RUSSIAN MARITIME REGISTER OF SHIPPING

RULES

FOR THE CLASSIFICATION AND CONSTRUCTION OF SHIPS CARRYING COMPRESSED NATURAL GAS

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The Rules for the Classification and Construction of Ships Carrying Compressed Natural Gas have been approved in accordance with the established approval procedure and come into force on 1 January 2020.

The present edition is based on the Rules for the Classification and Construction of Ships Carrying Compressed Natural Gas, 2019.

The Rules set the requirements, which are specific for the ships carrying compressed natural gas, and supplement the Rules for the Classification and Construction of Sea-Going Ships and the Rules for the Equipment of Sea-Going Ships of Russian Maritime Register of Shipping.

REVISION HISTORY

(editorial amendments are not included in the Revision History)

For this version, there are no amendments to be included in the Revision History.

PART I. CLASSIFICATION

1 GENERAL

1.1 Application.

1.1.1 The Rules for the Classification and Construction of Ships Carrying Compressed Natural Gas[1] apply to specially built or converted ships, regardless of their gross tonnage and powerplant output, intended for the carriage of compressed natural gas (CNG). Ships carrying compressed natural gas[2] are fully covered by the requirements of the Rules for the Equipment of Sea-Going Ships and Load Line Rules for Sea-Going Ships. The Rules for the Classification and Construction of Sea-Going Ships[3], as well as the Rules for the Classification and Construction of Ships Carrying Liquefied Gases[4] apply to the CNG carriers to the extent stipulated in the text of the CNG Rules.

1.2 Definitions and explanations.

1.2.1 The general definitions and explanations are given in the LG Rules. The following definitions and explanations are used in the CNG Rules.

C a r g o t a n k c y l i n d e r is a cylindrical vessel made of a standard large diameter pipe as used for subsea pipelines with dished ends forming the basic volume of the cargo tank.

C o i l e d c a r g o t a n k is a cargo tank consisting of a long length small diameter coiled pipe.

C y l i n d r i c a l c a r g o t a n k is a cargo tank consisting of multiple cylindrical pressure vessels interconnected by the cargo tank piping.

C a r g o h o l d c o v e r is the upper hatch cover of the cargo hold which makes it possible to monitor conditions of cargo carriage in the cargo holds.

M a x i m u m a l l o w a b l e w o r k i n g p r e s s u r e is a pressure equal to 95 % of the design value.

C a r g o h o l d s p a c e is the space enclosed by the ship’s structures, in which the cargo tanks are situated.

D e s i g n p r e s s u r e is the maximum gas pressure at the top of a cargo tank, which is used in design of cargo tanks and cargo piping.

D e s i g n t e m p e r a t u r e is the maximum or minimum temperature, which may take place in the material of cargo tanks, piping, foundations and in the inner hull structures of cargo holds in service.

C a r g o t a n k p i p i n g is the piping, which interconnects cargo tank cylinders and connects cargo cylinders with the cargo valve of a cargo tank.

2 EQUIVALENTS

2.1 The Register may allow the use of the ship's structures, equipment, materials, appliances and apparatus or carrying out of arrangements others than those required by the CNG Rules.

In the above cases, the data, which allow to establish the conformity of such structures, equipment, materials, appliances and apparatus, or arrangements to the conditions ensuring ship's safety, safety of life and prevention of pollution from ships are to be submitted to the Register.

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[1]Hereinafter referred to as "the CNG Rules".
[2]Hereinafter referred to as "the CNG carriers".
[3]Hereinafter referred to as "the Rules for the Classification".
[4]Hereinafter referred to as "the LG Rules".

3 DOCUMENTS

3.1 A Certificate of Fitness for the Carriage of Compressed Natural Gas[5] based on the positive results of survey reflected in the survey reports is issued to the ships meeting the requirements of the CNG Rules in addition to the documents provided for in the General Regulations for the Classification and Other Activity of the Rules for the Classification.

The Certificate period of validity is not more than 5 years.

3.2 The Certificate is to be permanently kept on board a ship and be available for inspection.

3.3 If the equivalents specified in Section 2 are allowed for a ship by the Register, the contents of these equivalents is to be reflected in the Certificate.

4 CLASS NOTATION

4.1 Class notation of a ship.

4.1.1 The character of classification and additional distinguishing marks are assigned in compliance with the requirements of 2.2, Part I "Classification" of the Rules for the Classification.

4.2 Descriptive notation in the class notation.

4.2.1 The ships meeting the requirements of the Rules for the Classification and the CNG Rules are assigned the descriptive notation: **Gas carrier CNG** added to the character of classification (refer to Section 2, Part I "Classification" of the Rules for the Classification).

5 CLASSIFICATION SURVEYS

5.1 Initial and/or periodical surveys to assign and/or confirm the class of the CNG carriers are carried out in compliance with the requirements of Section 8, Part III "Additional Surveys of Ships Depending on Their Purpose and Hull Material" of the Rules for the Classification Surveys of Ships in Service.

5.2 Survey of a ship to issue the Certificate is carried out during the initial or periodical survey of the ship.

5.3 Ship's annual surveys are carried out within 3 months before or after every anniversary date since the day of issue of the Certificate, and are intended to ascertain that the equipment, fittings, arrangements and materials of the ship meet the relevant requirements of the CNG Rules.

An appropriate entry on the surveys carried out is made in the Certificate.

6 PLAN APPROVAL DOCUMENTATION

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

.1 arrangement plans of cargo tanks with their distance from side plating and the bottom specified;

.2 drawings and strength calculations of cargo tanks with information on the scope of non-destructive testing of welds, strength and leakage tests;

.3 arrangement plans of cargo piping intended for connection to shore or offshore facilities, including arrangements for unloading, loading and emergency disconnection, if provided;

.4 specification of design loads and structural analysis of cargo tanks;

.5 calculations of the minimum and maximum design temperatures of materials in a cargo tank, supports and foundations in a cargo hold during loading/unloading/decompression;

.6 calculation of cooling effect of gas release due to leaks or pipe fracture;

.7 program and procedure for testing full-scale prototype of a cargo tank for fatigue and fracture due to internal pressure;

.8 drawings and stress analysis in cargo piping in compliance with the requirements of Part VI "Systems and Piping" of the LG Rules, including loads due to vibration and fatigue analysis;

.9 calculation to determine the crack propagation characteristics for cargo tank piping, using the "leakage – fracture" principle;

.10 detailed drawings of all sections of cargo tank piping under pressure;

.11 documentation and calculations for holds and cargo tanks, using results of model tests, analysis methods to determine stress levels, fatigue life and crack propagation characteristics;

.12 calculations of stresses and analysis of fatigue stresses in cargo tank cylinders in compliance with the requirements of 3.6, Part I "Subsea Pipelines" of the Rules for the Classification and Construction of Subsea Pipelines for class **G3** pipeline;

.13 calculations of fatigue crack propagation for cargo tank cylinders in compliance with the requirements of 3.5, Part I "Subsea Pipelines" of the Rules for the Classification and Construction of Subsea Pipelines;

.14 drawings of foundations of the cargo tank cylinders with calculations made in compliance with the requirements of Section 8, Part IV "Cargo Containment" of the LG Rules;

.15 degassing arrangements and procedures;

.16 forced ventilation arrangement in a cargo area;

.17 description of tests by elevated pressure.

PART II. GAS CARRIER DESIGN

1 GENERAL

1.1 The CNG carrier design is to comply with the requirements of Part II "Ship Arrangement" of the LG Rules, as for the ships carrying liquefied gases in bulk[1] of **Type 2G**.

1.2 The CNG carrier is to be double-skin sided and double-bottomed. For the CNG carrier, the depth of the double bottom is to be not less than 1/15 of the ship breadth or 2 m, whichever is less. The width of the double skin of the CNG carrier is to be 760 mm minimum. The minimum distance from the cargo hold to the shell plating is to be not less than 760 mm. If the width of the double skin and the depth of the double bottom are different, the structure in the transition area is to be as shown in Fig. 2.6-1 of Part II "Ship Arrangement" of the LG Rules.

1.3 The structure equivalent to the inner bottom may be used, provided that a calculation or test proves that the proposed structure protects the cargo tanks against damage and is capable of absorbing energy as the standard double-bottomed structure.

[1]Hereinafter referred to as "the LG carriers".

PART III. STABILITY. SUBDIVISION. FREEBOARD

1 GENERAL

1.1 Stability of the CNG carrier is to meet the requirements of Part IV "Stability" of the Rules for the Classification covering dry cargo ships and is to be verified for voyage in ballast and in full-load condition.

1.2 The CNG carrier is to meet the requirements of Part V "Subdivision" of the Rules for the Classification as for LG carriers of **Type 2G**. The cargo hold spaces are to be isolated from machinery, accommodation and other similar spaces by cofferdams.

1.3 The damage stability of the CNG carrier is to meet the requirements of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) as for LG carriers of **Type 2G**.

1.4 The freeboard of the CNG carrier is assigned in compliance with the requirements of the Load Line Rules for Sea-Going Ships.

PART IV. CARGO TANKS

1 GENERAL

1.1 The cargo tanks are to be designed using model tests, proven analytical procedures and analysis methods to determine stress levels, fatigue life and crack propagation characteristics. For composite materials, changes in the material properties with time due to exposure to long-term static loads under various environmental conditions are to be reviewed and taken into account.

1.2 The cargo tanks together with foundations and supports are to be designed with regard to all loads specified in Section 11, Part IV "Cargo Containment" of the LG Rules for LG carriers. Design load due to internal pressure is to be determined as a sum of the design internal pressure in the cargo tank and pressure of the cargo column with regard to the cargo density and accelerations arising in service (refer to 28.2, Part IV "Cargo Containment" of the LG Rules).

1.3 The dynamic loads acting during the ship motion are to be assumed as the most probable maximum loads occurring during the ship's life. The frequency of load application is to be especially considered for composite materials as these materials have frequency-dependent properties.

1.4 Dynamic effect due to pressure variations during cargo handling operations is to be presented with regard to the most probable extreme operating conditions of the ship. The number of the pressure fluctuation cycles from the maximum to the minimum is to be consistent with the ship's service life of not less than 50 years.

1.5 The calculations are to consider the transient thermal loads arising during loading and unloading of the ship.

1.6 The effect of all static and dynamic loads is to be considered in strength analysis of the structures with account of the following:

maximum allowable stresses due to internal pressure;

buckling;

failure due to combined action of alternating cyclic and static loads;

possible crack propagation characteristics.

1.7 Tests of the cargo tank prototype are to show effectiveness of the proposed structure as it relates to separation and draining of liquid from the cargo system. During tests the possibility of a hydraulic shock in piping during any cargo handling operation is to be checked, and structural measures are to be taken to exclude such possibility. If the full-scale tests corresponding to operating conditions are impractical, computer simulation or model non-full-scale tests may be performed. Acceptance tests are to be carried out by the surveyor and are to be considered only when all the systems, equipment and devices are fully functioning.

2 COILED CARGO TANKS

2.1 The requirements for cylindrical cargo tanks are to be applicable to the coiled cargo tanks, as far as practicable.

3 CYLINDRICAL CARGO TANKS

3.1 Cargo tank cylinders.

3.1.1 Stresses in the cargo tank cylinders are to comply with the requirements for class **G3** pipelines specified in the Rules for the Classification and Construction of Subsea Pipelines. As a rule, the spherical ends are to be used. The stresses in the spherical ends are to comply with the requirements of the LG Rules

for **Type C** independent tanks of LG carriers. Pressure used in the calculation of the wall thickness is the design pressure as indicated in 1.2, Part I "Classification". The maximum working pressure is to be at least by 5 % less than the design pressure. The spherical ends are to have a cylindrical part, which width to the circumferential weld on the cylindrical part of the cargo tank is to be not less than $1{,}0\sqrt{Rt}$ where R = radius of the spherical end; t = wall thickness of the spherical end.

For elliptical and torospherical ends the additional requirements may be applied on agreement with the Register.

3.1.2 Cylinders and other components of cargo tanks are to be subjected to fatigue analysis to predict the state of the structural material in service. During design the fatigue curve is to be determined by the model tests of the cargo tank components. The critical level of a sum of cumulative fatigue damages (both due to dynamic loads and due to loads caused by the cargo handling operations) is to be not more than 0,1 (i.e. the minimal life time obtained by means of the fatigue curve is to be not less than 200 years with the designed service life of the ship being 20 years).

3.1.3 In addition to the fatigue calculations given in 3.1.2, it will be necessary to make calculations of the propagation time of fatigue cracks, which can develop in the welds. The analysis is to be made for planar defects both in the longitudinal and circumferential welds. The estimated time of crack growth through the cylinder shell is to be by three times longer than the design service life of the cylinder but not less than 60 years. These calculations are to account for the actual stress concentration factor at the weld root. The initial defect initiating the crack is to be dimensioned in compliance with the maximum value of the defect permissible in the process of flaw detection of the welds. The adopted crack growth characteristic is to be recorded both for the cylinder material and for the welds.

3.1.4 If the requirement concerning the time of fatigue crack propagation stated in 3.1.3 cannot be fulfilled for a given cylinder shell thickness, it is necessary to demonstrate that the "leakage – fracture" principle is applicable, i.e. to prove that any defect mentioned in 3.1.3 in its development will become through and detected before the crack becomes instable with the cylinder complete loss followed. In this case, the value of fracture toughness (critical value of the stress intensity factor K_{IC}) is to be experimentally determined for the cylinder material within the heat affected zone and welding at the operating temperatures.

3.1.5 Cargo tanks cylinders are to be supported by the hull in a manner, which will prevent bodily movement of the cylinders under static and dynamic loads while allowing contraction and expansion of the cylinders under temperature variations without additional stressing of the cargo tanks and hull structures. The following forces are to be taken into account:

the most probable maximum resulting acceleration in compliance with the requirements of 28.2, Part IV "Cargo Containment" of the LG Rules for LG carriers;

static loads at heel up to 30 degrees;

collision loads.

3.1.6 Where empty cargo tanks have positive buoyancy and are situated below the summer waterline, provision is to be made for antiflotation arrangements during flooding. The antiflotation arrangements are to be designed to withstand an upward force without plastic deformations likely to endanger the hull structures.

3.1.7 Supports and foundations within the cargo area are to be protected against direct effect of the cold impact when directly exposed to gas leakages.

The local equivalent stresses in the cargo tank cylinders with regard to the loads in supports are to be not more than 0,8 yield stress of the material. The mentioned loads are to be taken into account in fatigue analysis as mentioned in 3.1.2.

4 CARGO TANK PIPING

4.1 The strength of the cargo tank piping is to meet the requirements for cargo piping for LG carriers set out in Part VI "Systems and Piping" of the LG Rules. Stress analyses shall consider all the applicable loads, including vibration. All design requirements and principles set out in Section 2, Part VI "Systems and Piping" of the LG Rules are applicable to the cargo tank piping of CNG carriers.

4.2 The cargo tank piping is to be subjected to the fatigue analysis. The fatigue curve is to be applied to material, structural members and stress state during investigations. Model tests of the piping components may be required to make the fatigue curve. The curve is to be based on average values of logarithmic fatigue curve, excluding two standard deviations. The critical level of a sum of cumulative fatigue damages (both due to dynamic loads and due to the loads caused by the cargo handling operations) is to be not more than 0,1.

4.3 Calculations of the fatigue crack propagation time are to be made for the cargo tank piping similarly to Section 3. If seamless pipes or equivalent are used, the analysis is to be carried out only for defects in circumferential welds. Moreover, it is necessary to demonstrate that the "leakage – fracture" principle is followed in the same manner as stated in Section 4, i.e. it is necessary to prove that any defect mentioned in Section 3 in its development will become through and will be detected before the crack becomes instable with the complete piping loss followed. The criteria set out in Section 3 are to be used as criteria for the possibility of using a material or a structure.

4.4 The cargo tank pipes are to be properly secured with the attachments, which, in the event of complete failure of the upper pipe, would prevent other pipes from being damaged as a result of impact due to falling of the fractured pipe. At the same time, a sufficient flexibility of piping is to be provided to allow vertical expansion of the cylinders and horizontal displacement of the cylinder heads due to accelerations and vibrations without any significant additional stresses in cargo pipes which may cause strength or fatigue-related damages. The cargo tank piping upstream of the master cargo valve is to be completely welded.

4.5 All fittings of the cargo tank piping shall be made of forgings.

5 PRESSURE TESTING

5.1 Hydraulic pressure tests of the finished cargo tank are to be carried out in compliance with the requirements of the Rules for the Classification and Construction of Subsea Pipelines and the LG Rules, as far as applicable. Test pressure equal to 1,25 design pressure is considered to be sufficient.

6 PROTOTYPE TESTING

6.1 The full-scale cargo tank cylinder prototype (full-scale as regards diameter, shell thickness, number of transverse welds, including welded ends but not of full length) is to be subjected to fatigue and fracture tests. The tests are to confirm that the thickness of the vessel cylindrical part and ends, as well as the welds have adequate resistance to fatigue effect and the cylinder has adequate safety margin after the doubled expected number of loading cycles. Not less than 3 tests are to be carried out.

One specimen is to be tested to fracture after being tested by doubled expected (design) number of stress cycles. Two specimens are to be subjected to fatigue test with the number of stress cycles exceeding the expected number of cycles in service by at least 15 times.

PART V. FIRE PROTECTION

1 GENERAL

1.1 The CNG carrier is to meet the applicable requirements set out in Part VI "Fire Protection" of the Rules for the Classification and in Part V "Fire Protection" of the LG Rules applied to LG carriers and the additional requirements contained in this Part.

2 STRUCTURAL FIRE PROTECTION

2.1 The external boundary of deckhouses and superstructures, including any overhangs, is to be made as "A-60" class division as applied to the surfaces facing the cargo area, space of the wing fuel tanks and spaces containing cargo handling equipment and at a distance of 3 m from any specified boundary line.

2.2 Where the cargo handling equipment or any other potential source of high pressure gas is situated nearby the accommodation spaces, the additional fire protection measures are to be taken. Such measures may be application of "H-60" class fire-protection divisions (refer to definition given in 1.2.2 Part VI "Fire Protection" of the Rules for the Classification, Construction and Equipment of Mobile Offshore Drilling Units and Fixed Offshore Platforms[1]) of the external boundaries mentioned in Section 2 or a special enclosure to prevent the accommodation spaces from being hit by a gas jet.

2.3 In order to protect against fire progress covers of cargo holds facing the cargo handling spaces are to be made as divisions having fire integrity not lower than "H-0" class. The cargo hold covers facing the engine room or after signal mast are to be made as divisions having fire integrity not lower than "A-0" class. Along with that, the cargo hold covers are to:

maintain integrity under exposure to fire equivalent to exposure during the tests of "A" class divisions with external thermal radiation;

the surface flame propagation characteristic of the material, from which they are manufactured is to meet the requirements of IMO Resolution A.653(16) (relating to weather decks).

2.4 The cargo hold situated below the upper deck is to be protected from overlaying spaces or spaces containing cargo handling equipment by "A-0" class division. Where the cargo tanks are made of a material not equivalent to steel, the cargo hold covers are to be made as "A-60" class divisions. Moreover, in this case, the surfaces of the cargo hold covers facing the spaces containing cargo handling equipment or equipment that contains compressed hydrocarbons are to be made as "H-60" class fire-protection divisions.

2.5 Accommodation, service and machinery spaces situated below the upper deck are to be isolated from the spaces containing the cargo handling equipment and from the cargo areas by cofferdams. The minimum distance between the bulkheads in such cofferdam is to be 600 mm.

2.6 The cargo hold covers and other essential spaces or equipment, which can be heated due to ignition of gas leaking from the tanks/piping are to be protected within the time necessary to reduce pressure in the cargo tanks.

2.7 The bulkheads and decks, which are supposed to be the "H" class divisions, are to meet the requirements set out in 1.2.2, Part VI "Fire Protection" of the MODU/FOP Rules.

[1]Hereinafter referred to as "the MODU/FOP Rules".

3 ESCAPE ROUTES

3.1 Provision is to be made for escape routes from the engine room or service spaces to the accommodation spaces by means of a trunk, which, in general, has no surfaces, which can be exposed to thermal radiation.

3.2 The transverse fire-fighting divisions mentioned in Section 2 are to protect lifeboats against heating due to thermal radiation.

4 FIREMAN'S OUTFIT

4.1 4 sets of the fireman's outfit stored at 2 separate stations in accommodation spaces are to be provided. Where the cargo area separates the accommodation spaces from the engine room or service spaces, 2 additional sets of the fireman's outfit are to be stored in the engine room or service spaces.

5 WATER FIRE MAIN SYSTEM

5.1 In addition to the main requirements for fire pumps, hydrants and fire hoses set by Regulation II-2/10.2 of SOLAS and 3.2, Part VI "Fire Protection" of the Rules for the Classification, the requirements of the present Chapter are to be met.

5.2 The system is to be so arranged as to ensure delivery of at least two water jets from different hydrants, one of the jets being delivered through a single hose to any area of deck and external surface of cargo hold covers. The minimum pressure in the hydrants with two connected hoses is to be not less than 5 kg/cm^2. The length of the fire hose is to be not more than 33 m.

5.3 The fire main is to be designed in one of the following ways:

circled starboard and port main;

single line along the centerline through the cargo area, forming the fire main, which is to be protected against possible effect of flame jets from the cargo piping.

5.4 Two main fire pumps are to be installed, each having the capacity not less than specified in 3.2, Part VI "Fire Protection" of the Rules for the Classification. One of the pumps is to be located forward of the cargo area and the other — aft of the cargo area. Both pumps are to be remotely controlled from the bridge and from the engine room.

5.5 Both main fire pumps are to be ready for starting and delivery of water at any time of operation when the ship is not degassed.

5.6 Remotely controlled cut-off valves are to be fitted on the weather deck on each end of the fire main leading to the cargo or working area. Additionally the cut-off valves are to be fitted on the protected side of fire-fighting divisions or at the protected area boundary. Manually controlled shut-off valves are to be fitted between the cargo holds at the intervals not more than 40 m.

5.7 All pipes, valves, fire nozzles and other fittings of the fire-fighting system are to be resistant to corrosion in sea water and to fire.

5.8 The mooring equipment installed within the gas-dangerous area is to be protected by a sprinkler system with a capacity not less than 5 l/min per m^2. The sprinkler system is to be set in operation before the use of any mooring arrangement and prior to cargo handling operations. Where in this case the mooring equipment only on one ship’s side is used, the sprinkler system capacity may be designed taking into consideration operation of the mooring equipment on one ship’s side. The sprinkler system may be fed from the water fire main.

5.9 The loading/unloading area on the weather deck is to be covered by the water monitors, which are to be remotely controlled from a safe position.

6 DRY CHEMICAL POWDER FIRE EXTINGUISHING SYSTEM

6.1 A ship is to be provided with a dry chemical powder fire extinguishing system meeting the requirements of 3.10, Part VI "Fire Protection" of the Rules for the Classification.

6.2 In addition to the requirements mentioned in 6.1, the system is to be capable of delivering simultaneously water and dry powder in the form of two-component mixture from at least two widely spaced connections to the cargo area, working area and any other area of greater fire risk located on the upper deck. Hoses are to be of 25 to 30 m long.

6.3 The system may be fed from the water fire main, provided that when determining the capacity of the main fire pumps, the delivery of two-component powder will be additionally taken into account.

6.4 The dry powder is to be stored in two units each being capable of delivering 3,5 kg of powder per second within not less than 60 s for one fire nozzle.

7 WATER SPRAY SYSTEM

7.1 Water spray system may not be considered as the means for fulfilling requirements for the minimum fire integrity of the structures mentioned in Section 2.

7.2 The water spray system is to protect:

working area;

superstructure;

unprotected cargo tanks and piping under pressure located on the upper deck;

emergency cut-off valves;

other essential equipment to monitor and control pressure in cargo tanks during fire;

part of accommodation spaces facing the cargo area;

external bulkhead of the cargo hold covers facing the machinery space and flare mast.

7.3 The system is to be capable of covering all the areas mentioned in 7.2 through uniform distribution of water sprayed at a rate of at least 10 l/min per m^2 for horizontal surfaces and 4 l/min per m^2 for vertical surfaces.

7.4 Outlets of the pressure relief system, of the additional pressure relief systems of flare type or using cold gas discharge or gas discharge from pressure relief valves are to discharge gas into spaces so that the gas and thermal radiation due to its burning could not present threat to the ship, personnel or equipment. Thermal radiation from the flare directed onto the cargo tanks or other essential equipment is to be calculated in order to verify that the thermal radiation does not cause temperature rise in the cargo tanks and breakdown of the equipment. The flare is to satisfy the requirements of the recognized international or national standard, for example, API RP521 or equivalent.

7.5 The water spray system main is to be arranged in the following way:

starboard and port circled main; or

single line along the centerline passing through the cargo area and forming the fire main, which is to be protected against possible effect of flame jets from the cargo piping.

7.6 Both water spray pumps are to be able to be immediately started and to deliver water.

7.7 Provision is to be made for two water spray pumps, each of a capacity not less than 100 % of the capacity required by the water spray system. One pump is to be installed forward of the cargo area and the other pump — aft of the cargo area. Both pumps are to be remotely controlled from the bridge as well as from the engine room.

7.8 The capacity of each water spray pump is to be determined proceeding from the necessity of delivering water simultaneously to all the areas mentioned in 7.2 and 7.3.

7.9 Remotely controlled cut-off valves are to be fitted on the weather deck at each end of the fire main leading to a cargo or working area. Besides, the cut-off valves are to be fitted on the protected side of the fire-fighting divisions or at the protected area boundary. Manually controlled shut-off valves are to be fitted between the cargo holds at the intervals not more than 40 m.

PART VI. SYSTEMS AND PIPING

1 PIPING SYSTEMS IN CARGO AREA

1.1 The requirements of the LG Rules, covering LG carriers, are also applicable to the bilge, ballast and fuel oil systems in the cargo area, which do not form part of the cargo system. Systems serving several cargo holds are to be so arranged that gas from one cargo space cannot permeate into another cargo space.

2 CARGO SYSTEM

2.1 Cargo piping is to comply with the requirements of the LG Rules applied to the cargo piping of LG carriers and the requirements of Part VIII "Systems and Piping" of the Rules for the Classification applied to the ship's piping, and in addition, with the following requirements.

2.2 During design of the piping, the minimum temperature expected in service (loading/unloading) and in the event of emergency (pressure relief) is to be considered as design temperature.

2.3 The maximum pressure, to which the system is likely to be subjected in service, i.e. setting pressure of the pressure relief valves is to be considered as design pressure.

2.4 Pipes are to be seamless or equivalent.

2.5 After fabrication but prior to installation on board the ship, each pipe is to be subjected to hydraulic test by a pressure not less than 1,5 design pressure.

2.6 After final installation on board the ship, the cargo piping is to be subjected to the leakage test using air, halogens or other suitable fluid in accordance with the approved technical documentation.

2.7 The vibration effect on the cargo piping is to be evaluated.

2.8 Stress analysis in each piping section is to be made according to the method approved by the Register.

2.9 Cargo handling operations, including emergency procedures, are to be described in a special instruction to be submitted to the Register for review. This instruction is to contain the potential faults associated with the cargo handling operations and information associated with the emergency disconnection, emergency closing and establishment of communication with the terminal (offshore or shore-based), etc.

2.10 Hull structures and foundations are to be protected against cargo leakages from the flanges, valves and other possible leakages in those cases when the cooling effect is not to be neglected.

2.11 Where cargo piping is arranged in an enclosed space, this space is to be protected from overpressure due to cargo leakages or explosion.

3 CARGO VALVES

3.1 All the remotely controlled valves are to be manually driven.

3.2 Each cargo tank is to be separated from the cargo piping by two shut-off valves (manually controlled and remotely controlled) connected in series. Means for leakage testing of the valves are to be provided.

3.3 Each cargo hose connection on the cargo manifolds is to be fitted with two shut-off valves (manually controlled and remotely controlled) connected in series.

3.4 All the shut-off valves required in 3.2 and 3.3 are to be controlled from the stations arranged at least in two distant locations onboard the ship; one of these locations is to be the cargo control room.

The control system is to be also provided with fusible elements designed to melt temperature from 98 °C to 104 °C which will cause the emergency shut-off valves to close automatically in the event of fire. Locations for such fusible elements are to include loading stations.

Shut-off valves in cargo piping are to fully close under all service conditions with 30 s of actuation.

Valves connected with the high pressure level alarm in cargo tanks and the sensor for automatic closure thereof, in compliance with Part VIII "Instrumentation and Automation Systems" of the LG Rules, are to comply with the requirements to prevent excessive pressure in the cargo main and prevent the cargo tank from becoming liquid full.

3.5 Cargo compressors are to be arranged to shutdown automatically in case of the emergency shutdown system actuation.

4 PROTECTION OF CARGO TANKS AND CARGO PIPING AGAINST EXCESSIVE PRESSURE

4.1 The system for protection against excessive pressure in cargo tanks is to consist of the pressure relief system and the additional pressure relief system and meet the requirements in 3.3 and 3.4, Part VI "Systems and Piping" of the LG Rules. At that the capacity of pressure relief valves shall be determined on the basis of national or international standard agreed with the Register.

4.2 In order to prevent cargo piping from excessive pressure, pressure relief valves are to be provided. The pressure relief valves are to be so adjusted that the setting pressure does not exceed the design pressure of a cargo piping, considering allowance for the valve actuation.

5 GAS DISCHARGE FROM CARGO SYSTEM

5.1 Facilities for gas discharge are to be provided for all parts of the cargo system. Detailed gas discharge procedure is to be described in the Operating Instruction for the Cargo System and is to be submitted to the Register for review.

6 FILLING LIMITS FOR CARGO TANKS

6.1 Pressure in the cargo tanks after the loading is to be limited in such a manner as not to exceed 95 % of the design pressure throughout transportation and unloading with regard to the following:

for uncooled system — ambient temperature conditions (sea water temperature 32 °C and air temperature 45 °C);

for cooled system — cooling system capacity under ambient temperature conditions mentioned above.

7 INERTING OF CARGO SPACES

7.1 Cargo spaces are to be inerted by nitrogen or by other suitable inert gas. The nitrogen producing system is to preclude backflow in the event of excessive pressure in a cargo space. The system is to be designed with a redundancy level providing maintenance of the necessary safety level on board the ship in service.

8 PROTECTION OF CARGO SPACES AGAINST EXCESSIVE PRESSURE

8.1 Cargo spaces are to be equipped with a pressure relief system covered by the following requirements.

8.1.1 Means are to be provided to automatically maintain the pressure of inert medium in cargo spaces by 0,05 — 0,15 kg/cm^2 above the atmospheric pressure.

8.1.2 Safety devices are to be provided with the setting pressure by 0,25 kg/cm^2 above the atmospheric pressure. The mentioned safety devices are to have a capacity sufficient for gas discharge in case of the complete rupture of the greatest pipe of the cylindrical cargo tank or complete rupture of a single pipe of the coiled cargo tank. This requirement is applicable to the largest cargo tank located in the protected cargo hold.

8.1.3 Gas is to be vented from the safety devices to a safe area.

8.1.4 In addition to the safety devices required in 8.1.2, provision is to be made for special covers (diaphragms) breaking under excessive pressure 0,4 kg/cm^2.

8.1.5 During tests it is necessary to demonstrate that the safety devices and surrounding structures are capable of functioning at low temperatures due to pressure relief with the maximum capacity.

9 DRAINAGE

9.1 Cargo spaces are to be fitted with the drainage system not connected with machinery spaces. Moreover, water level detectors in the cargo holds are to be provided.

10 EXHAUST GAS SYSTEM

10.1 Outlets of the exhaust gas system of the internal combustion engines and boilers are to be provided with spark arresters.

11 TESTING

11.1 Testing of the systems and piping is to meet the requirements of Section 12, Part VI "Systems and Piping" of the LG Rules.

PART VII. ELECTRICAL EQUIPMENT

1 GENERAL

1.1 The electrical equipment is to meet the requirements of Part VII "Electrical Equipment" of the LG Rules.

2 CLASSIFICATION OF DANGEROUS ZONES

2.1 The sizes of gas-dangerous spaces and zones are to comply with the requirements set in Part VII "Electrical Equipment" of the LG Rules.

2.2 If the additional pressure relief system makes use of the cold gas discharge, a gas dissipation analysis is to be made in order to determine gas dangerous spaces. The analysis is to be made in compliance with the recognized standard or design module, and the boundaries of a dangerous zone are to be based on 50 % of the lower limit of the explosive range.

PART VIII. INSTRUMENTATION

1 GENERAL

1.1 The ship is to meet the requirements of Part VIII "Instrumentation" and Automation Systems of the LG Rules applied to LG carriers, and the additional requirements set in the present Section.

1.2 Alarm signals are to be heard on the bridge and in the cargo control room.

1.3 Devices are to be provided to detect moisture and hydrogen sulphide (H_2S) in a loading/unloading piping or in a shore connection.

1.4 As a minimum, the following compartments and spaces are to be provided with the gas analyzers:

each cargo tank area;

deck piping area;

ventilation inlets to gas safe spaces;

air intakes of the engine room;

cargo manifold area.

1.5 As a minimum, the following compartments and spaces are to be provided with the pressure gauges and alarms:

each cargo hold;

each cargo tank;

cargo piping in way of the manifold.

1.6 Temperature sensors and oxygen content detectors are to be provided in each cargo hold.

1.7 Provision is to be made for the means to measure temperature inside the cargo tanks.

1.8 Temperature in cargo tanks is to be monitored in way of the exhaust piping when the pressure is reduced (i.e. during unloading, pressure relief). This monitoring is required to prevent the temperature drop below the design value.

PART IX. MATERIALS AND WELDING

1 GENERAL. DESIGN CONDITIONS FOR SELECTING MATERIAL

1.1 All materials used in cargo tanks and cargo systems are to be delivered with a Register Certificate.

1.2 The maximum design temperature for selecting materials is to be the highest temperature observed in cargo tanks during loading, unloading and transportation. The minimum design temperature for selecting materials is to be the lowest temperature observed in cargo tanks, piping, supports and internal hull structures of the cargo holds:

during loading, unloading and transportation;

due to cooling effect at cargo leakage.

The determined minimum design temperature in the cargo holds during cargo leakage is to be supported by calculation. In so doing, the following cases are to be considered:

complete rupture of a pipe in a cargo tank (for cylindrical cargo tank);

complete rupture of a single pipe in a cargo tank (for coiled cargo tank).

In such calculations, the temperatures of sea water and outside air are to be assumed to be equal to 5 °C and 0 °C, respectively.

Partial closing is to prevent the hull structures from direct cooling effect due to cargo leakages.

2 MATERIALS FOR HULL STRUCTURES

2.1 The materials for hull structures are to comply with the requirements of Part XIII "Materials" of the Rules for the Classification.

3 MATERIALS FOR CYLINDRICAL CARGO TANKS

3.1 The materials for cylindrical cargo tanks (including pipes and ends) are to comply with the requirements of Section 4, Part I "Subsea Pipelines" of the Rules for the Classification and Construction of Subsea Pipelines. The corrosion protection is to be specially agreed with the Register.

4 MATERIALS FOR COILED CARGO TANKS

4.1 The materials for coiled cargo tanks are to comply with the requirements of Section 4, Part I "Subsea Pipelines" of the Rules for the Classification and Construction of Subsea Pipelines or any other standard agreed with the Register.

5 MATERIALS FOR CARGO SYSTEMS AND PIPING

5.1 The materials for cargo systems (piping, cargo tank piping, all valves and fittings) are to comply with the requirements of Part IX "Materials and Welding" of the LG Rules.

The determined minimum design temperature in cargo holds during cargo leakage is to be supported by calculation. In so doing, the following cases are to be considered:

complete rupture of a pipe in a cylindrical cargo tank;

complete rupture of a single pipe in a coiled cargo tank.

In such calculations, the temperatures of sea water and outside air are to be assumed to be equal to 5 °C and 0 °C, respectively.

Partial closing is to prevent the hull structures from direct cooling effect due to cargo leakages.

6 COMPOSITE MATERIALS

6.1 The application of composite materials for cargo tanks and other essential components shall be agreed with the Register. Subject to agreement are the following:

raw materials used;

production technology of products from composite materials;

list of physical and mechanical tests of material samples.

7 WELDING REQUIREMENTS

7.1 Welding is to comply with the requirements of Part IX "Materials and Welding" of the LG Rules applied to LG carriers and with the additional requirements set in the present Section.

7.2 Prior to welding of cargo tanks, material specimens are to be subjected to weldability test together with the test of mechanical properties. In order to detect local metal embrittlement zones in the near-weld area, a metallographic examination is to be carried out.

7.3 When testing the specimens, the maximum and minimum current, which provides acceptable properties of material in the near-weld area with regard to preheating, working (welding) temperature and postweld heat treatment (where necessary) both for manufacture and installation of cargo tanks is to be determined.

7.4 Testing program for cargo tank cylinders is to comply with the requirements for testing subsea pipelines. The necessary documentation may be agreed upon results of weldability tests.

7.5 Tests of the specimen mechanical properties at the minimum temperature are to be carried out both for the base metal in the heat affected zone and for the weld metal after postweld heat treatment.

Welding tests are to be conducted in compliance with the requirements of the Rules for the Classification and Construction of Subsea Pipelines.

7.6 All welds of the cargo tanks are to be subjected to heat treatment or stress relief using equivalent procedure agreed with the Register.

7.7 100 % of welds in the cargo tank cylinders and piping are subject to non-destructive examination according to the approved scheme. In so doing, the maximum size of non-recorded crack-like defect is to be specified for the calculation required in 13.3, Part IV "Cargo Containment" of the LG Rules.

APPENDIX 1

CARGO SPECIFICATION

1. Natural gas intended for loading on CNG carrier is to be delivered to the ship in properly prepared condition.

2. The dew point of water vapours contained in natural gas is to be such that their condensation during cargo handling operations could not result in formation of hydrates or corrosion due to free water in the system.

3. Chemical treatment of natural gas (removal of H_2S and other impurities) is to be carried out on the shore to obtain safe (from the corrosion standpoint) concentrations of the impurities with regard to protection of the ship's cargo tanks and piping against corrosion.

4. Information on safe carriage of natural gas with full description of its physical and chemical properties and emergency measures is to be kept on board the ship.

APPENDIX 2

GENERAL SAFETY REQUIREMENTS

1. Safety levels with regard to the human life, safety of cargo, ship and environment for CNG carriers are to be not lower than those for the corresponding LG carrier.

2. For safety assessment it is necessary to use the quantitative risk assessment concept (IMO Report 72/16), as well as the following documents of the Register:

applicable requirements of Part XV "MODU and FOP Safety Assessment" of the MODU/FOP Rules;

applicable requirements of Appendices 1 and 2 of the Rules for the Classification and Construction of Subsea Pipelines.

Российский морской регистр судоходства

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Rules for the Classification and Construction of Ships Carrying Compressed Natural Gas

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