RUSSIAN MARITIME REGISTER OF SHIPPING

HEAD OFFICE

CIRCULAR LETTER **№ 313-08- 700c** 09.12.2013

Re:

content and procedure for application of the requirements for using gas fuel in ships

Item of technical supervision:

Technical documentation on ships

Implementation since	01.01.2014
Valid: until	re-publication of the Rules
Validity period extended till	----
Cancels/amends/adds Circular letter №	--- of ---
Number of pages:	1+26
Appendices:	Amendments to Section 2, Part I "Classification" and Section 9, Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships" of the Rules for the Classification and Construction of Sea-Going Ships, – on 26 pages

Technical Director V.I. Evenko

Amends Rules for the Classification and Construction of Sea-Going Ships, ND No. 2-020101-077, Section 2, Part I "Classification" and Section 9, Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships"

We hereby inform you about development of the requirements for using gas fuel in ships. The requirements have been developed on the basis of IMO Resolution MSC.285(86) "Interim Guidelines on Safety for Natural Gas-Fuelled Engine Installations in Ships".

The amendments to the Rules are given in the Appendix to the Circular Letter.

The above amendments shall be introduced during re-publication of the Rules for the Classification and Construction of Sea-Going Ships into Section 2, Part I "Classification" and in Section 9, Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships".

It is necessary to do the following:

1. Familiarize the surveyors of the RS Branch Offices with the content of the Circular Letter.
2. Apply the amendments introduced into the RS Rules during review and approval of the technical documentation on ships.
3. Familiarize the interested organizations in the area of the RS Branch Offices' activity with the content of the Circular Letter.

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Appendix to the Circular letter No. 313-08-700c of 09.12.2013

Alterations (amendments) to be introduced in the Rules for the Classification and Construction of Sea-going Ships (2014)

Part I “Classification”

Part I “Classification” shall be supplemented by para. 2.2.28 as follows:

«2.2.28 Distinguishing mark of ship equipped for using gas fuel**.**

For ships equipped for using gas fuel in compliance with the Section 9 of Part XVII "DISTINGUISHING MARKS AND DESCRIPTIVE NOTATIONS IN CLASS NOTATIONS SPECIFYING STRUCTURAL AND OPERATIONAL PARTICULARS OF SHIPS", SYMBOL **GFS** (gas fuelled ships) is added to the main class notation".

Paras. 2.2.28 – 2.2.29 renumbered to 2.2.29-2.2.30.

Part XVII. Distinguishing Marks and Description Notations in Class Notations Specifying Structural and Operational Particulars of Ships

Section 9. REQUIREMENTS FOR SHIPS EQUIPPED FOR USING GAS FUEL.

9.1 GENERAL.

9.1.1 Application area.

The requirements of Section 9 are intended for ships using a mixture of various hydrocarbon gases in liquid or liquefied condition as gas fuel.

Use of hydrocarbon gases with methane content below 85 % as fuel in ships is subject to special consideration of the Register. Moreover, using gas fuel with methane content below 85 % shall be agreed with the flag state Maritime Administration.

If a ship is a gas carrier, except the present requirements, it shall comply with the requirements of the International Code for the Construction and Equipment of Ships

Carrying Liquefied Gases in Bulk (*IGC Code*) and the Rules for the Classification and Construction for Ships Carrying Liquefied Gases in Bulk.

If a ship is not a gas carrier, the use of gas fuel shall be specially approved by flag state Maritime Administration.

In addition to these requirements, the ship shall comply with the requirements of flag state Maritime Administration and Port State Control.

Besides sea-going ships, the requirements of the present Section are applicable to other offshore installations subject to the Register supervision, oil-and-gas production units and other offshore facilities. Applicability of particular paragraphs of these requirements to such items is subject to special consideration of the Register with due regard to national requirements applicable to such installations.

9.1.2 Class notation.

Ships fitted for the use of gas fuel in compliance with the present Section are assigned a distinguishing mark **GFS** (gas fuelled ship) added to the character of classification.

9.1.3 Terms and definitions.

Besides the below mentioned, the definitions given in 1.2, Part I “Classification” of the Rules for the Classification and Construction for Ships Carrying Liquefied Gases in Bulk are applicable to the requirements of this Section.

Non-hazardous atmosphere means air environment where gas concentration is lower than the level corresponding to activating an alarm on high gas concentration in the air.

Gas fuel means any hydrocarbon fuel having at the temperature of 37,8°C the absolute pressure of saturated vapors according to Reid equal to 0,28 MPa and above.

Fuel oil means any hydrocarbon fuel having at the temperature of 37,8 degr C the absolute pressure of saturated vapor as per Reid equal to 0,28 MPa or higher.

Gas area means an area where gas-containing systems and equipment are located, including the weather deck spaces above them.

Gas-hazardous area means an area in the gas zone which is not equipped with approved arrangement to ensure that its atmosphere is at all times maintained in a gas-safe condition. It is divided into explosion hazard zones 0, 1, 2, the boundaries of which are given in 9.9.2.

Gas safe space is a space other than a gas-dangerous space.

Gas-hazardous machinery space means closed gas-hazardous space with gas fuel consumers, explosion safety of which in case of gas fuel leakage is ensured by emergency shutdown (ESD) of all machinery and equipment which may be an ignition source.

Gas safe machinery space means closed gas safe space with gas fuel consumers, explosion safety of which is ensured by installation of gas-containing equipment in gastight enclosures (piping, ducting, partitions) for gas fuel bleed-off, and the inner space of partitions and ducting shall be considered gastight.

Gas-containing systems means systems intended for storage, feed, supply and discharge of gas to ship consumers.

Master gas fuel valve means an automatic valve installed at gas supply pipeline to each engine located outside machinery space when the equipment for gas fuel combustion is used.

Dual fuel engine means a heat engine so designed that both gas and fuel oil may be used as fuel, simultaneously or separately.

Gas fuel storage tank means a tank designed as an initial gas fuel tank for storage on board the ship in liquid or compressed gaseous form.

LNG tank means liquefied gas fuel storage tank.

CNG tank means compressed gas fuel storage tank.

A, B and C type tanks means an independent tanks complying with the requirements to A, B and C type independent tanks of gas carriers stated in the *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk*.

Enclosed space means any space inside of which, in the absence of mechanical ventilation, natural ventilation is restricted in such a way that any explosive atmosphere is not subject to natural dispersion.

Open space means a space open from one or several sides, in all parts of which an effective natural ventilation is arranged via permanently open openings in the side partitions and in the above located deck.

Gas fuel storage room means a room where gas fuel storage tanks are located.

Gas fuel consumer means any ship equipment or machinery (engine, boiler, inert gas generator, galley stove, etc.) where gas fuel is used for generation of power or combustion products.

Semi-enclosed space means a space restricted by decks and bulkheads where natural ventilation is available but its efficiency sufficiently differs from normal one at the weather deck.

Gas-dangerous space means a apace in the gas area which is not equipped with an approved device to ensure that its atmosphere is at all times maintained in a gas-safe condition. It is subdivided into explosion hazard zones 0, 1 and 2, the boundaries of which are specified in 8.9.2.

Gas-safe space is a space other than a gas-dangerous space.

Non-hazardous atmosphere means air environment where gas concentration is lower than the level corresponding to activating an alarm on high gas concentration in the air.

9.1.4 Technical documentation.

In addition to the technical documentation specified in Section 3, Part I "Classification" of the Rules for the Classification, the following technical data and ship documents confirming fulfillment of the Rules shall be submitted to the Register:

.1 drawings of fuel tanks arrangement with their distances from side plating and the bottom specified;

.2 drawings of supports and other structures to ensure fastening and limiting shifting of fuel tanks;

.3 calculations of heat emission from the flame which may occur during the fire affecting gas fuel tanks and other equipment and spaces related to gas fuel;

.4 drawings and diagrams of systems and piping for gas fuel specifying such assemblies as compensators, flange joints, stop and control fittings, drawings of quick-closing arrangements of gas fuel system, diagrams of gas fuel preparation, heating and pressure control, calculations of stresses in piping containing gas fuel at a temperature below -110^{o} C;

.5 drawings of safety and vacuum safety valves of fuel tanks;

.6 drawings and descriptions of all systems and arrangements for the measurement of cargo amount and characteristics, and for gas detection;

.7 diagrams of gas fuel pressure and temperature control and regulating systems;

.8 drawings and calculations of draining and ballast systems in gas-hazardous spaces;

.9 diagrams and calculations of gas-dangerous spaces ventilation;

.10 diagrams and calculations of gas-freeing system;

.11 circuit diagrams of electric drives and control systems for a fuel preparation plants, ventilation of hazardous spaces and airlocks;

.12 circuit diagrams of electric measurement and alarm systems for equipment related to the use of gas fuel;

.13 general arrangement drawings of electrical equipment related to the use of gas fuel;

.14 drawings of cable laying in hazardous spaces and areas;

.15 of earthing for electrical equipment, cables, piping located in gas-dangerous spaces;

.16 justification of electrical equipment fitness;

.17 ship general arrangement drawings specifying the layout of:

-gas fuel storage rooms and any openings in them;

- spaces for fuel storage and preparation and any openings to them;

- doors, hatches and any other openings into hazardous spaces and areas;

- vent pipes and air inlet and outlet locations of a ventilation system of hazardous spaces and areas;

- doors, scuttles, companions, ventilation duct outlets locations and other openings in spaces adjacent to hazardous area;

.18 data on the properties of gas fuel intended for the use on board the ship;

.19 analysis of risks related to the use and storage of gas fuel and possible consequences of its leakages as per the procedure agreed with the Register. The analysis shall consider the risks of damage of hull structural members and failure of any equipment after accident related to the use of gas fuel. The results of risk analysis shall be taken into consideration on the Operating manual.

Regarding the LNG tanks, the technical documentation shall be submitted in the extent required for approval of cargo tank for carrying LNG on board the gas carrier in

compliance with the requirements of the Rules for the Classification and Construction of Gas Carriers and the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

Regarding the CNG tanks, the technical documentation shall be submitted in the extent required for approval of cargo tank for carrying CNG on board the gas carrier in compliance with the Rules for the Classification and Construction of CNG Gas Carriers. When the standard cylinders are used, the calculation of permissible pressure shall be submitted.

9.2 GENERAL REQUIREMENTS TO SHIP STRUCTURE.

9.2.1 All dimensions of hull structure elements, except those specially mentioned in the present Chapter, shall be determined in accordance with the requirements of *the Rules for the Classification and Construction of Sea-going Ships* depending on purpose and constructive type of the ship.

9.2.2 Tanks for storage of gas fuel both in liquefied (LNG) and compressed (CNG) condition may be located directly at the weather deck of the ship or in special enclosed spaces in the ship's hull. In the closed spaces liquefied gas fuel shall be stored at the pressure not exceeding 1 MPa.

Membranes ensuring a seal between a deck and gas fuel storage tank are be provided, where the gas fuel storage tank gets through the upper weather deck. Therewith, the space located below the membrane may be considered as an enclosed gas-dangerous space, and the space above the membranes may be considered as an open space.

9.2.3 When located at the weather deck, gas fuel storage tanks shall be arranged at the distance of at least *B/5 (one fifth of the ship's breadth)* from the outer plating. On board ships not being passenger ships, upon special consideration of the Register, the distance from the outer plating may be reduced less than *B/5,* but not less than 760 mm.

When located at the weather deck, the gas fuel storage tanks shall be located in the special partition made in the form of semi-closed space with sufficient natural ventilation preventing accumulation of gases in any part of it.

Under the storage tank for liquefied gas fuel a stainless steel tray shall be provided to prevent intrusion of liquefied gas to the deck in case of damage of piping connected to the tank below the possible level of liquefied gas.

Direct contact between the tray and the hull shall be avoided. Insulation shall be sufficient to ensure strength of hull structures in case of leakage.

9.2.4 Access to gas-dangerous spaces for their inspection shall be provided. Access shall be provided:

.1 to the spaces located in the ship's hull — directly from the weather deck through the openings, hatches and manholes with clear dimensions of at least 800 x 800 mm;

.2 to the spaces at the weather deck through the openings or manholes in the vertical walls with clear dimensions of at least 800 x 800 mm.

Gas fuel storage tanks

9.2.5 When type C gas fuel storage tanks are located in special enclosed space, the storage tanks shall be located minimum at the distance of *1/5 of the ship's breadth* or 11,5 m, whichever is lesser, from the side shell plating. Furthermore, gas fuel storage tanks shall be located minimum at the distance of 1/15 of ship's breadth or 2 m, whichever is lesser, from the bottom plating. For ships other than passenger ships a tank location closer than *B/5* but not less than 760 mm from the ship side may be accepted upon the special consideration of the Register.

9.2.6 When the tanks other than type C tanks are used as gas fuel storage tanks, the ship shall have double sides and double bottom in the area of location of the gas fuel storage tanks. Height of double bottom shall be at least 1/15 of the ship's breadth or 2 m, whichever is lesser. Width of double side shall be at least *1/5 of ship's breadth* or 11,5 m, whichever is lesser. When the width of double side and double bottom are different, the structure in the junction point shall be equal to those shown at the Figures 2.6.a and 2.6.2, Part II "Gas Carrier Design" of the *Rules for the Classification and Construction of Gas Carriers*.

9.2.7 Gas fuel storage tank shall be gas-tight and access to them shall be located in the gas safe area at the weather deck. When the latter is not fulfilled, an air lock shall be provided at the access to the gas fuel storage tank. Air lock shall be formed by two self-closing steel gastight doors located at the distance of at least 1,5 m but not greater than 2,5 m from each other. Air lock coaming height shall be at least 300 mm.

9.2.8 Gas fuel storage rooms shall not be located adjacent to machinery spaces of category A.

If the machinery spaces are separated from the gas fuel storage room by cofferdams, then an additional fire-resistant insulation to class A-60 standard shall be fitted for one of the bulkheads.

9.2.9 When gas fuel storage tanks are double walled, the gas fuel storage tank could be arranged as a tight enclosure covering any openings to gas fuel storage tanks and fittings installed on them. Joints of a bulkhead with the outer shell of the gas fuel storage tank shall be tight and fully welded.

9.2.10 Bilge system of tank rooms shall be made separate and shall not be connected to the bilge system for the rest of the ship.

Gas compressor room and gas fuel pump room.

9.2.11 Compressor rooms and gas fuel pump rooms, if arranged, shall be subject to the requirements of 9.2.7 and 9.2.8 for gas fuel storage rooms.

9.2.12 Where compressors are driven by shafting passing through a bulkhead or deck, the bulkhead penetration shall be of gastight type.

Engine rooms.

9.2.13 One of two below mentioned methods for provision of safety in the engine room may be accepted:

- machinery space is considered gas safe. Furthermore, single failure of gas containing equipment located in such space does not result in accumulation of explosive concentration and the requirements of 9.2.14 shall be met.

- machinery space is considered gas dangerous. Furthermore, single failure of gas containing equipment located in such space results in accumulation of explosive concentration, therewith, safety is provided by the emergency shutdown of any ignition sources and the requirements of 9.2.15 shall be met.

9.2.14 To consider the engine room gas safe the following requirements shall be met:
- pipes and equipment with gas fuel shall be installed in tight pipes with inert gas (pipe inside the pipe) or continuously ventilated duct in compliance with the requirements of 9.5.3.2 or 9.5.3.3;
- electrical equipment inside the duct shall be explosion-proof;
- when leakage is detected, supply of gas fuel to the equipment shall be stopped, and the piping shall be blown off using the fittings given in 9.5.3.4. In this case another piping for supplying fuel oil or gas fuel or, in the installations with several main engines, a separate piping for supplying another main engine shall be provided.

9.2.15 When the engine room is considered gas dangerous space, the following requirements shall be met to ensure its safety:
- piping and equipment containing gas fuel are located directly in the engine room, therewith gas safe and gas dangerous parts of the engine room are separated by a ventilated lock;

- gas dangerous part of the engine room shall be continuously actively ventilated in compliance with 9.7.12;
- all electrical equipment inside the gas dangerous part of the engine room is of explosion-proof version;
- inside the engine room gas concentration is constantly monitored in accordance with 9.8.4, and in case of leakage the main gas valve shall be closed, gas supply to the engine room shall be shut down and all the sources of ignition shall be stopped (including the main engine).

9.2.16 Use of gas dangerous engine rooms specified in 9.2.17 is only allowed, when at least one more main engine is available on board ship which is located outside the engine room so protected and the power of which is roughly equal to the power of the engines located in the gas-hazardous engine room. Arrangement of the engines in two fully autonomous gas-hazardous spaces is allowed.

9.2.17 Arrangement of boilers, incinerators and other equipment with fuel nozzles in the gas-hazardous spaces is not allowed.

9.2.18 Use of gas-hazardous machinery spaces specified in 9.2.15 is only allowed when gas fuel is applied, the density of which at normal conditions is lower than the air density and the pressure in gas fuel piping shall not exceed 1 MPa.

9.2.19 Use of gas-hazardous machinery spaces on gas carriers is only permitted subject to approval of the flag state Maritime Administration.

9.3 DESIGN OF GAS FUEL STORAGE TANKS.

9.3.1 General requirements to gas fuel storage tanks

9.3.1.1 Gas fuel storage tanks shall be supported by the hull in a manner which will prevent movement of the tank under static and dynamic loads.
A possibility of contraction and expansion for the structures, forming the cargo tank, under temperature variations without due stresses of the tank and hull structures shall be ensured.
Gas fuel storage tanks with supports shall be designed for a static angle of heel of 30^{o}. The supports shall be calculated for the most probable maximum resulting acceleration determined in compliance with 3.5 of Part IV of RS Rules for the Classification and Construction of Gas Carriers.

9.3.1.2 The design of the gas fuel storage tank attachment to the hull shall provide for special stops which can withstand horizontal forces due to the ship's collision equal to 0,5 and 0,25 of the weight of the tank and cargo in the forward and aft directions respectively; any damages therewith to cargo structures shall be prevented.

9.3.1.3 A structural analysis of gas fuel storage tank structures and tank supports shall be carried out on the assumption that the loads specified in 9.3.1.2 and loads generated due to heel according to 9.3.1.1, are not superimposed on the forces due to ship's hull deformation in the seas.

9.3.1.4 Provision shall be made for structural measures to prevent potential cargo tanks (independent tanks and, where necessary, membrane and semi-membrane tanks) shifting relative to the ship's hull under the inertia forces caused by rolling.

9.3.1.5 The design of independent cargo tanks shall provide for antifloating arrangements (keys, stops, etc.) which withstand an upward force caused by an empty tank in a hold space flooded to the full-load draught; in such a case, a stress in ship's hull structure elements is not exceed yield point.

9.3.1.6 Each gas fuel storage tank (LNG or CNG) shall be provided with a tank isolation shutoff valve capable of being remote operated. The valve shall be located as close to the tank as possible at any piping connected to the tank or directly on the tank.

9.3.1.7 For single fuel (gas only) installations at least two gas fuel storage tanks of approximately equal capacity shall be provided and they shall be located in separate spaces.

9.3.2 Liquefied gas fuel storage tanks.

9.3.2.1 Liquefied gas storage tanks (LNG) shall be designed in compliance with the requirements of Part IV "Cargo tanks" of RS Rules for the Classification and Construction of Gas Carriers for liquefied gas fuel transfer tanks.

9.3.2.2 Each liquefied gas fuel storage tanks (LNG) shall be fitted with safety valves in compliance with the requirements to safety valves of cargo tanks set forth in the Part VI "Systems and piping" of the Rules for the Classification and Construction of Gas Carriers.

9.3.2.3 Liquefied gas storage tanks shall be fitted with safety valves in compliance with the requirements to safety valves of LNG transportation tanks set forth in the Part VI "Systems and piping" of the Rules for the Classification and Construction of Gas Carriers.

9.3.2.4 The outlets of vent pipes from the pressure relief valves shall be located at least B/3 or 6 m, whichever is greater, above the weather deck and 6 m above the working area and gangways. Gas outlet pipes shall be designed so that the outgoing gas shall be directed upwards and the possibility of water and snow ingress into the system shall be kept to minimum.

9.3.2.5 All gas outlets shall be located at the distance of at least 10 m from:
- the nearest air inlet or openings in the accommodation and service spaces and control posts or from other gas safe spaces;
- outlets in the engine room.

9.3.3 Compressed gas storage tanks.

9.3.3.1 Compressed gas storage tanks (CNG) shall be designed in compliance with the requirements of Part X "Boilers, heat exchanger and pressure vessels" of the *Rules for the Classification and Construction of Sea-going Ships*. Standard cylinders, for which it is necessary to make calculation of permitted pressure, and specially designed pressure vessels may be used as compressed gas storage tanks.

9.3.3.2 Each compressed gas storage tank shall be equipped with safety valves complying the requirements for cargo tanks in accordance with Section 2, Part VI Systems and piping" of the Rules for the Classification and Construction of Gas Carriers.

9.3.3.3 Safety valves of CNG tanks located in the hull or at the weather deck of gas carrier shall be connected with gas outlet piping. Gas outlets from the safety valves shall meet the requirements of 9.3.2.3 and 9.3.2.4.

9.4 GAS FUEL CONSUMERS ON BOARD SHIP.

9.4.1 Internal combustion engines.

General requirements for IC engines

9.4.1.1 Crankcases of IC engines shall be fitted with safety valves in way of each crankshaft crank. Design and actuating pressures of safety valves shall be specified with due regard to the possible explosion of gas fuel leakage accumulated in the crankcase.

9.4.1.2 Crankcase of trunk-case engines 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.

9.4.1.3 Crankcase of a cross-head type engine shall be equipped with oil mist concentration sensor or temperature control system of the engine bearings. Sub-bearing spaces of the cross-head engine shall be provided with gas fuel leakage detectors or any other equivalent devices.

9.4.1.4 When gas fuel is supplied to the cylinders as part of gas-and-air mixture via the common intake manifold, the intake gas-and-air collector shall be fitted with a safety valve or other safety device to ensure its sufficient strength to withstand the explosion.

9.4.1.5 Exhaust gas collectors shall be fitted with safety valves or other protective means, the dimensions of which shall be designed to withstand explosion of gas fuel entering it in case of no ignition in one cylinder.

9.4.1.6 The exhaust gas piping of gas-fuelled engines shall be equipped with effective means of blowing off and shall not be combined with exhaust gas piping from other engines, boilers and incinerators. All exhaust gas piping shall be fitted with spark arresters.

9.4.1.7 Branch pipes of starting air piping laid to each cylinder shall be equipped with flame arresters. Engine gas collector connection with shipboard gas fuel piping shall ensure the necessary flexibility. The connection of gas fuel supply collector and gas fuel injection valves shall provide complete coverage by the protection pipes or ducts.

9.4.1.8 Lubricating oil system and cooling system of gas-fuelled engines shall be equipped with the effective gas extraction measures fitted after the outlet of oil and cooling water from the engine. Air pipes for extraction of gas from the said means and from oil daily tanks and cooling tanks shall be extracted to open parts in a safety place.

9.4.1.9 Measures for control of fuel combustion shall be provided. Extent of control shall be established and submitted for approval with due regard to the review of failure origin and their consequences for all engine components affecting combustion. The minimum extent of control, type of automatic protection and warning protection system are given in the Table 9.4.1.9.

Table 9.4.1.9

Item No.	Testing parameter or engine component	Place of measurement or testing conditions	Limit values of parameters (warning alarm system) or failure signs	Automatic closing of gas fuel supply valves	Indication in CCR
1	Gas valves	Each cylinder	Seizure of gas valve in open position	X	Permanently
2	Pilot fuel nozzles or spark plugs	Each cylinder	Incorrect firing	X	Permanently
3	Exhaust gas temperature	At each cylinder outlet Deviation from average value	Max	X	Permanently
4	Combustion pressure	In each cylinder Deviation from average value	Max	X	On call
5	Gas fuel supply pressure	At the engine inlet	Min	X	Permanently

Dual fuel internal combustion engines

9.4.1.10 When operated on dual fuel, the internal combustion engines shall be fitted with the means for injection of liquid pilot fuel to each cylinder of the engine. The amount of pilot fuel fed to each cylinder shall be sufficient to ensure a positive ignition of the gas mixture in every mode of dual fuel engine operation. The engine shall be so

designed that to preclude shut off of the pilot fuel supply prior to or simultaneously with the gas fuel cutoff.

9.4.1.11 Start and normal stop of the duel fuel engine, low power and variable duty operation, ship maneuvering, mooring operations and any modes related to the possibility of reducing the engine number of revolutions per minute below the minimum stable speed shall be on oil fuel only. The engines shall be capable of continuous operation by fuel oil only.

9.4.1.12 In case of sudden shut-off the fuel oil to the dual-fuel engine, gas fuel supply shall be shut off simultaneously and the engine shall be stopped. In emergency shut-down of gas fuel supply the engine shall continue operation on fuel oil without stop.

9.4.1.13 Dual-fuel engines shall be fitted with the appropriate arrangements to avoid simultaneous supply of gas fuel and full supply of fuel oil.

9.4.1.14 Changeover to gas fuel shall only be possible at a power level where the engine demonstrates stable safe operation on dual fuel that shall be determined through testing. Changeover to gas fuel shall be made automatically at obtaining this power by the engine, and when the power is reduced below this power value, the gas fuel supply shall be automatically stopped.

Gas fuel internal combustion engines

9.4.1.15 The starting sequence of gas fuelled engine shall exclude admission of gas fuel to the cylinders until ignition is activated and the engine has reached the minimum rotation frequency necessary for firing gas-air mixture in the cylinder.

9.4.1.16 If ignition has not been detected by the engine monitoring system within 10 sec after opening of the gas-air supply valve, the gas supply valve shall be automatically shut off and the stop procedure shall be activated to eliminate the ignition of any unburned gas-air mixture.

9.4.1.17 On normal stop, as well as emergency shutdown, gas fuel supply shall be not earlier than closing the gas supply valves to each cylinder and to the complete engine.

9.4.1.18 When restarting after a failed start attempt shall be possible only after the exhaust gas manifold is purged and exhaust gas piping system is ventilated with a volume of air at least equal to 3 times the volume of the exhaust gas system before the turbocharger. The above purging may be carried out through running the engine on starting air.

9.4.2 Gas-turbine engines (GTE).

9.4.2.1 Start and operation of gas-turbine engines in all modes shall be performed both on gas fuel and fuel oil.

9.4.2.2 Measures shall be provided to prevent availability of liquids in gas fuel entering the gas turbine engine.

9.4.2.3 In case of gas fuel shut-off the gas-turbine engine shall be automatically stopped or transferred to fuel oil operation , and the possibility of repeated supply of gas fuel shall

be eliminated by closing of quick-closing valve located as closer to the gas-turbine engine as possible.

9.4.2.4 An arrangement located in close proximity to the gas-turbine engine shall be provided for manual shut-off of gas fuel supply.

9.4.2.5 All exhaust gas piping shall be fitted with spark arresters and shall not be combined with the exhaust gas piping of other engines, boilers and incinerators.

9.4.3 Boiler installations.

9.4.3.1 Each boiler shall be fitted with a separate uptake. Burner unit of the boiler shall be shaped so that to prevent forming of pockets where gas may be accumulated.

9.4.3.2 Burner unit shall be suitable to burn either fuel oil and gas fuel alone or oil and gas fuel simultaneously. Changeover from gas to oil burning shall not cause change of the boiler operating mode.

Burner unit shall be equipped by the pilot burner operating on fuel oil. Burner units shall have interlocking and non-disconnectable protection specified in 5.3.2 – 5.3.4 of Part X "Boilers, heat exchangers and pressure vessels".

9.4.3.3 On the pipe of each gas burner a manually operated shut-off valve shall be fitted.

An installation shall be provided for purging the gas supply piping to the burner by means of inert gas or steam, after the extinguishing of this burner.

9.4.3.4 The controls, regulators, interlocking, protective devices and alarms of the automated burning installations shall comply with the requirements of 4.3, Part XV "Automation".

9.4.3.5 The requirements of 9.5.3 and 9.8.4.4 shall be applicable to gas supply systems and piping.

9.4.3.6 All exhaust gas piping shall be fitted with spark arrestors and shall not be combined with the exhaust gas piping from other engines, boilers and incinerators.

9.4.4 Other gas consumers.

9.4.4.1 Gas fuel for domestic purposes may be used only as an autonomous system complying the requirements of 13.14, Part VIII "Systems and piping”.

9.4.4.2 Use of gas fuel for other purposes, not specified in 9.4.1-9.4.3, for instance, inert gas producing, shall be subject to special consideration of the Register in each particular case.

9.5 FUEL SYSTEM.

9.5.1 Gas bunkering stations.

9.5.1.1 Gas bunkering stations shall be so located at open parts of the deck that sufficient natural ventilation is provided. Use of enclosed or semi-enclosed spaces as bunkering stations shall be subject to special consideration of the Register.

9.5.1.2 Measures shall be taken to prevent damage of hull structures due to effect of spilled liquefied gas. For ships using CNG, bunkering stations shall be separated from the control stations and accommodations, guarded by a coaming and equipped with a special drip tray made of stainless steel for leakage accumulation. Leakage draining piping for drip tray discharge shall be provided. Leakage drainage piping shall be located over the ship's side and preferably leads down near the sea. Leakage draining piping may be removable and may be installed for the bunkering period.

9.5.1.3 An operator work place shall be equipped at the bunkering station and be protected against possible leakage of bunkering fuel. Monitoring of pressure and fuel tank level, overfill alarm and automatic shutdown of intake fittings and the necessary communication means shall be provided at the operator work place; shall also be indicated at this location.

9.5.1.4 Every bunkering line shall be fitted with a local manually-operated and remotely controlled stop valve. It shall be possible to release the remote-operated valve from safe easily-accessible place.

9.5.1.5 The bunkering system shall be so arranged that no gas is discharged to air during filling of storage tanks.

9.5.2 Gas compressors.

9.5.2.1 The fuel gas compressors shall meet the requirements of 5.5, Part IX “Machinery”. Gas compressors shall be fitted with accessories and instrumentation necessary for efficient and reliable function. As a minimum, the warning alarms shall be fitted in respect of the following parameters: compressor operation, low gas input pressure and low gas output pressure and excess output pressure build-up.

9.5.2.2 The gas compressors shall be equipped with the emergency stop devices from the following locations:

- the cargo control room (relevant for cargo ships);
- navigation bridge;
- central control room;
- fire control station.

9.5.3 System of gas supply to consumers.

9.5.3.1 Gas fuel piping shall not be laid through control stations, accommodation and service spaces. Laying of gas fuel pipelines through other enclosed areas and spaces

and inside gas-safe machinery spaces (refer to 9.2.13 and 9.2.14) is allowed in compliance with the requirements of 9.5.3.2 or 9.5.3.3.

Gas fuel piping shall not be laid at the distance below 760 mm from the outer shell.

During the design and calculation of gas fuel supply piping, besides compliance with the requirements of 2.3, Part VIII " Systems and piping" the possibility shall be considered of fatigue failure of gas piping due to vibrations, as well as due to pulse pressure when supplying gas fuel to compressors.

9.5.3.2 The pipeline represents a piping system with double walls containing gas fuel inside the internal pipe. The following conditions shall be met:

.1 the space between the walls shall be filled with inert gas under pressure exceeding gas fuel pressure;

.2 inert gas pressure shall be constantly monitored by the alarm system;

.3 at the alarm system activation the automatic valves mentioned in 9.5.3.4 shall be automatically closed prior to the inert gas pressure drops lower than the pressure of gas fuel, and *ven*t valve stated in 9.5.3.4 shall be automatically opened;

.4 the system shall be so arranged that the internal part of gas fuel supply pipeline between the main gas valve and engine be automatically purged with inert gas, when the main gas valve is closed.

9.5.3.3 Gas fuel pipelines shall be installed in the pipe or duct with artificial exhaust ventilation of the space between them, The capacity of exhaust ventilation shall be calculated based on the velocity of gas fuel flow, structure and location of protective pipes or ducts rand provide at least 30 air changes per hour. Therewith, the following conditions shall be met:

.1 the pressure in the space between the external and internal walls of pipelines or ducts shall be kept lower than the atmospheric pressure;

.2 provision shall be made for the gas leakage detector and when this detector or alarm system is activated, the automatic valves specified in 9.5.3.4, shall be automatically closed before the inert gas pressure is reduced below the fuel gas pressure and the *gas exhaust* valve indicated in 9.5.3.4 shall be automatically opened;

.3 electrical motors shall be of explosion-proof design and be located outside the pipes or ducts;

.4 when the required air flow is not maintained by the ventilation system, the main gas valve, mentioned in **9.5.3.5**, shall be closed automatically. Ventilation shall function every time when gas is supplied through the pipeline;

.5 air intakes of the ventilation system shall be provided with non-return devices. These requirements are not compulsory when gas detectors are fitted in air intakes;

.6 provision shall be made for inertization and degasification of gas fuel pipeline system section located in the engine room.

9.5.3.4 Gas fuel supply system *to every consumes* shall be fitted with three automatic valves. Two of them shall be installed in succession in the system of gas fuel supply to the engine. The third valve (gas outlet) shall be mounted for gas discharge from the pipe section located between two automatic valves installed in succession to the safe place on the weather deck. The system shall be so constructed that when the pressure in the gas fuel supply pipeline fluctuates from the set values, loss of energy for valve control, violation of the conditions specified in 9.5.3.2 and 9.5.3.3, as well as stop of engine due to any reason two valves installed in succession shall be closed automatically and the third valve (gas outlet) shall be opened automatically.
As an alternative, one of two valves installed in succession and the ventilation valve may be combined in one body, provided their performance of the above-mentioned functions.
All three valves shall be manually operated.

9.5.3.5 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 9.5.3.2 and 9.5.3.3;

actuation of oil mist concentration sensor in the engine crankcase or in the temperature control system of the engine bearings.

9.5.3.6 Gas lines shall have sufficient structural strength with regard to stresses caused by the mass of the pipelines, internal pressure, loads caused by bends of the ship's hull and possible accelerations during the operation.

9.5.3.7 The structure of protective pipes or ducts of the ventilation system mentioned in 9.5.3.2 and 9.5.3.3, shall have strength sufficient to withstand fast increase of internal pressure in case of pipeline break. A number of split connections in protective pipes or ducts shall be minimum.

9.5.3.8 As a rule, gas pipelines shall be connected with complete-penetration butt welds and special means for provision of weld root quality and completely radiographically tested. All butt welds after welding are subject to heat treatment depending on the material. The use of other joints shall be specially considered by the Register in each case.

9.6 FIRE PROTECTION

9.6.1 General

9.6.1.1 Subject to the character of the ship classification and in addition to the requirements of the present Section, fire protection shall meet the requirements of Part VI ‘Fire Protection’.

9.6.2 Structural fire protection

9.6.2.1 Gas fuel tanks located at the weather deck shall be separated from the accommodation, service, cargo and machinery spaces by a special screen made as class A-60 fire structure.

9.6.2.2 Gas fuel tank rooms and ventilation trunks to such spaces shall be separated from accommodation, service, cargo and machinery spaces by class A-60 fire structures. They may be separated from other spaces of little fire risk by class A-0 fire.

9.6.2.3 Gas pipes led through ro-ro spaces on open deck should be provided with guards to prevent vehicle collision damage. The fire protection of such piping is subject to special consideration by the Register.

9.6.2.4 When more than one machinery space is arranged on board the ship, they shall be separated by class A-60 bulkhead.

9.6.2.5 Gas compressor room shall be regarded as a machinery space of category A for fire insulation requirements and shall have relevant fire protection.

9.6.2.6 Gas fuel bunkering room shall be separated from other spaces by class A-650 structures, except cofferdams of ballast tanks and other spaces of low fire risk which may be separated by class A-0 structures.

9.6.3 Fire water main system

9.6.3.1 Fire water main system shall be in compliance with the requirements of 3.2, Part VI ‘Fire Protection’ with due regard for the character of the ship classification.

9.6.3.2 Where fire water main pumps are used as part of the water spray system, the required pump capacity shall be determined for the case of both the fire water main system and the water spray system being in operation.

9.6.3.3 Where gas fuel tanks are installed on the open deck, the fire water mains shall be provided with a shutoff valve to isolate the damaged pipe section with the system remaining operable all the time.

9.6.4 Water spray system

9.6.4.1 A water spray system shall be fitted on board gas-fuelled ships for cooling and fire prevention and to cover exposed parts of gas storage tank located above deck.

9.6.4.2 The system shall be designed to cover all areas specified in 9.6.4.1 with an application rate as follows:

.1 10 l/min/m^2 for horizontal surfaces;

.2 4 l/min/m^2 for vertical surfaces.

9.6.4.3 For the purpose of isolating damaged sections, stop valves shall be fitted. Alternatively, the system may be divided into two sections which shall be independently operated. Control of the sections shall be located in a safe and readily accessible position.

9.6.4.4 Connection to the ship's fire main should be provided through a stop valve fitted on the open deck in a safe position outside the bunkering station area.

9.6.4.5 Remote start of pumps supplying the drenching system and remote operation of fittings shall be located in a readily accessible position which is not likely to be cut off in case of fire.

9.6.4.6 The nozzles of the drenching system should be of an approved full bore type and they should be arranged to ensure an effective distribution of water throughout the space being protected.

9.6.5 Dry chemical powder system

9.6.5.1 To protect the bunkering station area and cover all possible leak points, gas-fuelled ships should be equipped with a dry chemical powder system complying with the requirements of Part VI "Fire Protection". The capacity should be at least 3.5 kg/s and the power capacity shall be sufficient for a minimum of 45 s discharges.

9.6.6 Fire detection and alarm system

9.6.6.1 In gas fuel storage spaces and in ventilation ducts leading thereto, a fire detection system of an approved type shall be installed. The system shall ensure clear identification of activated detector and determine its location.

9.6.6.2 A smoke detection system cannot be contemplated as an efficient and quick-acting means of fire detection complying with **9.6.6.1** unless other fire detecting equipment is provided additionally.

9.6.7 Fire safety requirements

9.6.7.1 Two portable dry chemical powder fire extinguishers, each of at least 5 kg capacity shall be provided in the vicinity of the bunkering station.

9.6.7.2 Engine room where the gas fuel is heavier than air shall be provided with two dry chemical powder extinguishers of at least 5 kg capacity each, located at the entrance to the rooms.

9.7 VENTILATION OF SPACES

9.7.1 Ventilation ducts opening to spaces classed as hazardous zones shall be completely insulated from ventilation ducts opening to gas-safe spaces. Ventilation ducts opening to spaces containing gas compressors and gas-fuel storage tanks as well as machinery spaces shall be provided with A-60 class automatic fire dampers.

9.7.2 The design of ventilators serving hazardous zones shall be in compliance with the requirements of 5.3.3, Part IX 'Machinery'. Electric drives of ventilators fitted inside hazardous zones are to be intrinsically safe. When fitted inside the ventilation duct, the explosion proofness of electric drives of ventilators shall be the same as that of the space through which they are led.

9.7.3 Provision shall be made for an alarm to warn of ventilation being shut down in spaces and rooms to be continuously ventilated.

9.7.4 Ventilation system shall ensure the absence of gas pockets in spaces being served.

9.7.5 The inlets of ventilation ducts opening into enclosed hazardous spaces shall draw air from spaces which, in the absence of considered inlets of the said ventilation ducts, would be non-hazardous.

Air inlets for non-hazardous enclosed spaces shall be taken from non-hazardous zones at least 1.5 m away from any boundaries of any hazardous zone.

Where the inlet duct passes through a more hazardous space, this duct shall have overpressure relative to this space so the air from it would not leak into the duct in case of tightness loss.

9.7.6 Air outlets from non-hazardous spaces shall be located outside hazardous zones.

9.7.7 Air outlets from hazardous enclosed spaces shall be located in spaces which, in the absence of the considered outlet, would be of the same of lesser hazard than the ventilated space.

9.7.8 Where spaces classed as non-hazardous have openings to a hazardous zone, the openings shall be fitted with an air lock and be maintained at overpressure relative to the external hazardous zone. The overpressure ventilation shall be arranged according to the following requirements: on tightness loss, any electrical equipment which is not intrinsically safe shall be de-energized until 5 air changes at least have been made by means of ventilation and the space is pressurized. The pressure in these spaces shall be controlled continuously, and in the event of overpressure ventilation failure or overpressure loss an alarm shall be given and the electrical equipment which is not intrinsically safe shall be de-energized automatically.

9.7.9 Tank rooms shall be provided with an effective mechanical ventilation system of the extraction type, providing a ventilation capacity of at least 30 air changes per hour.

9.7.10 The ventilation system for machinery spaces containing gas consumers and boilers shall be independent of all other ventilation systems.

9.7.11 Hazardous engine rooms (see para 9.2.15) shall have ventilation with a capacity of at least 30 air changes per hour. The ventilation system shall ensure a good air circulation in all spaces without formation of gas pockets.

The capacity of the ventilation system shall not be reduced by more than 50% in case of a single failure within the system or a service equipment failure. Arrangements are acceptable whereby under normal operation of the system the machinery space is ventilated with at least 15 air changes per hour provided that, if gas is detected in the machinery space, the number of air changes will automatically be increased to 30 per hour.

9.7.12 In gas compressor and pump spaces, the ventilation system shall be of the extraction type, providing a ventilation capacity of at least 30 air changes per hour. The ventilation system shall ensure a good air circulation in all spaces without formation of gas pockets. The capacity of the ventilation system shall not be reduced by more than 50% in case of a single failure within the system or a service equipment failure.

9.7.13 In gas compressor and pump spaces, the ventilation system shall operate as long as the compressors and pumps are in operation. The operation of ventilation is to be permanently controlled, and, in the event of its failure, an alarm shall be given at a manned location. In case of ventilation loss, not less than 5 air changes shall be made in the gas compressor and pump space before energizing the electrical equipment installed therein which is not intrinsically safe.

9.8 MONITORING, CONTROL AND AUTOMATION SYSTEMS

9.8.1 General

9.8.1.1 The requirements of 2.4, Part XV ‘Automation’ shall be complied with.

9.8.2 Pressure and Temperature Monitoring

9.8.2.1 Each gas tank shall be provided with devices for remote monitoring from the bridge and local monitoring of gas pressure and temperature. The devices shall be clearly marked with upper and lower range values of allowable working pressure. Provision shall be made for upper and lower pressure alarms in the tank (where vacuum protection is required by tank design), which shall be activated before safety valve operation.

9.8.2.2 The gas fuel inlet pipe shall be fitted with a device for pressure control between the inlet valve and shore connection.

9.8.2.3 On the gas fuel outlet piping following the pump and on the gas fuel inlet piping following the inlet valve, a device shall be mounted for pressure control.

9.8.2.4 In the drain well of LNG tank storage space, level indicators and temperature indicating devices shall be fitted. As a result of temperature indicating device activation, the main gas valve of the tanks shall be automatically closed. Upper level indicator shall activate an alarm.

9.8.2.5 The LNG tanks the level indicators shall be provided.

9.8.3 Gas tank overflow prevention

9.8.3.1 Each LNG tank shall be provided with means of overflow prevention in compliance with the requirements for cargo tanks of gas carriers to be found in 3.1, Part VIII “Instrumentation” of Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk. Overflow prevention means shall be independent of level indicators mentioned under 9.8.2.4.

9.8.3.2 Each CNG tank shall be provided with means of overpressure prevention during bunkering with an alarm to be activated when reaching 95% of design pressure.

9.8.4 Gas content control in spaces

9.8.4.1 All enclosed gas-hazardous spaces shall be provided with effective gas-detection systems in areas of its possible accumulation and leakage. The number of detectors to be fitted in each space is subject to special consideration in each case proceeding from the size and configuration of the space. When the gas concentration equal to 20% of the lower explosion limit is reached in the space under control, visual and audible alarm is to be given on the bridge. In ventilation ducts containing gas-fuel pipes, the alarm shall be given when the concentration equal to 30% of the lower explosion limit is reached. In case the concentration equal to 40% of the lower explosion limit is reached, measures (at least those stated in Table 9.8.4.2) to automatically shut down gas-fuel supply to the space shall be taken.

9.8.4.2 In the gas-hazardous engine rooms, two independent systems shall be necessary to control gas supply to the machinery space.

9.8.4.3 In gas-safe machinery spaces at least two detectors of the gas supply control system shall be fitted to activate alarm at reaching 30% of the lower explosion limit.

9.8.4.4 Where gas-fuel leakage is found and in case of system failure, the safety system shall automatically activate regulating functions stated in Table 9.8.4.4.

Table 9.8.4.4

Monitoring and Control of Gas Supply System to Consumers

Parameter	Alarm	Automatic closure of main tank valve	Automatic shutdown of gas supply to consumers in machinery room	Comment
Gas detection in tank room above 20% LEL	X			
Gas detection on two detectors [1)] in tank room above 40% LEL	X	X		
Fire detection in tank room	X	X		
Bilge well high level tank room	X			
Bilge well low temperature in tank room	X	X		
Gas detection in duct between tank and machinery space containing gas consumers above 20% LEL	X			
Gas detection on two detectors[1)] in duct between tank and machinery space containing gas consumers above 40% LEL	X	X[2)]		
Gas detection in compressor room above 20% LEL	X			
Gas detection on one of two detectors[1)] in compressor room above 40% LEL	X	X[2)]		
Gas detection in duct inside machinery space containing gas consumers above 30% LEL	X			If double pipe fitted in machinery space containing gas consumers.
Gas detection on two detectors[1)] in duct in machinery space containing gas	X		X[3)]	If double pipe fitted in

consumers above 40% LEL				machinery space containing gas consumers.
Gas detection in machinery space containing gas consumers above 20% LEL	X			Gas detection only required for gas-hazardous machinery spaces.
Gas detection on one of two detectors[1)] in machinery space containing gas consumers above 40% LEL	X		X	Gas detection only required for ESD protected machinery spaces containing gas consumers. Disconnection of non-explosion proof equipment in the machinery spaces with gas consumers shall also be provided.
Loss of ventilation in duct between tank and machinery space containing gas	X		X[2)4)]	

consumers[6)]				
Loss of ventilation in duct inside machinery space containing gas consumers[6)]	X		X[3)4)]	If double pipe fitted in machinery space containing gas consumers.
Loss of ventilation in machinery space containing gas consumers	X		X	For protection of gas-hazardous machinery spaces only.
Fire detection in machinery space containing gas consumers	X		X	
Abnormal gas pressure in gas supply pipe	X		X[4)]	
Failure of valve control actuating medium	X		X[5)]	Time delayed as found necessary.
Automatic shutdown of engine (engine failure)	X		X[5)]	
Emergency shutdown of engine manually released	X		X	

1) Two independent gas detectors located close to each other are required for redundancy reasons. If the gas detector is of self-monitoring type, the installation of a single gas detector can be permitted.

2) If the tank is supplying gas to more than one engine and the different supply pipes are completely separated and fitted in separate ducts and with the master valves fitted outside of the duct, only the master valve on the supply pipe leading into the duct where gas or loss of ventilation is detected is to close.

3) If the gas is supplied to more than one engine and the different supply pipes are completely separated and fitted in separate ducts and with the master valve fitted outside of the duct and outside of the machinery space containing gas consumers, only

the master valve on the supply pipe leading into the duct where gas or loss of ventilation is detected is to close.

4) This parameter is not to lead to shutdown of gas supply to for single-fuel gas engines, only for dual-fuel gas engines.

5) Only for the case of the 3 valves activation, as mentioned under 9.5.3.4.

6) If the duct is protected by inert gas (see 9.5.3.2**),** then loss of inert gas overpressure is to lead to the same actions, as given in this Table.

9.9 ELECTRICAL EQUIPMENT

9.9.1 General

9.9.1.1 Electrical equipment of gas carriers shall be in compliance with the requirements of Part VII 'Electrical Equipment' of Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk. Rules for the Classification and Construction of Ships Carrying Compressed Natural Gas. The classification of dangerous zones shall be in accordance with 9.9.2.

9.9.2 Classification of dangerous zones, spaces and areas

9.9.2.1 The classification of dangerous zones in gas-fuelled ships shall be based on the provisions of IEC 60079-10 and IEC 6092-502. If a dangerous space is not covered by 9.9.2.2, one shall be guided by the above standards.

9.9.2.2 Zone 0: the interiors of gas tanks, pipes and equipment containing gas, any pipework of pressure-relief or other venting systems for gas tanks.

9.9.2.3 Zone 1:

- tank rooms,
- gas compressor spaces,
- areas on open deck or semi-enclosed spaces on deck, within 3 m of any gas tank outlet, gas or vapour outlet, bunker manifold outlet, other gas valve, gas pipe flange, gas pump-room ventilation outlets and gas tank openings;
- areas on open deck or semi-enclosed spaces on deck, within 1.5 m of gas compressor and pump room entrances, gas pump and compressor room ventilation inlets and other openings into zone 1 spaces;
- areas on open deck within spillage coamings surrounding gas bunker manifold valves and 3 m beyond these, up to a height of 2.4 m above the deck;
- enclosed or semi-enclosed spaces in which pipes containing gas are located and ventilation ducts around gas pipes;
- gas-hazardous machinery spaces are considered as non-hazardous areas during normal operation, but changes to zone **1** in the event of gas leakage.

9.9.2.4 Zone 2:

Area at the weather deck within 1.5 m surrounding zone 1.

9.10 PERSONNEL PROTECTION

9.10.1 Where the equipment of gas system is installed in enclosed spaces of the ship, provision shall be made for at least two sets of safety equipment each permitting personnel to enter and work in spaces filled with natural gas.

9.10.2 A set of safety equipment mentioned under 10.1 shall consist of:

.1 one self-contained air-breathing apparatus not using stored oxygen having a capacity of at least 1200 l of free air;

.2 tight-fitting goggles, gloves, intrinsically safe protective clothing and boots;

.3 steel-cored rescue line with an intrinsically safe belt;

.4 explosion-proof lamp.

9.10.3 For breathing apparatuses mentioned under 9.10.2.1, fully charged air bottles with a total free air capacity of at 3600 l for each breathing apparatus shall be provided.

9.10.4 Medical first-aid equipment shall be available on board for persons suffering from burns, frostbites (including cryogenic ones) as well as intoxication with natural gas or products of incomplete fuel burning.

9.10.5 The following service documentation shall be available on board:

.1 bunkering instructions,
.2 purging and gas removal instructions,
.3 instructions for using gas fuel,
.4 instructions describing the crew behaviour in emergencies which may arise during operations with gas fuel.

9.10.6 A plan of periodic audits and maintenance in connection with using gas as fuel shall be developed on board.