13.1 DF engines.
9.13.1.1 General.
The maximum continuous power that a DF engine can develop in gas mode may be lower than 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 shall be stated in the technical documentation and demonstrated during the type test taking into account the requirements of Section 5, Part IV "Technical Supervision during manufacture of products" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships.
9.13.1.2 Starting, changeover DF engines and stopping.
DF engines shall be arranged to use either oil fuel or gas fuel for the main fuel charge and with pilot oil fuel for ignition. The engines shall be arranged for rapid changeover from gas use to fuel oil use. In the case of changeover to either fuel supply, the engines shall be capable of continuous operation using the alternative fuel supply without interruption to the power supply.
Changeover to gas fuel operation shall be only possible at a power level and under conditions where it can be done with acceptable reliability and safety as demonstrated through testing.
Changeover from gas fuel operation mode to oil fuel operation mode shall be possible at all situations and power levels.
The changeover process itself from and to gas operation shall be automatic but manual interruption shall be possible in all cases.
In case of shut-off of the gas supply, the engines shall be capable of continuous operation by oil fuel only.
9.13.1.3 Pilot injection.
Gas supply to the combustion chamber shall not be possible without operation of the pilot oil injection.
Pilot injection shall be monitored by fuel oil pressure and combustion parameters or otherwise.
9.13.2 GF engines.
9.13.2.1 Spark ignition system.
In case of failure of the spark ignition, the engine is to be shut down except if this failure is limited to one cylinder, subject to immediate shut off of the cylinder gas supply and provided that the safe operation of the engine is substantiated by the risk analysis and by tests.
9.13.3 Pre-mixed engines.
9.13.3.1 Charge air system.
Inlet manifold, turbo-charger, 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 shall be considered in the risk analysis (refer to 9.3).
Flame arresters shall be installed before each cylinder head, unless otherwise justified in the risk analysis, considering design parameters of the engine such as the gas concentration in the charge air system, the path length of the gas-air mixture in the charge air system, etc.".