PART VIII. SYSTEMS AND PIPING

1. GENERAL

1.1 APPLICATION

1.1.1 The requirements of this Part of the Rules apply to the following pumping and piping arrangements used in ships:

.1 bilge and drain;

.2 ballast, heel and trim;

.3 special systems of tankers and combination carriers;

.4 liquefied gas;

.5 toxic media;

.6 steam and blow-down pipelines;

.7 feed water and condensate;

.8 fuel oil;

.9 lubricating oil;

.10 water cooling;

.11 compressed air;

.12 air, venting, overflow and sounding pipes;

.13 exhaust gas;

.14 ventilation;

.15 open-ended steam pipes from safety valves;

.16 cleaning and washing of tanks;

.17 hydraulic drives;

.**18** containing organic coolants.

Special requirements for systems other than stated above are set out in the relevant parts of the Rules.

Pumping and piping of berth-connected ships shall comply with the requirements of this Part in so much as applicable and sufficient unless expressly provided otherwise below.

1.1.2 The fuel oil used in ships shall comply with the requirements of 1.1.2, Part VII "Machinery Installations".

On gas carriers for gas turbine engines, boilers and dual-fuel internal combustion engines the use of the natural gas (methane) carried as fuel is allowed in accordance with 1.1.2, Part VII "Machinery Installations".

1.1.3 Machinery and other elements of the systems indicated in 1.1.1 shall remain operative under environmental conditions set out in 2.3, Part VII "Machinery Installations".

1.1.4 Pumps, fans, compressors and their electric drives used in systems covered by the requirements of the present Part shall also comply with the requirements of Part IX "Machinery" and Part XI "Electrical Equipment".

Control and monitoring devices of piping systems shall comply with the requirements of Part XV "Automation".

Heat exchangers and pressure vessels used in ship systems shall comply with the requirements of Part X "Boilers, Heat Exchangers and Pressure Vessels".

1.1.5 Compliance of passenger ships marked **A**, **A-R1, A-R2**, **A-R2-RS**, **A-R2-S**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **or D-R3-RS** in their class notation, in accordance with the Directive of the European Parliament and of the Council 2009/45/EC of May 6, 2009 on safety rules and standards for passenger ships, effective from July 15, 2009 (as amended by the Commission Directive 2010/36/EU of June 1, 2010), hereinafter referred to as the Directive 2009/45/EC, shall be confirmed under

2.6.1 of the General Regulations for the Classification and Other Activity, with the application of these Rules and/or special requirements of these Rules to the ship, based on the mark in its class notation, both for new or existing (refer to 2.6.1.1.4.2 or 2.6.1.1.4.3 of the General Regulations for the Classification and Other Activity, respectively) ships specified in certain clauses, both with or without reference to the mark in the ship's class notation, namely its compliance with the requirements as follows:

— new ships marked **A**, **A-R1, A-R2**, **A-R2-RS**, **or A-R2-S** — with all relevant requirements of this Part, with regard to, where specific requirements apply to the above marks, the reference to the mark in the ship's class notation;

— existing ships marked **B-R3-S**, **or B-R3-RS**, carrying more than 36 passengers *(not later than until October 1, 2000)* — with the requirements of 12.3.6;

— existing ships marked **B-R3-S**, **or B-R3-RS**, carrying more than 36 passengers *(not later than until October 1, 2003)* — with the requirements of 7.6.12, 7.6.12.1, 7.6.12.2, 12.3.1, 12.6.1.1, 12.6.2, 12.6.3, 12.6.5, 12.6.6;

— new ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS** and **D-R3-S**, **D-R3-RS**, as well as existing ro-ro ships — with the requirements of 7.6.12.1;

— new ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS** and **D-R3-S**, **D-R3-RS**, as well as existing ships marked **B-R3-S**, **B-R3-RS** — with the requirements of 1.3.2, 2.1.1, 2.1.4, 2.5, 2.3.5, 2.3.6, 3.3.1.2, 4.1.4, 4.3.2, 5.1.2, 5.1.4, 7.1.1, 7.1.6, 7.1.7, 7.1.11, 7.2.1, 7.2.2, 7.3, 7.4.3, 7.4.11, 7.6, 10.1.1 **to** 10.1.4, 10.1.8 **to** 10.1.15, 10.1.18, 10.2, 10.2.2, 10.2.4, 10.2.8, 10.4, 10.4.2, 12.1.10, 12.2.2, 12.2.3.1, 12.2.5, 12.2.9, 12.3.2, 12.3.3, 12.3.8, 12.5.1, 12.6.1.1, 12.6.2, 12.6.3, 12.6.5, 12.6.6, 12.6.7, 13.2.2, 13.2.3, 13.2.4, 13.3.4, 13.5.2, 13.7.1, 13.7.2, and 13.7.6;

— new ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS** and **D-R3-S**, **D-R3-RS**, built before January 1, 2003, as well as existing ships marked **B-R3-S**, **B-R3-RS** — with the requirements of 12.9.1;

— new ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS** and **D-R3-S**, **D-R3-RS** — with the requirements of 1.3.2, 1.4.4, 4.1.2.1, 4.3.2.4, 4.3.2.7, 4.3.2.14, 7.6.12.1, 7.6.12.2, 7.6.12.3, 7.12.8, 10.4.1, 10.4.2, 10.4.4, 10.4.4.7, 12.2.3.1, 12.2.3.2, 12.2.4, 12.2.5, 12.2.6, 12.2.7, 12.2.8, 12.2.11, 12.3.4, 12.3.5, 12.3.6, 12.3.7, 12.6.6, 13.2.1, 13.2.2, 13.2.3, 16.3.1, 16.3.3, 16.3.6, 18.1.5, 18.2.1, and 18.3;

— ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS** and **D-R3-S**, **D-R3-RS**, built on January 1, 2003 or later — with the requirements of 2.1.1, 5.5.1, 7.6.12.2.2, 7.6.12.2.3, 12.2.12, 12.2.3.1, 13.2.1, 13.2.2, 13.2.3, 13.8.1, 13.8.3.2, 13.8.7, and 14.5.4.

1.2 DEFINITIONS AND EXPLANATIONS

In the present Part following definitions have been adopted.

Valves are stop, regulating and safety devices intended for motion control, consumption distribution and regulation and other parameters of the conveying medium by means of entire or partial opening or closing of flow section.

Pipeline fire resistance is the ability of a pipeline to retain its func-

tional properties and sufficient strength within a given period when exposed to fire.

Bottom and side valves are shut-off valves installed in the ship's shell plating or on sea chests and ice boxes, intended for closing the openings in the shell plating.

System **is** a combination of pipelines, machinery, apparatus, devices, appliances and reservoirs, intended for performance of certain functions providing ship's operation.

Pipeline is a combination of pipes, valves, fittings, pipe joints, any internal and external linings, insulation coatings, fastening elements and components for protection of pipes, intended for conveying of liquid, gaseous and compound media, as well as for transmission of pressure and sound waves.

Essential pipeline is a pipeline, which damage may result in a combustible medium spillage in the machinery spaces, flooding, toxic media leakage, failure of system ensuring the operation of main and auxiliary engines, loss of run or control.

Pipeline formed components (fittings) are bends, t-pieces, bulkhead and deck penetrations and other elements of pipelines, intended for pipelines branching, changing of conveying medium direction and ensuring of hull structures tightness.

1.3 SCOPE OF SURVEYS

1.3.1 General provisions relating to classification procedure, surveys during construction and in service, as well as requirements for technical documentation submitted to the Register for consideration and approval, are set forth in General Regulations for the Classification and Other Activity and in Part I "Classification" of the Rules for the Classification and Construction of Sea-Going Ships[1].

1.3.2 Proceeding from the test categories, types of joints, heat treatment, welding procedures, and characteristics of the conveyed medium, pipes are subdivided into three classes as indicated in Fig. 1.3.2 and Table 1.3.2.

Test categories, types of joints, welding procedure and heat treatment are determined proceeding from the pipe class.

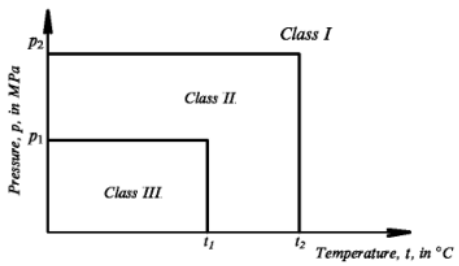


Fig. 1.3.2

1.3.3 Class I and Class II pipes, pipelines valves, side and bottom valves, remote-controlled valves, venting valves, air pipe covers, flexible joints (including expansion joints), as well as the valves on the forepeak bulkhead, are subject to survey by the Register during manufacture.

1.4 PROTECTION AND INSULATION OF PIPING

1.4.1 Constructional measures on corrosion protection

1.4.1.1 In order to reduce the corrosion and erosion wear of ship sea water pipelines during their design and installation, the following shall be taken into account:

[1] Hereinafter — Part I "Classification".

.1 the number of detachable joints shall be kept to a minimum. Detachable joints shall be located in places accessible for inspection, maintenance and repair;

.2 the number of shut-off devices on pipelines shall be kept to a minimum provided the system is functioning properly. Valves shall be located in places accessible for inspection, maintenance and repair;

.3 pipelines shall have the minimum number of bends. The radii of pipe bends shall be at least 2.5 times of their external diameter.

Where the use of bends with less radii is required, the special fittings shall be applied;

Table 1.3.2

Pipeline media	Class I ($p > p_2$ or $t > t_2$)	Class II	Class III ($p < p_1$ or $t < t_1$)
Toxic or corrosive media	No special precautions	With special precautions[1, 2]	–
Flammable media heated up to a temperature above the flash point or with a temperature below 60 °C[3], liquefied gases	No special precautions	With special precautions[1]	–
Vapour[4]	$p > 1.6$ or $t > 300$	Any pressure/temperature combination, except for the values specified for Class I and III	$p \le 0.7$ and $t \le 170$
Thermal liquids[4]	$p > 1.6$ or $t > 300$	Any pressure/temperature combination, except for the values specified for Class I and III	$p \le 0.7$ and $t \le 150$
Fuel oil, lube oil, hydraulic oil[4]	$p > 1.6$ or $t > 300$	Any pressure/temperature combination, except for the values specified for Class I and III	$p \le 0.7$ and $t \le 60$
Other media [4, 5, 6]	$p > 4.0$ or $t > 300$	Any pressure/temperature combination, except for the values specified for Class I and III	$p \le 1.6$ and $t \le 200$

[1] Precautions to reduce possible leakage and limit the leakage impact through proper laying of piping, use of special ducts, protective casings, screening etc., are subject to special consideration by the Register in any case.

[2] Class II shall not apply to toxic media.

[3] Cargo piping is Class III.

[4] p — design pressure, MPa; t — design temperature, °C (refer to 2.3.1).

[5] Including water, air, gases, non-flammable hydraulic liquids.

[6] Gravity pipelines (drain, overflow, exhaust gas, air and steam discharge from safety valves) are Class III, irrespective of the temperature.

.4 the use of welded bends made of segments for pipes of the nominal diameter less than 200 mm is not allowed. The number of segments for the 90° bend shall not be less than three.

The use of bent or welded fittings for manufacturing of side or kingston valve branch pipes is not permitted (refer to 4.3.2.10);

.5 the use of tee-pipes, branch pipes, nipples, welded-on pieces and other components shall not result in reduction of open flow area of the main in the places of their installation;

.6 the average flow velocity determined from the Formula (1.4.1.1.6) shall not exceed the values specified in Table 1.4.1.1.6.

Compliance with these requirements for the average flow velocity V_{avg} in the aforesaid piping sections, as well as in kingston connecting ducts, shall be confirmed by calculation using the following formula:

$$V_{avg} = 354Q/d^2, \quad (1.4.1.1.6)$$

with Q — maximum flow at the design section, m^3/h;

d — inner pipe diameter, mm.

Table 1.4.1.1.6

Pipe material	Permissible average flow velocity, in m/s
Steel including galvanized	2.5
Spheroidal graphite cast iron	2.5
Copper	0.9
Aluminium brass	2.0
Copper-nickel alloys:	
CuNi 5 Fe	2.0
CuNi 10 Fe	2.5
CuNi 30 Fe	3.5
Titanium alloys	10.0

Notes: 1. For pipelines of over 50 mm diameter with shaped elements with the rounding radii in the places of conjunctions with the main equal to 0.15 diameter of the latter and more, bent with the bending radius in excess of 2.5 external diameters and without welded turns and throttle membranes, the flow velocity may be 30 per cent higher than specified in the Table.

2. In bilge, ballast, heel and trim systems the permissible values of a flow velocity, regardless of the design and technological version of the applied piping components, may be 30 per cent higher than specified in the Table.

In fire-fighting, drenching, water screen, fire sprinkling systems the flow velocity increase is allowed up to 5 m/s.

3. In systems with titanium pipes and valves of other materials, when permissible velocities are determined, the decisive components are those made of other materials, and the permissible velocities are subject to special consideration by the Register in each case.

1.4.2 General uniform corrosion protection

Steel seawater pipes, as well as air, sounding and overflow pipes of water and ballast tanks, venting pipes of cargo tanks and air cofferdam pipes of oil tankers after bending and welding shall be protected against corrosion by the Register-approved method. Such methods include:

.1 galvanized zinc coating applied after bending and welding. The minimum thickness of zinc coating layer shall not

be less than 50 mkm. Depending on the purpose of piping, the Register may require increasing of the coating thickness;

.2 zinc-filled paint coatings not less than 120 mkm thick;

.3 effective paint protective coatings (epoxy or equivalent in water-resistance).

When selecting the coating type, consideration shall be given to its resistance to the medium conveyed by the system in accordance with the operating conditions of the pipeline.

Aluminium coatings of pipelines are allowed in ballast tanks, in cargo inerted tanks, as well as in hazardous areas on the open deck provided they are protected against accidental impacts. Application of zinc or another metal coating does not relieve of the need for protection of pipelines against contact corrosion.

1.4.3 Protection against contact corrosion

1.4.3.1 One of the following methods to protect against contact corrosion shall be used when pipes made of different metals are joined in sea water systems: application of protective coating on internal pipelines surfaces, electrical insulation, cathodic protection, use of "sacrificial" branch pipes (refer to 1.4.3.5).

1.4.3.2 The protective water proofing coating (polymeric, paintwork or of another type approved by the Register) is applied to contacting metals surfaces washed by sea water at the length of at least 5 pipe diameters from a contact point (but more than 1 m is not required).

The planar oxidation may be used for titanium alloys instead of water proofing.

It is recommended to use coatings along with other methods of protection against contact corrosion.

1.4.3.3 Electrical insulation of different metals is effected by means of fitting electric insulating joints. In this case the following requirements shall be fulfilled:

.1 to protect heat exchangers, other equipment and pipes hooked up to them against contact corrosion, one electric insulating joint at the contact place of different metals and another one at a distance of at least 5 nominal diameters of those pipes shall be fitted;

.2 to protect pipes and valves connected to them, bellows-shaped expansion joints and other similar pipeline components made of different metals against contact corrosion, electric insulating joints shall be fitted at both sides of those components;

.3 to protect interconnected pipes made of different materials against contact corrosion, the pipe made of any above pipe material and having a length of at least 5 nominal diameters of those pipes shall be fitted between pipes using electric insulating joints at both ends;

.4 to protect hull structures from contact with bottom and side valves of nonferrous metal alloys, electric insulating joints shall be fitted at both ends of the bottom and side valves, and also on the pipe itself and its branch pipes at a distance of at least 5 nominal pipe diameters if the pipe and the ship hull materials form an electric pair.

Bottom, side and pipeline valves shall be electrically insulated from all types of joints (control, heating, blow-off, etc. pipelines), which may form a metal contact between the valves and the ship hull. Where bottom and side valves are provided with other shut-off valves made of the same metal, they shall be

electrically insulated as a unified structure;

.5 pipes with two or more electric insulating joints shall be insulated from hangers;

.6 the structure of an electric insulating joint shall be approved by the Register, have the tightness required, be tested by hydraulic pressure in accordance with 21.2 and have an electrical resistance in a dry condition not less than 10 kOhm prior to the system filling and not less than 1 kOhm following the system filling and hydraulic tests. Where resistance is monitored afloat, electric insulating joints shall be checked for metal contact in operation (voltage drop shall be at least 0.1 V).

1.4.3.4 Cathodic protection shall be applied where sea water system components made of metals specified in Table 1.4.3.4 are in contact.

1.4.3.4.1 Protectors shall be fitted immediately between the surfaces of mating different metals. Where it is impossible, they may be fitted on the surface protected as close to the pipe contact place as possible (at least one inner pipe diameter).

1.4.3.4.2 In pipelines with valves and pipes of different metals, protectors shall be fitted behind each valve along the flow. For permanently closed valves and in sections with changing flow direction, protectors shall be fitted at both valve sides.

1.4.3.4.3 Corrosion-resistant steel, tin brass or manganese bronze, and aluminium bronze may be used in sea water if only cathodic protection is provided.

1.4.3.4.4 When fitting protectors, the reliable electrical contact of a protector with an article protected shall be provided.

1.4.3.4.5 The protector design shall allow its replacement, which is effected after the protector life cycle expires. In this case, joints tightness shall not be broken.

1.4.3.4.6 The protector service life shall be at least 2.5 years (at least 3 years for protection of kingston and side branch pipes) and shall be determined according to the formula

$$T = A\frac{M}{S}, \quad (1.4.3.4.6)$$

where T = protector service life, in years;

M = mass of a protector working metal, in kg;

S = area of protected surface, in m^2; the protected pipe surface therewith is assumed equal to an internal surface area of 5 internal diameters long;

A = coefficient equal to 0.75 for zinc protectors and to 1.71 for steel protectors.

Table 1.4.3.4

Combination of metals		Corrodible material	Protector material
Carbon, low-alloy steel, cast iron	Copper, brass, bronze, copper and nickel alloys, corrosion-resistant steel, titanium alloys	Carbon, low-alloy steel, cast iron	Zinc alloys
Copper, brass, bronze, copper and nickel alloys	Corrosion-resistant austenitic steel, titanium alloys	Copper, brass, bronze, copper and nickel alloys	Carbon steel
Copper, brass	Non-austenitic corrosion-resistant steel	Copper, brass	Carbon steel

Bronze, copper and nickel alloys	Non-austenitic corrosion-resistant steel	Corrosion of any material is possible	Carbon steel
Corrosion-resistant steel	Titanium alloy	Corrosion-resistant steel	Carbon steel
Corrosion-resistant austenitic steel, titanium alloys	Non-austenitic corrosion-resistant steel	Corrosion of any material is possible	Carbon steel
Brass	Bronze, copper, copper and nickel alloys	Brass	Carbon steel

1.4.3.3.7 In addition to the materials specified in Table 1.4.4.3, aluminium alloys may be used as the material for protectors. However, the application of aluminium protectors is, in each case, subject to special consideration by the Register.

1.4.3.5 Where other methods of protection against contact corrosion cannot be used, it is permitted to apply "sacrificial" branch pipes.

1.4.3.5.1 The "sacrificial" branch pipe is a thick-walled cylindrical section of a carbon steel pipe intended for displacement of a contact zone of pipeline components made of nonferrous metals and alloys from essential steel structures and equipment. The "sacrificial" branch pipe shall not be internally coated.

1.4.3.5.2 "Sacrificial" branch pipes shall be machined of forgings or rolled products. The length of a "sacrificial" branch pipe shall be at least 1.5 of the internal pipe diameter.

The sealing flange surface of the "sacrificial" branch pipe in contact with a different metal shall be protected against contact corrosion by facing or by another approved method of cladding metal on the contacting item.

1.4.3.5.3 The wear margin of a "sacrificial" branch pipe wall shall provide a pipeline service period of at least 10 years on the basis of the total wall corrosion rate of 1.5 mm/year.

1.4.3.5.4 The "sacrificial" branch pipe shall be located in a place accessible for inspection and replacement. A spare "sacrificial" branch pipe shall be available on the ship.

1.4.3.5.5 Dismantling, inspection of contact surfaces and measurements of "sacrificial" branch pipe wall thicknesses shall be carried out at least once in 5 years.

1.4.4 Protection against excessive pressure

1.4.4.1 Pipelines, in which pressure in excess of the design pressure is possible, shall be equipped with safety devices so that the pressure does not exceed the design value for the pipes.

The liquid diversion from relief valves of pumps for flammable liquids transfer shall be effected into the suction side of the pump or to the suction pipeline. This requirement does not apply to centrifugal pumps.

1.4.4.2 Where provision is made for a reducing valve on the pipeline, a pressure gauge and a safety valve shall be installed downstream of the reducing valve.

An arrangement for by-passing the reducing valve is allowed.

1.4.5 Insulation of piping

Insulation of piping shall comply with 4.6, Part VII "Machinery Installations" and 8.2, Part XII "Refrigerating Plants".

1.4.6 Protection against green sea forces

1.4.6.1 The requirements of 1.4.6 apply to all ship types of sea-going service of 80 m or more, where the height of the exposed deck over the forward within ¼L is less than 0.1L or 22 m above the summer load waterline, whichever is the lesser.

1.4.6.2 Air pipes of tanks, vent pipes and their covers located on the fore end of the exposed deck within ¼ of the ship's length shall be of sufficient strength to withstand green sea forces. The requirements of 1.4.6 shall not apply to exhaust gas pipes.

1.4.6.3 Design loads

1.4.6.3.1 Wave pressure, p, kN/m², on air and vent pipes and their covers is calculated from the formula

$$p = 0{,}5\rho V^2 C_d C_s C_p \quad (1.4.6.3.1)$$

where: ρ = sea water density (1.025 t/m^3);

V = velocity of water flow on the foredeck;

V = 13.5 m/s with $d \le 0.5d_1$;

V = $13.5\{2[1 - (d/d_1)]\}^{0.5}$ with $0.5d_1 < d < d_1$;

d = distance from summer load waterline to exposed deck, in m;

d_1 = 0.1 L or 22 m, whichever is more;

L — refer to 1.1.3.2.1, Part II "Hull";

C_d = shape coefficient taken equal to:

0.5 — for pipes;

1.3 — for air pipes or ventilator heads;

0.8 — for air pipes or ventilator heads of cylindrical form with its axis in the vertical direction;

C_s = slamming coefficient taken equal to 3.2;

C_p = protection coefficient taken equal to:

0.7 — for pipes and ventilator heads located immediately behind a breakwater or forecastle,

1.0 — elsewhere and immediately behind a bulwark.

1.4.6.3.2 Forces acting on the pipes and their closing devices in horizontal direction may be determined by Formula (1.4.6.3.1) using the largest projected area of each component.

1.4.6.4 Strength requirements

1.4.6.4.1 Bending stresses and loads in air and vent pipes shall be determined at critical positions: at penetration pieces, at weld or flange connections, at toes of supporting brackets.

Bending stresses shall not exceed 0.8 σ_y, where σ_y is the yield stress or proof stress of steel at 0.2 per cent elongation at room temperature.

Irrespective of corrosion protection, allowance for corrosion to the net section of 2 mm shall be then applied.

1.4.6.4.2 For standard pipes of 760 mm in height closed by heads of not more than the tabulated projected area, pipe thicknesses and bracket heights are specified in Table 1.4.6.4.2. Where brackets are required, three or more radial brackets shall be fitted.

Brackets shall be of gross thickness of 8 mm or more, of minimum length not less than 100 mm, and height according to Table 1.4.6.4.2 but shall not extend over the joint flange for the head. Bracket toes at the deck shall be suitably supported.

1.4.6.4.3 For other configurations, loads and means of support shall be determined in accordance with 1.4.6.3 and 1.4.6.4. Brackets, where fitted, shall be of suitable thickness and length according to their height.

Pipe thickness shall not be taken less than as indicated in 10.1.4.

1.4.6.4.4 For standard vent pipes of 900 mm in height, pipe thicknesses and

bracket heights are specified in Table 1.4.6.4.4.

Brackets, where required, shall be as specified in 1.4.6.4.2.

Table 1.4.6.4.2 **Wall and bracket thicknesses for standard air pipes of 760 mm in height**

Nominal pipe diameter, mm	Minimum pipe thickness, mm	Maximum projection area of head, cm^2	Bracket height, mm
50	6.0	–	520
65	6.0	–	480
80	6.3	–	460
100	7.0	–	380
125	7.8	–	300
150	8.5	–	300
175	8.5	–	300
200	8.5[1]	1900	300[2]
250	8.5[1]	2500	300[2]
300	8.5[1]	3200	300[2]
350	8.5[1]	3800	300[2]
400	8.5[1]	4500	300[2]

[1] Brackets shall be installed for pipes less than 10.5 mm thick or where the head projection area value exceeds that specified in the Table.

[2] For other air pipe heights the relevant requirements of 1.4.6.4.3 shall apply.

Table 1.4.6.4.4 **Vent pipe and bracket thicknesses for pipes 900 mm in height**

Nominal pipe diameter, mm	Minimum pipe thickness, mm	Maximum projection area of head, cm^2	Bracket height[1], mm
80	6.3	–	460
100	7.0	–	380
150	8.5	–	300
175	8.5	55	–
200	8.5	880	–
250	8.5	1200	–
300	8.5	2000	–
350	8.5	2700	–
400	8.5	3300	–
500	8.5	4000	–

[1] For other vent pipe heights the relevant requirements of 1.4.6.4.5 shall apply.

1.4.6.4.5 For vent pipes of height greater than 900 mm, brackets or alternative means of support are subject to special consideration by the Register in each case.

1.4.6.4.6 All component parts and connections of air or vent pipes shall be capable of withstanding the loads defined in 1.4.6.3.

1.4.6.5 Rotating type mushroom ventilator heads are not permitted for installation in the areas defined in 1.4.6.2.

1.5 WELDING AND NON-DESTRUCTIVE TESTING OF WELDS

1.5.1 Welding and non-destructive testing of welds in pipes shall be effected in compliance with 2.5 and 3, Part XIV "Welding".

2. METAL PIPING

2.1 MATERIAL, MANUFACTURE AND APPLICATION

2.1.1 The materials, used in pipes and valves, as well as the methods of material testing shall comply with the requirements of Part XIII "Materials".

The materials for pipes, valves and drives operating in corrosive environment are subject to special consideration by the Register in any case.

The fuel oil pipes shall be manufactured of steel or other materials meeting the Register requirements as to strength and fire-resistance. These requirements apply to lubricating oil pipes in machinery spaces and to pipes conveying other flammable oil products including hydraulic and thermal liquids if they are installed in spaces with sources of ignition.

The coatings and parts of non-metallic materials used in manufacture of valves shall be compatible with the medium conveyed at working pressure within the whole range of working temperatures.

The pipes and valves of fire extinguishing systems shall comply with 3.1.4.1, Part VI "Fire Protection".

2.1.2 As a rule, pipes and valves of carbon steel and carbon-manganese steel shall be used for media with temperature not exceeding 400 °C, and of low-alloy steel — with temperature not exceeding 500 °C.

These steels are admitted for temperatures higher than mentioned above, if their mechanical properties and the average stress to produce rupture in 100,000 hours at the design temperature comply with the effective standards and are guaranteed by the steel manufacturer as suitable for high temperature service.

Pipes and valves for media with temperature above 500 °C shall be manufactured of alloy steel. Exhaust gas pipes are excluded from this requirement.

2.1.3 Copper and copper alloy pipes shall be seamless drawn pipes or another type approved by the Register.

Copper pipes for Classes I and II shall be seamless.

Pipes and valves of copper and copper alloys shall generally be used for media with temperature not exceeding 200 °C, and those of copper-nickel alloys, for temperature not exceeding 300 °C. Bronze valves are admitted for media with temperatures up to 260 °C.

2.1.4 Grey cast iron is admitted for pipes and valves of Class III piping used at ambient temperatures not below −15 °C. In this case, the ultimate strength of grey cast iron shall not be less than 200 MPa, and that of the fitting casings and shaped components — not less than 300 MPa. Apart from cargo pipelines, the permissible working pressure in grey cast iron pipelines shall not exceed 1 MPa, and for steam pipelines — 0.3 MPa.

Pipes and valves of grey cast iron may be also used for cargo lines with pressures up to 1.6 MPa on the weather deck, inside cargo and slop tanks, except for the manifolds, their valves and connections to the cargo hoses.

Grey cast iron shall not be used for:

.1 pipes and valves handling media with temperatures above 220 °C;

.2 pipes and valves subject to water hammer, increased strains and vibration;

.3 pipes directly connected to the shell plating;

.4 valves fitted directly on the shell plating and collision bulkhead;

.5 valves under static head, fitted directly on fuel and lubricating oil tanks, unless protected against mechanical damage by a Register-approved method;

.6 fire smothering systems;

.7 ballast lines inside cargo and slop tanks.

2.1.5 Spheroidal or nodular graphite cast iron is admitted for pipes and valves of Classes II and III piping, including ballast, bilge and cargo lines, if the elongation of cast iron is not less than 12 per cent. Where the elongation is less than required, the area of application of the pipes and valves of spheroidal or nodular graphite cast iron shall be the same as specified in 2.1.4 for grey cast iron.

The working temperature for piping components made of spheroidal graphite cast iron of perlitic or ferritic-perlitic structure shall not exceed 300 °C, and for cast iron of ferritic structure — 350 °C.

The impact toughness (KCU) of spheroidal graphite cast iron for pipes and valves used at the temperature lower than −15 °C shall not be less than 20 J/cm^2.

Ship bottom and side valves as well as the valves and fittings referred to in 4.3.2.4, 4.3.2.6 to 4.3.2.7 and the valves on the collision bulkhead, fuel and lube oil tanks may be of spheroidal graphite cast iron of fully ferritic structure in accordance with Table 3.9.3.1, Part XIII "Materials".

2.1.6 Pipes up to 50 mm in diameter and valves of ductile cast iron of ferritic structure with elongation more than 12 per cent may be used for services mentioned in 2.1.5 at the working temperature not lower than −15 °C and not higher than 350 °C and under working pressure up to 2 MPa.

The area of application of pipes and valves made of ductile cast iron with elongation less than 12 per cent shall be the same as specified in 2.1.4 for products made of grey cast iron.

2.1.7 The use of pipes and other pipeline components made of aluminium alloys in systems mentioned under 1.1.1 is subject to special consideration of the Register.

2.1.8 The plugs and threaded portion of deck bushes of sounding pipes with terminations on the open decks, shall be of bronze or brass. The use of other materials shall be specially considered by the Register.

2.1.9 Sight-glasses on fuel oil and oil pipes shall be refractory.

2.2 RADII OF PIPE BENDS, HEAT TREATMENT AFTER BENDING

2.2.1 Radii of pipe bends

The inner radius of pipe bend of the boiler blow off pipes shall be at least $3.5d_1$ (d_1 = pipe inside diameter).

The inner radius of bend of the steel and copper pipes subjected to a pressure

exceeding 0.49 MPa or a working medium temperature exceeding 60 °C, as well as bending radius of pipes with allowance for thermal expansion, shall be at least 2.5*d* (*d* = pipe outside diameter).

On agreement with the Register, bending to a lesser radius may be permitted, provided no thinning of pipe wall below the values stated in 2.3 occurs during bending.

2.2.2 Hot bending of steel pipes shall be carried out, as a rule, within the temperature range of 1000 to 850 °C; however, the temperature may decrease to 750 °C during the bending process.

For pipes bended within this temperature range, the following applies:

.1 for C, C-Mn and C-Mo steels, no subsequent heat treatment is required;

.2 for 1 Cr — 0.5 Mo steel with a wall thickness greater than 8 mm, subsequent stress relieving heat treatment within the temperature range of 620 to 680 °C is required;

.3 for 2.25 Cr — 1 Mo and 0.5 Cr — 0.5 Mo — 0.25 V steels of all thicknesses, subsequent stress relieving heat treatment within the temperature range of 650 to 720 °C is required, except for pipes with wall thickness < 8 mm, diameter < 100 mm and the maximum service temperature up to 450 °C, for which no subsequent heat treatment is needed.

2.2.3 When hot bending is carried out outside the temperature range stated in 2.2.2, subsequent heat treatment in accordance with Table 2.2.3 is generally required.

Table 2.2.3

Steel	Heat treatment and temperature, °C
C and C-Mn	Normalization, 880–940
C-Mo, 0.3 Mo	Normalization, 900–940
Cr-Mo, 1 Cr — 0.5 Mo	Normalization, 900–960 Tempering, 640–720
Cr-Mo, 2.25 Cr — 1 Mo	Normalization, 900–960 Tempering, 650–780
Cr-Mo-V, 0.5 Cr — 0.5 Mo — 0.25 V	Normalization, 930–980 Tempering, 670–720

2.2.4 After cold bending when r = 4*d* (*d* = pipe inside diameter) and less, complete heat treatment in accordance with Table 2.2.3 is generally required.

However, in any case, stress relieving heat treatment is required for 0.3 Mo steel with a wall thickness ≥ 15 mm at 580 to 640 °C, 1 Cr — 0.5 Mo steel with a wall thickness ≥ 8 mm at 620 to 680 °C, and for 2.25 Cr — 1 Mo and 0.5 Cr — 0.5 Mo — 0.25 V steel with a wall thickness ≥ 8 mm, diameter ≥ 100 mm and service temperature above 450 °C at 650 to 720 °C.

2.2.5 Copper and copper-alloy pipes, except for the pipes of measuring instruments, shall be annealed before hydraulic testing.

2.2.6 Preheating before welding and postweld heat treatment shall be effected in accordance with 2.5.5 to 2.5.7, Part XIV “Welding”.

2.3 METAL PIPE WALL THICKNESS

2.3.1 The wall thickness of metal pipes (except cast iron pipes) operating under the internal pressure shall correspond to the greater of the values determined from Table 2.3.8 or by the following formula:

$$S = \frac{S_0 + b + c}{1 - (a/100)}, \quad (2.3.1)$$

$$S_0 = \frac{dp}{2\sigma\varphi + p};$$

where:

S_0 = theoretical wall thickness, in mm;

d = external pipe diameter, in mm;

p = design pressure taken under 2.3.2, in MPa;

φ = strength factor determined under 2.3.3;

b = allowance for an actual reduction of pipe wall thickness because of bending, taken under 2.3.4, in mm;

σ = permissible normal stress determined under 2.3.5–2.3.7, in MPa;

c = allowance for corrosion taken in accordance with Table 2.3.1-1 for steel pipes and Table 2.3.1-2 for pipes of nonferrous metals, mm;

a = negative manufacturing tolerance for pipe wall thickness, %, (where pipes without negative allowance are used, $a = 0$).

2.3.2 The maximum operating pressure in the system shall be taken as design pressure used to calculate pipe strength. Where safety valves are used, the greatest value of their opening pressure shall be the design pressure.

Pipelines and piping system components that have no safety valves or may have their safety valves disconnected shall be rated for the maximum possible discharge head of the pumps they are connected to.

The design pressure for pipelines conveying heated fuel oil shall be taken as per Table 2.3.2.

The design pressure for steering gear piping shall be taken as per 6.2.8.1, Part IX “Machinery”.

Table 2.3.1-1 **Allowance *c* for corrosion for steel pipes**

Working medium, piping service	***c***, mm
Superheated steam	0.3
Saturated steam	0.8
Heating steam coils for water and fuel oil products in tanks and cargo tanks	2.0
Feed water in open circuit systems	1.5
Feed water in closed circuit systems	0.5
Blow-down of boilers	1.5
Compressed air	1.0
Hydraulic oil systems	0.3
Lube oil	0.3
Fuel oil	1.0
Cargo pipelines	2.0
Liquefied gas	0.3
Refrigerant piping	0.3
Fresh water	0.8
Sea water	3.0

Notes: 1. On agreement with the Register, the allowance for corrosion may be reduced for pipes protected against corrosion by special coatings, linings, etc.

2. Where pipes of steel with sufficient corrosion resistance are used, the allowance for corrosion may be reduced to zero.

3. For pipes passing through tanks and on the open decks the table values shall be increased by the allowance for the influence of the external medium, which is assumed for the appropriate medium in accordance with this Table.

Table 2.3.1-2 **Allowance *c* for corrosion for pipes of nonferrous metals and alloys**

Pipe material	*c*, mm
Copper, brass, copper-tin alloys and similar alloys, except for alloys with lead content	0.8
Copper-nickel alloys (with Ni content > 10%)	0.5

Note. Where pipes of special alloys with sufficient corrosion resistance are used, the allowance for corrosion may be reduced to zero.

Table 2.3.2 **Determination of design pressure for fuel oil systems**

Working pressure *P,* MPa	Working temperature *T,* °C	
	60 and less	more than 60
0.7 and less	0.3 MPa or P_{max} (whichever is greater)	0.3 MPa or P_{max} (whichever is greater)
More than 0.7	P_{max}	1.4 MPa or P_{max} (whichever is greater)

In particular cases not provided by the Rules the design pressure is subject to special consideration by the Register.

2.3.3 The strength factor φ in strength calculations shall be taken as 1 for seamless pipes and approved welded pipes, which are considered equivalent to seamless pipes. For other welded pipes the strength factor φ is subject to special consideration by the Register in each case.

2.3.4 The allowance for an actual reduction of pipe wall thickness because of

bending shall be chosen so that the stresses in the bent part of the pipe because of internal pressure do not exceed the permissible stresses.

Where precise values of thickness reduction while bending are not known, the allowance *b*, mm, may be obtained by the formula

$$b = \frac{1}{2,5}\frac{d}{R}S_0, \qquad (2.3.4)$$

where R = mean radius of pipe bend, mm.

2.3.5 In strength calculations the permissible stresses are taken considering the following properties of material and working conditions:

$R_{m/20}$ = the ultimate resistance at room temperature, MPa;

$R_{eL/t}$ = the minimum yield strength at the design temperature, MPa;

$R_{0.2/t}$ = the conventional yield strength at the design temperature, MPa;

$R_{m/t}^{100000}$ = ultimate long-term strength for 100,000 hours at the design temperature, MPa;

$R_{p1/t}^{100000}$ = 1 per cent of creep limit for 100,000 hours at the design temperature, MPa.

The design temperature t to determine permissible stresses is taken as the maximum temperature of the medium inside the pipes. In particular cases the design temperature is specially considered by the Register.

2.3.5.1 For carbon or alloy steel pipes the permissible design stresses σ are chosen equal to the lowest of the following values:

$R_{m/20}/2.7$; $R_{eL/t}/1.8$ or $R_{0.2/t}/1.8$; $R_{m/t}^{100000}/1.8$; $R_{p1/t}^{100000}/1.0$.

The possibility of strength factor reduction shall be a matter of special consideration by the Register in each case.

When the design temperature is not included in the creep limit of the material, the permissible stresses on the creep limit are not compulsory for examination.

2.3.5.2 The permissible stresses for high-alloyed steels are subject to special consideration by the Register in each case.

2.3.5.3 For copper and copper alloys pipes, the permissible stresses shall be determined in accordance with Table 2.3.5.3.

Table 2.3.5.3 **Permissible stresses $\sigma_{perm.}$ for copper and copper alloy pipes**

Pipe material	Heat treatment	Tensile strength, MPa	$\sigma_{perm.}$, MPa, at ambient temperature, °C										
			50	75	100	125	150	175	200	225	250	275	300
Copper	Annealing	220	41	41	40	40	34	27	19	–	–	–	–
Aluminium bronze	As above	320	78	78	78	78	78	51	25	–	–	–	–
Copper-nickel alloy 95/5 and 90/10	"	270	69	69	68	66	64	62	59	56	52	48	44
Copper-nickel alloy 70/30	"	360	81	79	77	76	74	72	70	68	66	64	62

Notes: 1. Intermediate values shall be determined by linear interpolation.

2. Permissible stresses for materials not specified in the Table are subject to special consideration by the Register in any case.

2.3.5.4 The permissible stresses for aluminium and titanium pipes in the strength calculations are assumed equal to the minimum of the following values:

$R_{m/20}/4.0$; $R_{m/t}^{100000}/1.6$; $R_{0.2/t}/1.6$.

When the design temperature is not included in the creep limit of the material, the permissible stresses on the creep limit are not compulsory for examination.

2.3.6 Steam pipes with an external diameter of 80 mm and over for superheated steam at a temperature of 350 °C and over shall be calculated for stresses

caused by thermal expansion, and flanged joints — for strength and tightness.

The calculations of stresses in pipes because of thermal expansion shall comply with the requirements of 18.3.

2.3.7 The wall thickness t_{min}, in mm, of cast iron pipeline components shall not be less than that obtained from the formula

$$t_{\min} = k\left(0{,}5 + 0{,}001D_y\right) \qquad (2.3.7)$$

where $D_{nom.}$ = nominal diameter, in mm;
k = factor taken equal to:
9 — for pipes;
14 — for T-joints and valve bodies;
12 — for joints.

Moreover, the wall thickness of cast iron pipes and valves under internal pressure shall not be less than that obtained from Formula (2.3.1),

and the allowance for a reduction of pipe wall thickness because of bending in this case is b = 0;

weld efficiency factor φ is taken equal to:

1 — for pipes and couplings;

0.4 — for bends, T-joints and four-way unions;

0.25 — for fitting bodies;

permissible stress σ is determined with regard to 2.1.4.3, 2.1.4.6, and 2.1.5.5, Part X "Boilers, Heat Exchangers and Pressure Vessels";

allowance for corrosion c due to sea water is:

4 mm — for cast iron of ferritic and ferritic-perlitic structure;

3 mm — for cast iron of perlitic structure;

for low corrosivity media, corrosion allowance may be reduced on agreement with the Register.

2.3.8 The wall thickness of steel, copper, and copper alloy pipes shall not be less than indicated in Table 2.3.8.

2.4 PIPE JOINTS

2.4.1 Use of welded, flanged, threaded and mechanical joints, made in accordance with the standards approved by the Register, is allowed.

2.4.2 Welded joints.

2.4.2.1 Welded butt joints may be made with or without special provisions for full root penetration.

Welded butt joints of full penetration type with special provisions for root side quality, for instance, performed with the use of double-sided welds, backing strap or other equivalent methods, are allowed for piping of any class and diameter.

Welded butt joints of full penetration type without special provisions for root side quality are allowed for Classes II and III pipelines without diameter restrictions.

2.4.2.2 Slip-on and socket welded joints shall have sleeves and sockets of adequate dimensions, meeting the requirements of the standards approved by the Register. Slip-on sleeve and faucet welded joints may be used for Class III pipelines regardless of the pipe diameter.

In some cases such joints may be used for Classes I and II pipelines with outside diameter up to 88.9 mm except for the pipelines conveying toxic or corrosive media and for operation under heavy fatigue loads, excessive corrosion and erosion.

Table 2.3.8 **Minimum wall thickness of metal pipes, mm**

External diameter, mm	Pipes									
	Steel						Copper	Copper alloy	Corrosion-resistant steel	Titanium alloys
	Pipelines of systems, except as specified in columns 3, 4, 5, 6 and 7	Air, overflow sounding pipes, pipes of integrated tanks, except as specified in column 5 and in 10.1.4	Sea water piping (bilge, ballast, cooling water, fire extinguishing systems, etc.)	Bilge, air, overflow and sounding pipes passing through ballast and fuel tanks; ballast pipes passing through fuel tanks; fuel pipes passing through ballast tanks	Piping of C02 fire extinguishing system					
					From cylinders to starting valves	From starting valves to discharge nozzles				
1	2	3	4	5	6	7	8	9	10	11
Less than 8	1.0	–	–	–	–	–	–	–	1.0	0.8
8.0	1.2	–	–	–	–	–	1.0	0.8	1.0	0.8
10.2	1.6	–	–	–	–	–	1.0	0.8	1.0	0.8
12.0	1.6	–	–	–	–	–	1.2	1.0	1.0	1.0
13.5	1.8	–	–	–	–	–	1.2	1.0	1.0	1.0
16.0	1.8	–	–	–	–	–	1.2	1.0	1.0	1.0
17.2	1.8	–	–	–	–	–	1.2	1.0	1.0	1.0
19.3	1.8	–	–	–	–	–	1.2	1.0	1.0	1.0
20.0	2.0	–	–	–	–	–	1.2	1.0	1.0	1.0
21.3	2.0	–	3.2	–	3.2	2.6	1.2	1.0	1.6	1.0
25.0	2.0	–	3.2	–	3.2	2.6	1.5	1.2	1.6	1.0
26.9	2.0	–	3.2	–	3.2	2.6	1.5	1.2	1.6	1.0
30.0	2.0	–	3.2	–	4.0	3.2	1.5	1.2	1.6	1.0
33.7	2.0	–	3.2	–	4.0	3.2	1.5	1.2	1.6	1.0
38.0	2.0	4.5	3.6	6.3	4.0	3.2	1.5	1.2	1.6	1.0
42.4	2.0	4.5	3.6	6.3	4.0	3.2	1.5	1.2	1.6	1.0
44.5	2.0	4.5	3.6	6.3	4.0	3.2	1.5	1.2	1.6	1.0
48.3	2.3	4.5	3.6	6.3	4.0	3.2	2.0	1.5	1.6	1.5
51.0	2.3	4.5	4.0	6.3	4.5	3.6	2.0	1.5	1.6	1.5
54.0	2.3	4.5	4.0	6.3	4.5	3.6	2.0	1.5	1.6	1.5
57.0	2.3	4.5	4.0	6.3	4.5	3.6	2.0	1.5	1.6	1.5
60.3	2.3	4.5	4.0	6.3	4.5	3.6	2.0	1.5	2.0	1.5
63.5	2.3	4.5	4.0	6.3	5.0	3.6	2.0	1.5	2.0	1.5

Table 2.3.8 continued

1	2	3	4	5	6	7	8	9	10	11
70.0	2.6	4.5	4.0	6.3	5.0	3.6	2.0	1.5	2.0	1.5
76.1	2.6	4.5	4.5	6.3	5.0	3.6	2.0	1.5	2.0	1.5
82.5	2.6	4.5	4.5	6.3	5.6	4.0	2.0	1.5	2.0	1.5
88.9	2.9	4.5	4.5	7.1	5.6	4.0	2.5	2.0	2.0	2.0
101.6	2.9	4.5	4.5	7.1	6.3	4.0	2.5	2.0	2.0	2.0
108.0	2.9	4.5	4.5	7.1	7.1	4.5	2.5	2.0	2.0	2.0
114.3	3.2	4.5	4.5	8.0	7.1	4.5	2.5	2.0	2.3	2.0
127.0	3.2	4.5	4.5	8.0	8.0	4.5	2.5	2.0	2.3	2.0
133.0	3.6	4.5	4.5	8.0	8.0	5.0	3.0	2.5	2.3	2.0
139.7	3.6	4.5	4.5	8.0	8.0	5.0	3.0	2.5	2.3	2.0
152.4	4.0	4.5	4.5	8.8	8.8	5.6	3.0	2.5	2.3	2.0
159.0	4.0	4.5	4.5	8.8	8.8	5.6	3.0	2.5	2.3	2.0
168.3	4.0	4.5	4.5	8.8	8.8	5.6	3.0	2.5	2.3	2.0
177.8	4.5	5.0	5.0	8.8	–	–	3.0	2.5	2.3	2.0
193.7	4.5	5.4	5.4	8.8	–	–	3.5	3.0	2.3	2.5
219.1	4.5	5.9	5.9	8.8	–	–	3.5	3.0	2.6	2.5
244.5	5.0	6.3	6.3	8.8	–	–	3.5	3.0	2.6	2.5
267.0	5.0	6.3	6.3	8.8	–	–	3.5	3.0	2.6	2.5
273.0	5.0	6.3	6.3	8.8	–	–	4.0	3.5	2.9	3.0
298.5	5.6	6.3	6.3	8.8	–	–	4.0	3.5	2.9	3.0
323.9	5.6	6.3	6.3	8.8	–	–	4.0	3.5	3.6	3.0
355.6	5.6	6.3	6.3	8.8	–	–	4.0	3.5	3.6	3.0
368.0	5.6	6.3	6.3	8.8	–	–	4.0	3.5	3.6	3.0
406.4	6.3	6.3	6.3	8.8	–	–	4.0	3.5	4.0	3.0
419.0	6.3	6.3	6.3	8.8	–	–	4.0	3.5	4.0	3.0
457.2	6.3	6.3	6.3	8.8	–	–	4.0	3.5	4.0	3.0
508.0	–	–	–	–	–	–	4.5	4.0	4.0	3.5

N o t e s : 1. For pipes with thicknesses and diameters indicated in the Table, the nearest values specified in national and international standards may be accepted on agreement with the Register.

2. For the tabulated values no allowance need be made for negative manufacturing tolerance and reduction in thickness due to bending.

3. For the pipes with diameters greater than 450 mm, the minimum thickness shall be in accordance with the standards agreed upon with the Register; the minimum thickness value shall not be less than that specified for pipes with diameter of 450 mm.

4. The minimum internal diameters of bilge, sounding, air and overflow pipes shall be in compliance with 7.2.3, 10.1.12, 10.2.8, and 10.4.7 accordingly.

5. For pipes protected against corrosion by special coatings, linings, etc., the minimum wall thicknesses of pipes, listed in columns 3, 4 and 5, may be reduced by not more than 1 mm.

6. For sounding pipes, the thicknesses stated in columns 3 and 5 apply to the parts outside the tanks for which these pipes are intended.

7. For threaded pipes, the wall thickness shown is the minimum thickness at the bottom of the thread.

8. The thicknesses stated in columns 6 and 7 apply to the pipes which are galvanized on the inside.

End of Table 2.3.8

9. The minimum wall thicknesses of bilge and ballast lines passing through cargo tanks, as well as cargo lines, are subject to special consideration by the Register in each case.

10. The Table does not apply to the exhaust gas piping.

11. For low pressure carbon dioxide system the wall thickness of pipes on a length from the tank to discharge nozzles shall be the same as in column 7.

12. Wall thickness of scuppers and discharge pipes shall not be less than stated in 4.3.2.

13. Wall thickness of ballast and air pipes passing through cargo tanks shall comply with the requirements of Table 9.10.1.

2.4.2.3 Welding and non-destructive testing shall be effected in compliance with 2.5 and 3.2, Part XIV "Welding".

2.4.3 Flanged joints

2.4.3.1 The size and shape of flanges and coupling bolts shall be in accordance with the standards as approved by the Register.

The seals used shall be compatible with the media carried at the design pressure and temperature. The sizes of flanges and coupling bolts for non-standard joints are in any case subject to special consideration by the Register.

Flanged joints shall be selected with due account of the national or international standards as approved by the Register, for the media carried, design pressure and temperature, external and cyclic loads, as well as piping location.

2.4.3.2 Connection of flanges and pipes shall be made in accordance with Fig. 2.4.3.2.

Other types of joints may be accepted by the Register upon the special consideration.

2.4.3.3 Flange and pipe joint types depending on the pipeline class shall be selected in accordance with Table 2.4.3.3.

2.4.4 Tapered threaded connections

2.4.4.1 Threaded connections shall be made in compliance with the requirements of the approved national or international standards. Such connections shall not be used in systems conveying toxic and flammable media or media causing severe corrosive or erosive wear, as well as under heavy fatigue loads.

The threaded slip-on joints with taper thread may be used in Class I pipelines with the diameter up to 33.7 mm and Classes II and III pipelines with the diameter up to 60.3 mm.

Joints with parallel thread may be used in Class III pipelines with the diameter up to 60.3 mm.

In particular cases, sizes in excess of those mentioned above may be accepted by the Register after special consideration if in compliance with the national or international standards.

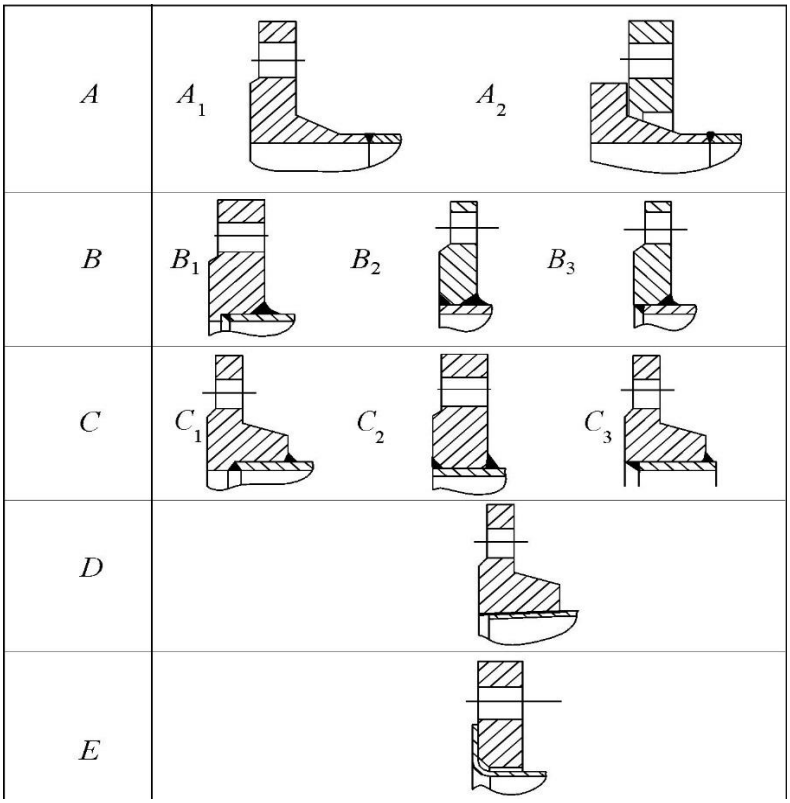


Fig. 2.4.3.2

N o t e . In type *D* taper thread joint, outside diameter of the pipe thread shall not be less than the outside diameter of the pipe. Following installation of the flange the pipe shall be flared.

Table 2.4.3.3

Piping class	Toxic, corrosive, flammable media, liquefied gas[3]	Fuel oil, lube oil, flammable hydraulic oil	Vapour	Other media[1]
I	*A, B*[5]	*A, B*	*A, B*[2, 5]	*A, B*
II	*A, B, C*	*A, B, C*	*A, B, C, D*[4]	*A, B, C, D*[4], *E*[4, 6]
III		*A, B, C*	*A, B, C, D*	*A, B, C, D, E*[6]

[1] Including water, air, gases, non-flammable hydraulic oil.

[2] Only type *A*, if design temperature is in excess of 400 °C.

[3] Only type *A*, if design pressure is in excess of 1.0 MPa.

[4] Type C_3, *D* and *E* (refer to Fig. 2.4.3.2) shall not be used if design temperature is in excess of 250 °C.

[5] Type *B* for pipes with outside diameter ≤ 154.4 mm only.

[6] Type *E* — flanging method to be approved by the Register.

2.4.4.2 The use of threaded connections in CO2 fire-extinguishing systems is allowed only inside the spaces to be protected and in CO2 cylinder room.

2.4.5 Mechanical joints

2.4.5.1 These requirements apply to compression couplings, pipe unions and slip-on joints shown in Table 2.4.5.1. The use of such joints may be also accepted by the Register.

Due to the great variations in design and configuration of mechanical joints, no specific recommendations regarding the check calculation of their strength are given.

Type approval of the mechanical joints shall be based on the results of testing of their specimens.

2.4.5.2 Application and pressure ratings for mechanical joints shall be approved by the Register. The approval shall be based on the type tests in accordance with a program approved by the Register.

2.4.5.3 Where the use of mechanical joints results in reduction in pipe wall thickness due to the use of bite type rings or other structural elements, this shall be taken into account in determining the minimum wall thickness of the pipe.

2.4.5.4 Mechanical joints design shall prevent tightness failure affected by pressure pulsation, piping vibration, temperature variation and other similar adverse effects as may occur during operation on board.

2.4.5.5 Material of mechanical joints shall be compatible with the piping material and media conveyed.

2.4.5.6 Mechanical joints shall withstand test pressure not less than 4 times the design pressure.

For design pressures of 20 MPa and above, the required test pressure may be reduced on agreement with the Register.

2.4.5.7 Mechanical joints listed in Table 2.4.5.13, intended for use in systems conveying flammable media and in essential purpose systems, shall be of fire resistant type.

2.4.5.8 Mechanical joints which in the event of damage may cause fire or flooding shall not be used in piping sections directly connected to the sea openings or tanks containing flammable fluids.

2.4.5.9 The mechanical joints shall be designed to withstand internal and external pressure as applicable and where used in suction lines shall be capable of operating under vacuum.

2.4.5.10 The number of mechanical joints in oil systems shall be kept to a minimum. The use of standard flanged joints is preferable.

2.4.5.11 Piping, in which a mechanical joint is fitted, shall be adequately adjusted, aligned and supported. Supports or hangers shall not be used for alignment of piping at the point of connection.

2.4.5.12 Slip-on joints shall not be used in pipelines in cargo holds, tanks, and other spaces, which are not easily accessible, unless approved by the Register.

The use of these joints inside tanks may be permitted only for the same media that is in the tanks.

The use of slip-on joints of slip type as the main means of pipe connection is not permitted.

They shall be used only in cases where compensation of lateral pipe deformation is necessary.

2.4.5.13 The application scope of mechanical joints based on the pipeline service is indicated in Table 2.4.5.13-1, and based on the class of piping, piping

dimensions, working pressure and temperature — in Table 2.4.5.13-2.

Table 2.4.5.1 **Mechanical joints examples**

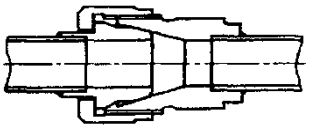
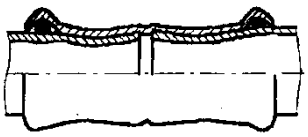
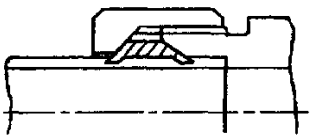
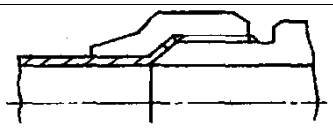
Pipe unions	
Soldered and welded	
Compression couplings	
With clamping rings	
Pressed	
With cutting rings	
Expanded	

Table 2.4.5.1 continued

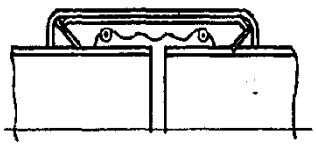
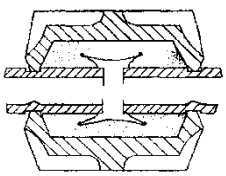
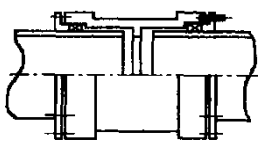
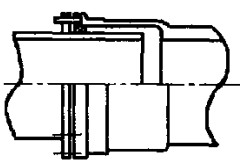
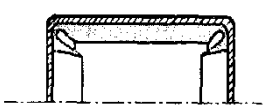
Slip-on joints	
With stopper rings	
With mounting groove	
Slip type	
	
	

Table 2.4.5.13-1 **The use of mechanical joints based on the pipeline service**

Ser. No.	Pipes	Pipe joints		
		Union	Compression couplings[1]	Slip-on joints
1	2	3	4	5
Flammable media with flash point ≤ 60 °C				
1	Cargo	+	+	+[2]
2	Crude oil washing	+	+	+[2]
3	Air	+	+	+[3]
Inert gas				
4	From hydraulic lock	+	+	+
5	From gas scrubber	+	+	+
6	Manifold	+	+	+[2, 5]
7	Distribution lines	+	+	+[2]

Table 2.4.5.13-1 continued

1	2	3	4	5
Flammable media with flash point ≥ 60 °C				
8	Cargo	+	+	+[2]
9	Fuel oil	+	+	+[3, 5]
10	Oil	+	+	+[3, 5]
11	Hydraulic	+	+	+[3, 5]
12	Thermal liquid	+	+	+[3, 5]
Sea water				
13	Bilge	+	+	+[6]
14	Fire-fighting and water-spraying	+	+	+[3]
15	Foam fire-extinguishing	+	+	+[3]
16	Sprinkler	+	+	+[3]
17	Ballast	+	+	+[6]
18	Cooling	+	+	+[6]
19	Tank washing	+	+	+
20	Non-essential purpose	+	+	+
Fresh water				
21	Cooling	+	+	+[6]
22	Condensate	+	+	+[6]
23	Non-essential purpose	+	+	+
Drain				
24	Deck drainage (interior)	+	+	+[4]
25	Sanitary	+	+	+
26	To discharges	+	+	–
Sounding and air				
27	Water tanks, cofferdams	+	+	+
28	Tanks for petroleum products with a flash point ≥ 60 °C	+	+	+[3, 5]
Miscellaneous				
29	Air (start, control)[6]	+	+	–
30	Air (domestic)	+	+	+
31	Brine	+	+	+
32	CO2 fire extinguishing systems [6]	+	+	–
33	Vapour	+	+	+[7]

Symbols: + use accepted;
— use not accepted.

[1] Where compression couplings include components easily damaged in case of fire, these components shall be of approved fireproof type as required for slip-on joints.

[2] In pump spaces and on open decks — approved fireproof type only.

[3] Approved fireproof type.

[4] Only above exposed deck level.

End of Table 2.4.5.13-1

[5] Apart from category A machinery spaces and accommodation spaces. The use in other machinery spaces is allowed if installed in visible and readily accessible positions.

[6] Inside category A machinery spaces — approved fireproof type only.

[7] Slip-on joints may be used in vapour piping under design pressure up to 1 MPa on open decks

Table 2.4.5.13-2 **The use of mechanical joints based on the class of piping**

Pipe joints	Piping class		
	I	II	III
Pipe unions			
Soldered and welded	+ (outside diameter not above 60.3 mm)	+ (outside diameter not above 60.3 mm)	+
Compression couplings			
With clamping rings	+	+	+
With cutting rings, flanged	+ (outside diameter not above 60.3 mm)	+ outside diameter not abov 60.3 mm)	+
Pressed	—	—	+
Slip-on joints			
With mounting grooves	+	+	+
With stopper rings	—	+	+
Slip type	—	+	+

S y m b o l s : + use accepted;
— use not accepted.

2.4.5.14 Mechanical joints shall be tested in accordance with a program approved by the Register, which shall include at least the following:

.1 leakage test;

.2 vibration test;

.3 fire endurance test (where necessary);

.4 pressure pulsation test (where necessary);

.5 vacuum test (where necessary);

.6 burst pressure test;

.7 pull-out test (where necessary);

.8 assembly test (where necessary).

The scope and nature of the tests shall be specified depending on the type of joint and the purpose of piping.

2.4.5.15 The installation of mechanical joints shall be in accordance with the manufacturer's assembly instructions.

Where special tools and gauges are required for installation of the joints, these shall be supplied by the manufacturer.

2.5 FLEXIBLE HOSES

2.5.1 F l e x i b l e h o s e is a short metallic or non-metallic hose normally

with prefabricated end fittings ready for installation.

2.5.2 Application

2.5.2.1 The requirements 2.5.3 to 2.5.6 apply to flexible hoses of metallic or non-metallic material intended for permanent connection between a fixed piping system and items of machinery.

The requirements may also apply to temporary connected flexible hoses or hoses of portable equipment.

2.5.2.2 Flexible hoses may be used in fuel oil, lubricating, hydraulic and thermal oil systems (cold portions), fresh water and sea water cooling systems, bilge and ballast systems, and Class III steam systems where they comply with 2.5.3 to 2.5.6.

Flexible hoses in high-pressure fuel oil injection systems shall not be accepted.

2.5.2.3 These requirements do not apply to hoses of water fire main system.

2.5.3 Construction requirements.

2.5.3.1 Flexible hoses shall be designed and constructed in accordance with the approved standards.

Flexible hoses of rubber intended for use in bilge, ballast, compressed air, fuel oil, lubricating, hydraulic and thermal oil systems shall incorporate a single or double closely woven integral wire braid or another suitable material reinforcement.

Flexible hoses for the above use constructed of plastic materials such as teflon and nylon where integral wire braid is not allowed, shall have reinforcement of another suitable material, if necessary.

Flexible hoses used as part of fuel oil pipes of oil burner units shall have external wire braid protection in addition to the above reinforcement.

Flexible hoses for use in steam systems shall be of metallic construction.

2.5.3.2 Flexible hoses shall be complete with approved end fittings.

Except for the flange connections, the end connections shall comply with the applicable requirements of 2.4.5 and each type of hose/fitting combination shall be subject to prototype testing.

2.5.3.3 The use of hose clamps and similar types of end attachments is not acceptable for flexible hoses in piping systems for steam, flammable media, starting air systems or for sea water systems where failure may result in flooding.

In other piping systems, the use of hose clamps may be accepted where the working pressure is less than 0.5 MPa and provided there are double clamps at each end connection.

2.5.3.4 Flexible hoses intended for installation in piping systems where pressure pulses or high levels of vibration are expected to occur in service, shall be designed for the maximum expected impulse peak pressure and forces due to vibration. The tests required under 2.5.5 shall take into consideration the maximum anticipated in-service pressures, vibration frequencies and forces due to installation.

2.5.3.5 Flexible hoses constructed of non-metallic materials intended for installation in piping systems for flammable media and sea water systems where failure may result in flooding, shall be of fire-resistant type.

Fire resistance shall be demonstrated by testing in accordance with the requirements of 2.5.5.6.

2.5.3.6 Flexible hoses shall be selected for the intended location and use taking into consideration ambient conditions, compatibility with the conveyed fluids under working pressure and temperature conditions consistent with the manufacturer's instructions.

Flexible hoses for use in fire extinguishing systems shall comply with the requirements of 3.1.4.1.6, Part VI "Fire Protection".

2.5.4 Installation.

2.5.4.1 As a rule, flexible hoses shall be limited to a length necessary to provide for relative movement between fixed and flexibly mounted items of machinery equipment or piping.

2.5.4.2 Flexible hoses shall not be installed where they may be subject to torsion deformation (twisting) under normal operation conditions.

2.5.4.3 The number of flexible hoses in piping systems shall be kept to a minimum and shall be limited for the purpose stated in 2.5.2.

2.5.4.4 Where flexible hoses are intended for use in piping systems conveying flammable fluids that are in close proximity of heated surfaces, the risk of ignition due to failure of the hose assembly shall be mitigated by screens or other similar protection as approved by the Register.

2.5.4.5 Flexible hoses shall be installed in clearly visible and readily accessible locations.

2.5.4.6 The installation of flexible hoses shall be in accordance with the manufacturer's instructions and use limitations with particular attention to the following:

orientation (with consideration for allowable movement in service);

end connection support (where necessary);

avoidance of hose contact that could cause rubbing and abrasion;

minimum bend radii.

2.5.5 Tests.

2.5.5.1 Acceptance of flexible hoses is subject to satisfactory prototype testing.

Prototype test programmes for flexible hoses shall be submitted by the manufacturer and shall be sufficiently detailed to demonstrate performance in accordance with the specified standards.

2.5.5.2 The tests shall be carried out on different nominal diameters of hose type complete with end fittings and shall incorporate tests in accordance with 2.5.5.3–2.5.5.6.

Other standards may be accepted when agreed by the Register.

2.5.5.3 Each flexible hose shall be tested by test pressure equal to 1.5 times the design pressure during 5 min. No residual deformations and damages are accepted.

2.5.5.4 All flexible hoses shall be tested by burst pressure equal to four times the design pressure during 5 min. Residual deformations without visible damages or leaks are accepted.

2.5.5.5 Pressure impulse tests shall be carried out during prototype tests for flexible hoses intended for installation in systems where pressure impulses are expected.

Pressure impulse tests shall be carried out to ISO 6802, ISO 6803, ISO 10380 or equivalent.

2.5.5.6 Fire resistance tests shall be carried out during prototype tests of flexible hoses referred to in 2.5.3.5.

The tests are carried out to ISO 15540 and ISO 15541 or equivalent.

2.5.6 Marking

2.5.6.1 Flexible hoses shall be permanently marked by the manufacturer with the following details:

hose manufacturer's name or trademark;

date of manufacture (month/year);

designation type reference;

nominal diameter;

pressure rating;

temperature rating.

Where a flexible hose is made up of items from different manufacturers, the components shall be clearly identified.

3. PLASTIC PIPELINES

3.1 DEFINITIONS

3.1.1 For the purpose of this Section, the following definitions have been adopted.

Fire resistance is the ability of plastic pipeline to maintain strength and integrity (i. e. ability to operate to its designated purpose) within the set period of time under flame exposure.

Joint is the connection of pipes by glueing, application of binding bands, welding, etc.

Nominal pressure is the maximum permissible working pressure as defined in 6.8.2.3, Part XIII "Materials".

Plastic materials are thermoplastic (thermoplasts) and thermosetting (thermosets) materials with or without reinforcement, such as polyvinyl chloride (PVC) and fibre reinforced plastic (FRP). Plastic materials include caoutchouc and materials with similar thermomechanical behaviour.

Design pressure is the maximum working pressure expected under operating conditions or the maximum pressure setting of the pressure-relief valve or pressure relieving device, if fitted.

Piping/piping system is a combination of plastic pipes, formed components, pipe joints and any internal or external coatings or linings as required under operating conditions.

Formed components are bends, elbows, connecting branches, etc. made of plastic.

3.2 SCOPE OF APPLICATION. GENERAL REQUIREMENTS

3.2.1 These requirements apply to all pipelines made from plastics.

3.2.2 The requirements do not apply to flexible non-metal joints, rubber hoses, as well as to mechanical unions used in systems with metal pipes.

3.2.3 General requirements to plastic pipes and fittings are stated in 6.8, Part XIII "Materials".

3.3 REQUIREMENTS FOR PIPING DEPENDING ON THEIR PURPOSE AND LOCATION

3.3.1 Fire resistance

3.3.1.1 Pipes and formed components, integrity of which has significant influence on ship's safety, shall meet the requirements of fire-resistance.

3.3.1.2 Depending on the pipeline ability to maintain integrity during fire-resistance tests according to the procedure

stated in IMO resolutions A.753(18) and MSC.313(88), five degrees of fire-resistance are specified:

L1 for pipelines withstanding fire-resistance test in dry state during 1 h without leakage during further hydraulic tests;

W1 for pipelines not carrying flammable liquid or any gas and withstanding fire-resistance test in dry state during 1 h with a maximum of 5 per cent flow loss in the system;

L2 for pipelines withstanding fire-resistance test in dry state during 30 min. without leakage during further hydraulic tests;

W2 for pipelines not carrying flammable liquid or any gas and withstanding fire-resistance test in dry state during 30 min. with a maximum of 5 per cent flow loss in the system;

L3 for pipelines withstanding fire-resistance test in filled state during 30 min. without leakage during further hydraulic tests.

The scope of application of pipelines based on their fire resistance level, location and the media conveyed is given in Table 3.3.1.2.

3.3.2 Flame spread, fire-retardant coatings

3.3.2.1 All pipes, except for those located on open deck, in tanks, cofferdams, empty spaces, pipe tunnels etc., shall have low surface flame spread characteristics not in excess of the mean values stated in IMO resolution A.653(16) and calculated using the method given in Annex 3 to resolution IMO A.753(18) as amended by MSC.313(88), with a due account of the changes due to the bent pipe surface, or in other Register-approved standards.

3.3.2.2 Where fire-retardant coatings are used to provide adequate fire resistance, these shall comply with the requirements of 6.8, Part XIII "Materials".

3.3.2.3 Fire-retardant coatings in joints shall be applied following system hydraulic tests in accordance with the manufacturer's recommendations using methods approved by the Register in each case.

Table 3.3.1.2 **Application of plastic pipelines**

Ser. No.	Conveyed medium	Pipeline systems	Location										
			A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Liquid cargo with $T_{flash} \leq 60^{o}C$	Cargo	–	–	L 1	–	–	O	–	O[10]	O	–	L 1[2]
		Crude oil tank washing	–	–	L 1	–	–	O	–	O[10]	O	–	L 1[2]
		Exhaust gas	–	–	–	–	–	O	–	O[10]	O	–	+
2	Inert gas	Pipelines from hydraulic lock	–	–	O[1]	–	–	O[1]	O[1]	O[1]	O[1]	–	O
		Pipeline from purifier	O[1]	O[1]	–	–	–	–	–	O[1]	O[1]	–	O
		Main pipe	O	O	L 1	–	–	–	–	–	O	–	L 1[6]
		Distribution pipelines	–	–	L 1	–	–	O	–	O[10]	O	–	L 1[2]
3	Flammable liquids	Cargo	+	+	L 1	+	+	–[3]	O	O	O	–	L 1
		Fuel oil	+	+	L1	+	+	–[3]	O	–	O	L1	L1

	with T_{flash} > 60 °C	Oil	+	+	L1	+	+	–	–	O	O	L1	L1
		Hydraulic	+	+	L1	+	+	O	O	O	O	L1	L1
4	Sea water	Bilge	L1[7]	L1[7]	L1	+	+	–	O	O	O	–	L1
		Drain pipelines of internal spaces	W1[4]	W1[4]	–	W1[4]	O	–	O	O	O	O	O
		Sanitary drains (internal)	O	O	–	O	O	–	O	O	O	O	O
		Drainage from weather decks	O[1, 8]	O[1, 8]	O[1, 8]	O[1, 8]	O[1, 8]	O	O	O	O	O[1, 8]	O
		Firemain system and water spraying	L 1	L 1	L 1	+	–	–	–	O	O	+	L1
		Foam fire-extinguishing	W 1	W 1	W 1	+	–	–	–	O	O	W 1	W 1
		Sprinkler	W 1	W 1	L 3	+	–	–	–	O	O	L 3	L 3
		Ballast	L 3	L 3	L 3	L 3	+	O[10]	O	O	O	W 2	W 2
		Essential purpose cooling systems	L 3	L 3	–	–	–	–	–	O	O	–	W 2
		Non-essential purpose cooling systems	O	O	O	O	O	–	O	O	O	O	O
		Crude oil tank washing	–	–	L 3	–	–	O	–	O	O	–	L 3[2]
5	Fresh water	Essential purpose cooling systems	L 3	L 3	–	–	–	–	O	O	O	L 3	L 3
		Condensate return system	L 3	L 3	L 3	O	O	–	–	–	O	O	O
		Non-essential purpose cooling systems	O	O	O	O	O	–	O	O	O	O	O
6	Other media	Air, sounding and overflow pipes: water tanks and dry compartments	O	O	O	O	O	O[10]	O	O	O	O	O
		Flammable liquids, T_{flash} > 60 °C	+	+	+	+	+	+[3]	O	O[10]	O	+	+
		Pneumatic control systems	L 1[5]	L 1[5]	L 1[5]	L 1[5]	L 1[5]	–	O	O	O	L 1[5]	L 1[5]
		Air pipes for domestic needs	O	O	O	O	O	–	O	O	O	O	O
		Brine	O	O	–	O	O	–	–	–	O	O	O
		Low pressure vapour	W 2	W 2	O[9]	O[9]	O[9]	O	O	O	O	O[9]	O[9]

Symbols:

A — machinery spaces of category A;
B — other machinery spaces;
C — cargo pump rooms, including accesses and trunks;
D — cargo spaces of roll-on/roll-off ships;
E — dry cargo rooms and trunks;
F — cargo tanks and trunks;
G — fuel oil tanks and trunks;
H — ballast tanks and trunks;
I — cofferdams, dry compartments etc.;
J — accommodation spaces, service spaces, control stations;
K — weather decks;
L1, L2, L3 — fire-resistance tests under 3.3.1.2;
O — fire-resistance test not required;
"–" — not applicable;
"+" — only metal materials with fusion point above 925 °C.

[1] Outside remote-controlled valves shall be installed at shipside.

[2] For cargo tanks the remotely closing valves shall be provided.

[3] When cargo tanks contain flammable liquids with flash point > 60 °C, "O" may be used instead of "–" or "+".

[4] For drainage pipelines servicing only the particular space "O" may be used instead of "L1".

[5] When control functions are not foreseen, "O" may be used instead of "L1".

[6] For pipeline between engine room and deck hydraulic lock "O" may be used instead of "L1".

[7] For passenger ships "+" shall be used instead of "L1".

[8] Scupper holes of weather decks in the positions 1 and 2 according to Regulation 13 of the International Convention on Load Line, 1966, shall be "+", if they are not provided with appropriate blanking means.

[9] For essential purposes, such as heating of cargo tanks and ship's typhon, "+" shall be used instead of "O".

[10] For oil tankers where compliance with 3.6, Regulation 19, Annex 1 to MARPOL 73/78, "–" shall be used instead of "O".

3.3.2.4 Fire-retardant coatings shall be used according to the approved recommendations of the manufacturer.

3.4 INSTALLATION REQUIREMENTS

3.4.1 Supports

3.4.1.1 Choice of supports and distances between them shall be determined depending on permissible stresses and maximum allowable pipe swag.

Distances between supports shall not exceed the values recommended by the manufacturer.

In selection of supports and distances between them pipes sizes, mechanical and physical properties of pipe material, mass of pipes and liquid contained, external pressure, working temperature, influence of heat expansion, load of outer forces, axial forces, hydraulic impact, vibration, which may occur in the system, shall be taken into consideration. Allowance shall be made for the possible simultaneous effect of the above mentioned loads.

3.4.1.2 The load from pipe weight shall be equally distributed over the entire load-bearing face of the support. Measures shall be taken to minimize pipe wear in the points of their junction with the supports.

3.4.1.3 Components of significant mass, such as valves, compensators, etc. shall be fitted with separate supports.

3.4.2 Heat expansion compensation

3.4.2.1 When assembling plastic pipelines the compensation tolerance for relative displacement between piping and steel structures with regard to difference in heat expansion ratio and ship's hull deformation shall be provided.

3.4.2.2 When calculating heat expansions the working temperature of a system and the temperature at which assembly is carried out, shall be taken into account.

3.4.3 Environmental stresses

3.4.3.1 In pipe laying, where necessary, allowance shall be made for periodically involved concentrated loads. At least the force generated by the load of one person of 100 kg in the middle of span of any pipe with the outer diameter over 100 mm shall be taken into consideration.

3.4.3.2 To ensure the appropriate rigidity of piping, including pipelines with open ends, the Register may require to increase the wall thickness in

comparison with that specified on the basis of strength control.

3.4.3.3 Where necessary, pipes shall be protected from mechanical damage.

3.4.4 Installation of electrically conductive pipes

3.4.4.1 In systems of liquids transmission with electrical conductivity less than 1000 pico-siemens per meter (PS/m), such as raffinates and distillates, the electrically conductive pipes shall be used.

3.4.4.2 Regardless of the liquids transmitted the plastic pipes passing through explosive areas shall be electrically conductive.

Resistance in any point of the pipeline system compared to earth shall not exceed 10^6 Ohm. Pipes and formed components with electrically conductive layers shall preferably be of equal conductivity.

Such pipes shall be sufficiently protected from damage by electric discharge caused by difference in the electrical conductivity of layers.

3.4.4.3 After installation earth connection shall be checked. Earthing wires shall be accessible for examination.

3.5 PLASTIC PIPE JOINTS

3.5.1 Strength of joints

3.5.1.1 The strength of joints shall not be less than the strength of a pipeline where they are mounted.

3.5.1.2 Pipes may be connected with glued, welded, flanged and other connections.

3.5.1.3 Glues used for pipe joints shall preserve tightness of joints over the whole pressure and temperature range.

3.5.1.4 Joints shall be tightened in compliance with the manufacturer's instructions.

3.5.2 Testing of joint quality

3.5.2.1 For the inspection of pipe joint quality test assemblies are prepared in accordance with the accepted procedure, which shall include at least one pipe-to-pipe joint and pipe-to-formed component joint.

3.5.2.2 Following joint setting, a test connection shall be subjected to a hydraulic pressure test during at least 1 hour at pressures 2.5 times the design one. Leakage and breaks of joint are not allowed.

Tests shall be arranged so that joints are loaded both in longitudinal and transverse directions.

3.5.2.3 When selecting pipes for test specimen the following shall be taken into consideration:

when the maximum outer diameter of joint assembly is less than 200 mm, the test assembly shall incorporate a pipe with the maximum diameter;

when the maximum outer diameter of joint assembly is over 200 mm, the outer diameter of test joint assembly shall be 200 mm or equal to 25 per cent of the maximum diameter of the coupling, whichever is greater.

3.6 PLASTIC PIPING LAYING

3.6.1 Where plastic pipes pass through watertight bulkheads and decks, A and B class divisions, the requirements of 5.1 shall be met.

3.7 INSPECTION DURING INSTALLATION

3.7.1 Installation shall be carried out in accordance with the instructions of the manufacturer.

3.7.2 The method of pipe connection (junction) shall be developed and approved prior to the installation.

3.7.3 Surveys and tests stated in this Section of the Rules shall precede the approval of the method.

3.7.4 Personnel involved in the works shall be properly qualified and attested.

3.7.5 In the method of joints connection the following shall be reflected: the applied materials, tools and accessories, the requirements for preparation of joints, temperature conditions, the requirements for dimensions and tolerances, as well as the acceptance criteria upon the work and testing completion.

3.7.6 Any alterations in the method resulting in a change of physical and mechanical properties of the joint call for its repeated consideration and re-approval.

3.8 TESTING OF PIPING AFTER INSTALLATION ABOARD THE SHIP

3.8.1 After installation the pipeline system of essential purpose shall be hydraulically tested with pressure at least 1.5 times higher than the design pressure.

3.8.2 The pipeline system of non-essential purpose may be tested for tightness with the working pressure.

3.8.3 For electrically conductive pipes the availability of grounding shall be checked and the spot check of resistance shall be carried out.

4. VALVES

4.1 CONSTRUCTION, MARKING, ARRANGEMENT AND INSTALLATION OF VALVES

4.1.1 Construction

4.1.1.1 Valves shall comply with the agreed standards.

Valve threaded covers shall be fitted with reliable stops.

Cock plug nut shall be protected against unscrewing when operating the cock.

4.1.1.2 Valves with remote control except those mentioned under 1.4.1.4 shall be arranged for local manual operation independent of the remote operating mechanism.

In the case of valves which are provided with remote control according to the requirements of the Rules, local manual operation of the valves shall not render the remote control system inoperable.

If the valves are provided with remote control, they shall be so designed that in case of failure of the remote control system, the valves remain, or automatically return, in a position that does not bring the ship in a dangerous situation.

4.1.1.3 Compressed air shall not be used in remote control systems to operate actuators inside cargo tanks.

4.1.1.4 Where the valves inside cargo tanks are remote-controlled by means of a hydraulic system, they shall be also operable with the aid of a hand pump, which can be connected to the hydraulic system in positions where the pipes are laid down to each valve, or to a separate pipe laid directly to the valve actuator.

4.1.1.5 The supply tank of the hydraulic remote control system of the valves inside cargo tanks shall be located

as high as practicable above the top of the cargo tanks, and all supply pipes shall enter the cargo tanks through the highest part of the cargo tanks.

The supply tank shall also have an air pipe laid to a safe position on the open deck and fitted with a flame-arresting gauze at the open end.

This tank shall be fitted with a low level audible and visual alarm.

4.1.2 Marking of valves

4.1.2.1 Shut-off valves shall be provided with conspicuous nameplates fixed in place and bearing clear inscriptions to show the purpose of valves.

4.1.2.2 At the control stations, the remote-controlled valves shall have identification plates, as well as "open" and "closed" position indicators.

Where the remote control is used only to close the valves, the indicators need not be fitted.

4.1.3 Installation of valves

4.1.3.1 The valves arranged on watertight bulkheads shall be secured to welded pads by studs, or to bulkhead sockets with flange connections. Joints of types D and E (refer to 2.4.3.2) are not allowed.

The stud holes shall not be through holes.

4.1.3.2 The valve chests and the hand-controlled valves shall be fitted in places where they are at all times readily accessible in normal operating conditions.

Where the valves of the fuel oil system are installed in the machinery space, the valve control gear shall be fitted above the plating**.**

4.1.3.3 The measuring instruments of fuel oil and lubricating oil systems shall be provided with valves or cocks to shut the instruments off from piping. Thermometer sensors shall be fitted in compact sleeves.

4.2 FILTERS

4.2.1 The design of filters shall facilitate their cleaning.

4.2.2 Filters shall be provided with a device to indicate the absence of pressure before they are opened.

The tubes of such devices shall be directed to trays so that spillages are not sprayed around.

4.2.3 Filters forming part of systems with a combustible working medium shall be provided with an interlock so that they cannot be opened when under pressure and that the working medium cannot be supplied therein when opened.

4.2.4 Filters shall be so arranged that they are readily accessible for maintenance.

Filters and strainers forming part of systems with a combustible working medium shall be located as far away as practicable from sources of ignition.

4.2.5 The pipelines used to supply and carry away fuel oil in/from the filters shall be equipped with shut-off valves or cocks.

4.2.6 Filters on seawater suction mains shall comply with 15.3.1.

4.3 SEA CHESTS AND ICE BOXES. BOTTOM AND SIDE VALVES. OPENINGS IN SHELL PLATING

4.3.1 Sea chests and ice boxes

4.3.1.1 The number and arrangement of sea chests for the cooling water system shall comply with 15.2.1.

In ships with the ice strengthening of categories **Ice5** and **Ice4** one of the sea chests shall function as an ice box. In

icebreakers and ships with **Ice6** ice category, at least two sea chests shall be ice boxes.

In icebreakers and ships with the ice strengthening of categories **Ice6, Ice5** and **Ice4**, the ice box design shall allow for an effective separation of ice and removal of air from the ice box to ensure reliable operation of the sea-water system.

Sea inlet valves shall be secured directly to sea chests or ice boxes.

4.3.1.2 In icebreakers and ships strengthened for ice navigation, provision shall be made for the heating of the sea chests and ice boxes as well as of the ship side valves and fittings above the load waterline.

For this purpose:

cooling water recirculation shall be used for ice boxes and sea chests;

ship side valves and fittings shall be supplied with heating medium through a non-return shut-off valve.

The heating arrangements shall be so designed as to prevent the side valves and fittings and shell plating from being damaged in case of defrosting.

Electric heating systems with special heating cables may be used for side valves and fittings heating.

When heating cables are used, the requirements of 5.8 shall be complied with.

For ice boxes the recirculated water pipes shall be laid to the upper and lower part of the box, and the total sectional area of these pipes shall not be less than the area of the cooling water discharge pipe. For sea chests, the diameter of the water recirculating pipe shall not be less than 0.85 of the discharge pipe diameter.

4.3.1.3 Provision shall be made for the access into these boxes via detachable gratings or manholes. If a manhole is provided in the ice box it shall be located above the deepest load line.

4.3.2 Shell openings. Bottom and side valves

4.3.2.1 The number of openings in shell plating shall be kept to a minimum. Therefore, where possible, discharge pipes shall be connected to common discharges.

4.3.2.2 The arrangement of sea inlet and discharge openings in ship sides shall be such as to prevent:

.1 sewage, ash and other waste being sucked by sea water pumps;

.2 sewage and discharge water penetrating into the ship spaces through side scuttles as well as any discharge of water into lifeboats and liferafts when lowered.

Where compliance with the requirements of 4.3.2.2.2 is impracticable, discharge openings shall be fitted with appropriate arrangements to prevent the ingress of water into ship spaces, lifeboats and liferafts.

4.3.2.3 Openings in ship side for sea chests and ice boxes shall be fitted with gratings. Instead of gratings, holes or slots in shell plating are permissible. The net area through the gratings or slots shall not be less than 2.5 times the area of the valve connected to the sea inlet. The diameter of holes and the width of slots in ratings or shell plating shall be about 20 mm.

The gratings of the sea chests shall be provided with a steam or compressed air connection for clearing purposes. For ice boxes, clearing arrangements are not compulsory.

Clearing pipes shall be provided with non-return shut-off valves. The pressure of steam or compressed air in the clearing system shall not exceed 0.5 MPa.

4.3.2.4 The overboard discharges from enclosed spaces below the freeboard deck or from enclosed superstructures and deckhouses on the freeboard deck shall be fitted with accessible means for preventing water from passing inboard.

Discharges from piping, which have, or may have, open ends within the mentioned spaces shall comply with the requirements of 3.2.11, Load Line Rules for Sea-Going Ships.

4.3.2.5 In ships less than 24 m in length, openings in shell plating of spaces on and below the freeboard deck may have one locally controlled non-return shut-off valve.

In floating docks, each discharge of pipes from spaces below the margin line, which have inboard ends in those spaces, shall have a non-return valve with a positive means of closing from a readily accessible position above the safety deck.

4.3.2.6 The scuppers and overboard discharge pipes from open decks and spaces not specified in 4.3.2.4 either 450 mm below the freeboard deck or less than 600 mm above the summer load waterline shall be fitted with non-return valves (dampers) at the outer shell. In this case, the wall thickness of scuppers and discharge pipes shall not be less than stated in column 3 of Table 2.3.8.

No valves need be provided if the wall thickness of pipes below the freeboard deck and in spaces within enclosed superstructures is at least:

7 mm for $d \leq 80$ mm,

10 mm for $d = 180$ mm,

12.5 mm for $d \geq 200$ mm,

where d = external diameter of pipes.

Intermediate sizes shall be determined by linear interpolation.

In open superstructures and deckhouses, overboard scuppers shall be provided.

In spaces intended for the carriage of motor vehicles with fuel in their tanks, overboard scupper pipes shall be provided to prevent accumulation of water during the operation of the water spraying system.

In floating docks, the overboard scuppers and discharge pipes below the margin line from spaces above the margin line and open decks shall have non-return valves at the outer shell. The valves may be omitted where the pipe thickness below the margin line is not less than that of the outer shell plating; however, it need not exceed 12 mm.

4.3.2.7 In engine rooms, the sea inlets and discharges of the systems and piping in connection with the operation of the main and auxiliary machinery shall be provided with readily accessible shut-off valves locally (to be closed clockwise using hand wheels) or remotely controlled.

The controls shall be provided with indicators showing whether the valve is open or closed.

The discharge valves, as a rule, shall be of the non-return shut-off type.

4.3.2.8 The controls of inlet bottom and side valves shall be readily accessible and shall be provided with an indicator showing whether the valve is open or closed.

In passenger ships, these controls shall be located above the floor level of the engine room.

4.3.2.9 In periodically unattended machinery spaces the controls of any valve serving a sea inlet, a discharge below the waterline or a bilge injection system shall be so sited as to allow the time taken for the influx of water to reach the control be greater than the time to reach and operate the control with the nominal speed of travel of a person onboard not more than 1 m/s. In any case, the time taken for the influx of water to reach the control shall be not less than 10 min.

If the level to which a space can be flooded with the ship in the fully loaded condition is above the controls, provision shall be made to operate them from a position above this level.

Machinery spaces fully automated in respect of control of sea inlet and discharge valves of the main and auxiliary machinery systems and piping shall be regarded equal to attended machinery spaces on condition that the provision is made for arrangements to be activated when the space is being flooded.

4.3.2.10 Bottom and side valves shall be attached to welded pads.

The valves may be also installed on branch pipes welded to the shell plating, provided they are straight, rigid and have the minimum length and cathodic protection against contact corrosion.

Branch pipes shall be located in readily accessible places for maintenance and for measuring of shell plating thickness under service conditions.

The use of flanged joins of D and E types (refer to 2.4.3.2), thread and mechanical joints to install bottom and side valves below the waterline is not allowed. The design of connections shall be submitted to the Register for approval.

The wall thickness of a branch pipe is determined according to 2.2.5.4, Part II "Hull".

The stud holes shall not be through holes.

4.3.2.11 The bottom and side valves shall have housings of steel, bronze or another viscous material as approved by the Register. Valves with housings of grey cast iron, aluminium alloys, plastic or other similar materials easily damaged in case of fire or impact are not accepted.

The material of the seal between the bottom and side valves and the hull (pad or nozzle) shall not be easily deteriorated in case of fire and shall not be fusible (like rubber or lead), or special structural measures shall be taken to prevent deterioration of the seal.

As a rule, the bottom and side valves shall be of flanged type. Valves of other types are also allowed provided that the attachment of the bottom and side valves to hull structures ensures their operability and watertightness of the hull when a piping section adjacent thereto is dismantled.

4.3.2.12 The spindles, movable and shut-off parts of bottom and side valves shall be manufactured of corrosion-resistant materials. Protection against contact corrosion shall be provided in accordance with 1.4.3.4.

4.3.2.13 The shell openings from garbage chutes of spaces located below the freeboard deck shall be provided with closing devices to prevent water from passing inboard.

The shut-off devices shall meet the requirements of 3.2.11.1 of the Load Line Rules for Sea-Going Ships.

4.3.2.14 Side valves of boiler blow off pipes shall be attached to welded pads. Welded protection rings shall be fitted at the outer side of the shell plating.

The flange collar of a valve shall pass through the welded pad, plating and the protection ring. Valve collars are not mandatory where such collars are fitted on the pad.

Valves shall installed in readily accessible places, not below the floor level of spaces. It should be easily seen whether the valve is open or closed.

4.4. AIR PIPE AUTOMATIC CLOSING DEVICES

4.4.1 Air pipe automatic closing devices shall be self-draining, have reliable attachments, and shall also:

.1 prevent the free entry of water into the tanks;

.2 allow the passage of air or liquid to prevent excessive pressure or vacuum coming on the tank.

4.4.2 Air pipe automatic closing devices shall be designed to allow inspection of the interior of the casing, as well as changing the seals.

4.4.3 Efficient float seating arrangements shall be provided for the closures. Beside seating arrangements, other means shall be provided to prevent the float from contacting the inner chamber in its normal state and to prevent the float damage from the water impact in case the tank is overfilled.

4.4.4 The clear area through an air pipe automatic closing device in the open position shall be at least equal to the area of the inlet.

4.4.5 Air pipe automatic closing devices shall be suitable for use at inclinations up to 40°.

4.4.6 In the case of air pipe automatic closing devices of the float type, suitable guides shall be provided to ensure unobstructed operation under all working conditions of heel and trim.

4.4.7 The maximum allowable tolerances for wall thickness of floats shall not exceed 10 per cent of thickness.

4.4.8 Casings of air pipe automatic closing devices shall be of approved metallic materials with the minimum wall thickness of 6 mm adequately protected against corrosion. The thickness of the zinc coating to be applied by the hot method shall be 70 to 100 microns.

4.4.9 For areas susceptible to erosion due to the ballast water impact when the tank is being overfilled, (e. g. the inner chamber area above the air pipe, overlap of ± 10° either side) an additional harder coating shall be applied. This shall be an aluminium bearing epoxy or another equivalent coating applied over zinc.

4.4.10 Elements of closures made of non-metallic materials shall be compatible with the media carried in the tank and suitable for operating at ambient temperatures between −25 °C and +85 °C.

4.4.11 Air pipe automatic closing devices shall be type approved.

The minimum test requirements shall be in compliance with 21.4.

5. PIPING LAYING

5.1 PIPING LAYING THROUGH WATERTIGHT AND FIREPROOF DIVISIONS

5.1.1 The number of pipelines passing through the watertight bulkheads shall be kept to a minimum.

Pipelines passing through main watertight bulkheads shall, as a rule, be situated at a distance from the ship's side of at least one-fifth of the ship's breadth (refer to 7.3.5).

Where this requirement is impracticable, measures shall be taken to prevent the spread of sea water
beyond the damaged compartment into other watertight compartments and tanks in case of damage to the ship's hull and deterioration of pipes.

5.1.2 In cargo ships of 80 m in length and more and in passenger ships irrespective of their length, not more than one pipe for dealing with liquid in the forepeak tank may pass through the collision bulkhead below the bulkhead deck. This pipe, at a point where it penetrates the collision bulkhead, shall be fitted with a screw-down valve on the collision bulkhead inside the forepeak, operated from a readily accessible place above the bulkhead deck. Such valve may be fitted on the after side of the collision bulkhead provided that the valve is readily accessible under all service conditions and the space in which it is located is not a cargo space. Butterfly valve may not be fitted instead of a screw-down valve.

If the forepeak is divided by a longitudinal bulkhead into two watertight compartments to hold two different kinds of liquids, the collision bulkhead may be allowed to be pierced below the bulkhead deck by two pipes, each fitted with such valve. On pipes passing through the collision bulkhead above the bulkhead deck or freeboard deck a screw-down valve may be omitted.

5.1.3 In cargo ships not mentioned in 5.1.2 each pipe passing through the collision bulkhead below the bulkhead deck shall be fitted with a screw-down valve installed on the collision bulkhead inside the forepeak.

Such valve may be fitted on the after side of the collision bulkhead, provided that the space in which it is located is not a cargo space.

Such valve shall be operated from a readily accessible place above the bulkhead deck for ships having the subdivision mark in the class notation, or above the freeboard deck for other ships.

On pipes passing through the collision bulkhead above the bulkhead deck or freeboard deck a screw-down valve may be omitted.

5.1.4 Where pipelines pass through watertight bulkheads, decks and other watertight structures, appropriate bulkhead (sockets), welded pads and other details shall be used to ensure the integrity of the structure concerned.

The holes for studs shall not penetrate through the plating of watertight structure and shall be kept within the welded pads.

Gaskets made of lead or a material which is readily deteriorated in the event of fire, shall not be used.

Sockets welded to watertight decks and bulkheads shall have the wall thickness at least 1.5 mm greater than that of pipes connected to the sockets.

In passenger ships, no valves that are not part of systems or pipelines may be installed on watertight subdivision bulkheads.

The bulkhead sleeves or sockets for pipes penetration through the watertight decks and bulkheads shall be attached by butt, full-penetration welding. The use of lap or fillet welds is allowed if the integrity is ensured by two welds (on both sides of the bulkhead).

5.1.5 Where plastic pipes pass through watertight bulkheads and decks forming boundaries of watertight compartments, valves operated from above the bulkhead deck shall be fitted.

The valves shall be of steel or another material equivalent to steel in fire resistance.

This requirement does not apply to ballast pipes laid within the double bottom.

5.1.6 Where pipes pass through fire-resisting divisions, the requirements of 2.1.2.2, Part VI "Fire Protection" shall be complied with.

5.1.7 Where a plastic pipe passes through a division of the main vertical fire zone, provision shall be made for bulkhead steel sleeve and valve that may be closed from either side of the bulkhead. The valves shall be of steel or another material equivalent to steel in fire resistance.

5.1.8 The arrangement of penetration and sealing of pipe bundles through the bulkhead socket shall be subject to special consideration by the Register.

The bulkhead sockets in watertight bulkheads and decks shall be filled with sealing masses with good adhesion with the pipe and socket metal, resistant to vibration and to water and oily products, which do not shrink and do not cause loss of sealing during prolonged operation under conditions specified in 2.3.1, Part VII "Machinery Installations".

The sealing of the pipe bundle penetration through the fireproof bulkheads shall be such as to withstand standard fire test specified for the bulkhead of this type in 2.1.2.2, Part VI "Fire Protection".

5.2 PIPING LAYING IN TANKS

5.2.1 Bilge pipes, drinking water and feed water pipes shall not be laid through fuel oil and lubricating oil storage tanks, nor shall fuel oil and lubricating oil pipes pass through drinking water and boiler feed water tanks, unless the pipes are laid in oiltight ducts forming part of the tank structure.

Sea water and lubricating oil piping, with no ducts as well as air, overflow and sounding pipes may pass through the fuel storage tanks, if these pipes are of seamless type and have no detachable joints inside the storage tanks; where detachable joints cannot be avoided, they shall be flanged with oilproof gaskets placed between them or compression couplings according to Table 2.4.5.1.

5.2.2 Where the pipes passing through the tanks are not carried in ducts and thermal expansion shall be considered, pipe bends shall be arranged inside the tank.

Where pipes are laid in ducts, it is recommended that thermal compensators be arranged outside the duct.

5.2.3 The pipes laid in oil tankers shall comply with the requirements of 9.2.

5.3 PIPING LAYING IN CARGO HOLDS AND OTHER SPACES

5.3.1 Pipes shall be secured in a way as not to cause stresses from thermal expansion, undue deformation of ship structure and vibration.

5.3.2 Pipes passing through cargo holds, chain lockers and other spaces, in which they are subject to mechanical damage, shall be adequately protected.

5.3.3 Fuel, steam and water pipes as well as pressure pipes of the hydraulic drives shall not, as a rule, be carried in dry cargo holds. Bilge pipes are excluded from this requirement.

In exceptional cases, which are subject to special consideration by the Register, these pipes are allowed, provided they are laid in special ducts or not in ducts where the pipes employed are of increased thickness and protected by strong steel casings.

5.3.4 Steam pipes shall not be laid in paint rooms, lantern rooms or other spaces intended for the carriage of flammable materials.

5.3.5 Pipes conveying fuel oil shall not be laid through the accommodation and service spaces as well as under the coating, with the exception of fuel pipe of the emergency diesel-generator and the filling pipes, which may be laid through sanitary spaces, provided the pipes used are not less than 5 mm thick and no detachable joints are employed.

5.3.6 Pipes of considerable longitudinal extension conveying hot media shall have thermal compensators or as many bends as will provide adequate self-compensation of the pipeline.

Thermal compensators are fitted in order to take up the axial and transverse displacements and shall not be used to compensate for misalignment of pipelines.

Pipelines shall have suitable supports. Brackets and hangers shall not be used to provide for alignment of pipelines and fittings.

The radii of pipe bends shall comply with the requirements of 2.2.1.

5.3.7 Piping and ventilation ducts, where necessary, shall be fitted with devices for draining or blow-down of the working medium or moisture.

Special structural measures shall be taken to prevent deterioration of the hull structural elements and equipment by blow-down products.

5.3.8 Fire fighting piping shall be laid in accordance with 3.1.4.1, Part VI “Fire Protection”.

5.3.9 Piping for Groups I and II refrigerants passing through accommodation and service spaces shall be laid in accordance with 6.2.8, Part XII “Refrigerating Plants”.

5.3.10 Where hot pipes pass through bulkheads of flammable materials, special structural measures shall be taken to prevent the impact of elevated temperatures on the bulkheads.

5.4 PIPING LAYING IN REFRIGERATED CARGO SPACES

5.4.1 It is recommended that no pipes be laid through refrigerated cargo spaces, unless they are intended to serve these spaces. Where laying of such pipes cannot be avoided, they shall be properly insulated. This requirement equally ap-

plies to air and sounding pipes. In these spaces the pipes shall not have sections in which water may collect and freeze.

5.5 PIPING LAYING IN THE VICINITY OF ELECTRICAL AND RADIO EQUIPMENT

5.5.1 Pressure pipes may not be laid above and behind the main and emergency switchboards as well as the control panels of essential machinery and equipment.

Piping may be laid at a distance of not less than 500 mm from the fronts and sides of the switchboards and control panels, provided that at a distance of 1500 mm to the switchboards and panels and along them no detachable joints are used on piping or the joints have protective casings.

5.5.2 Laying of pipes through special electrical spaces (refer to 1.2, Part XI "Electrical Equipment") and also through accumulator battery rooms is not allowed, with the exception of fire smothering pipes, compressed air pipes and the pipes serving the electrical equipment installed in these spaces.

5.5.3 Laying of pipes through the space with a gyrocompass is not allowed, with the exception of gyrocompass cooling pipes.

5.5.4 Laying of pipes through the radioroom is not allowed.

5.6 PIPING LAYING IN UNATTENDED MACHINERY SPACES

5.6.1 Class I pipes conveying fuel oil and lubricating oil shall have welded joints. Detachable joints may be used, but their number shall be kept to a minimum; if considered necessary, protective casings shall be provided in places where detachable joints are fitted.

5.7 PIPING LAYING IN SHIPS WITH TWIN HULLS

5.7.1 When routed along the common upper deck, the pipes connecting identical systems of both hulls shall be provided with compensators where necessary and protected against damage.

Damage to these pipes shall not involve failure of the systems connected by them.

5.8 PIPELINES WITH ELECTRIC HEATING

5.8.1 Electrical equipment in systems incorporating pipelines provided with electric heating shall meet the requirements of 15.4.3 to 15.4.6, Part XI "Electrical Equipment".

5.8.2 Cables and devices for control of electric heating of pipelines, as well as pipelines located in dangerous spaces shall be of safe type.

5.8.3 The heating cable shall be installed after hydraulic tests of the pipelines and application of anticorrosive coating using the manufacturer's technique approved by the Register.

5.8.4 If necessary, pipelines equipped with electric heating shall be covered by a protective casing placed over the insulation to prevent mechanical damage to heating cables.

5.8.5 When installing the heating cable, provision shall be made for loops at the locations of demountable joints of the pipeline to ensure dismounting of the pipeline without break of integrity of the heating cable.

5.8.6 Warning notices "Caution, electric heating" shall be affixed to pipelines and valves with electric heating. The notices shall be located in conspicuous places 3 m apart along the pipeline length.

6. SHIP'S HOSES

6.1 CONSTRUCTION OF HOSES

6.1.1 The requirements of this Section apply to ship's hoses for taking over and transfer of liquid cargo, fuel oil, lubricating oil, bilge and polluted ballast waters and transfer of cargo vapours.

6.1.2 Only the hoses as finished items consisting of sleeves and end components (branch pipes with flanges, nipples or other joints) may be used in ships.

6.1.3 As a rule, a hose sleeve shall be made of rubber reinforced with fabric, textile cord or cord with steel wire. In addition, the hose sleeve may be reinforced with one or several layers of wire coil, rings or by other means. The use of other materials and structures shall be specially considered by the Register in each case.

Sleeve material shall be resistant to the conveying medium within the whole range of temperatures, for which purpose special coating of the inner surface is allowed.

The outer surface shall be resistant to wear, attrition, insolation, atmosphere and impermeable for sea water and cargo. The outer surface may be coated with polyurethane or another material which affords buoyancy. This coating shall have similar properties with regard to external impacts.

Design and material of sleeves and hoses intended for transfer of liquefied gases is subject to special consideration by the Register in each case.

6.1.4 End components shall be connected to the hose sleeve mechanically or chemically.

Connection of sleeves with end components by means of clamps is permitted only by agreement with the Register.

6.1.5 When welding is used in the structure of end components, it shall be performed by certified welders and is subject to 100 per cent check by non-destructive testing methods.

6.1.6 The material of end components and flanges shall exclude the possibility of spark formation during interaction with the ship's hull. Surfaces of end components shall be protected against corrosion influence of sea water and medium conveyed.

6.1.7 The hose is assumed to be floating when its buoyancy reserve is at least 20 per cent, provided the hose is completely immersed in sea water and completely filled with it.

The hose buoyancy reserve is calculated as follows:

$$K = \frac{B - (W_h + W_w)}{W_h + W_w} \cdot 100\ \%$$

where K = buoyancy reserve, %;

B = weight of sea water displaced by the hose when immersed completely, including weight of sea water displaced by materials ensuring buoyancy and weight of sea water inside the hose, kg;

W_w = weight of sea water inside the hose, kg;

W_h = weight of empty hose in air, including weight of materials ensuring buoyancy, kg.

Materials applied to provide buoyancy shall be properly secured.

6.1.8 Floating hoses shall be orange-coloured or marked with a spiral-shaped orange strip. The width of strip is 100 mm, the pitch of spiral is 450 mm. The strip shall be fixed to the facing in the process of curing.

6.1.9 For the transfer of cargo at sea from one ship to another and during the cargo operations with the use of offset point berths, as a rule, the floating hoses shall be used; in the hose lines a quick-action device for emergency disconnection shall be provided.

The design of such device shall be specially considered by the Register in each case. In hose lines equipped with quick-action emergency disconnection devices allowance shall be made for hydraulic impact which may occur when the device is actuated and, if necessary, the flow velocity of liquid shall be limited.

The hoses of the devices for cargo and bunkering operations shall be a matter of special consideration by the Register in each case.

6.1.10 On both ends of a hose the following shall be clearly marked.

In hose documentation the following shall be indicated:

name of the manufacturer or trade mark;

serial number of the hose according to the manufacturer's data;

month and year of production;

permissible working pressure;

indication of electrical conductivity.

6.1.11 Hoses shall be stored on ship in a place shielded from direct sunlight, with allowance for the minimum bending radius and in accordance with the recommendations of the hose manufacturer. Provision shall be made for structural means for discharge and removal of cargo remains from the hoses. Measures for prevention of wear of the hoses while handling and operation shall be taken.

6.1.12 For cargo vapour discharge, hoses with the allowable working pressure of at least 0.2 MPa and vacuum of at least 0.014 MPa shall be used. Burst pressure of the hose shall not be less than 5 times working pressure of the hose.

The last meter from each end of the hose shall be painted in compliance with Fig. 6.1.12 and marked with the sign "VAPOUR" made in black letters not less than 50 mm high.

Each flange shall have an additional bore on the coupling bolts line for the stud of the shipboard manifold connecting flange (refer to 9.9.11 and Fig. 9.9.11-1).

Only electrically conductive hoses shall be used in the system for vapour to shore discharge.

6.2 TESTING OF HOSES

6.2.1 Each sleeve type used for manufacture of hoses shall be subjected to type tests according to 6.2.2 to 6.2.5, 6.2.7, 6.2.8.

Each hose type shall be type tested according to 6.2.2, 6.2.6, 6.2.7, and 6.2.8.

Hose type tests may be combined with sleeve type tests.

After manufacture, each hose shall be tested in accordance with 6.2.6.

6.2.2 Permissible working pressure p_{work} is determined as follows:

$$p_{work} = p_{burst}/k \quad (6.2.2)$$

where p_{burst} = pressure, at which the break of hose or end connection tightness occurs;

k = coefficient assumed equal to:

4 — for transfer of crude oil and oily products, bilge and polluted ballast water;

5 — for transfer of chemical cargoes, liquefied gases and cargo vapours.

Permissible working pressure of the hose shall not be less than 1.0 MPa, with exception of the hoses specified in 6.1.12.

When conducting the burst pressure tests, the testing of samples with the length not less than 10 nominal diameters but at least 1 m is allowed.

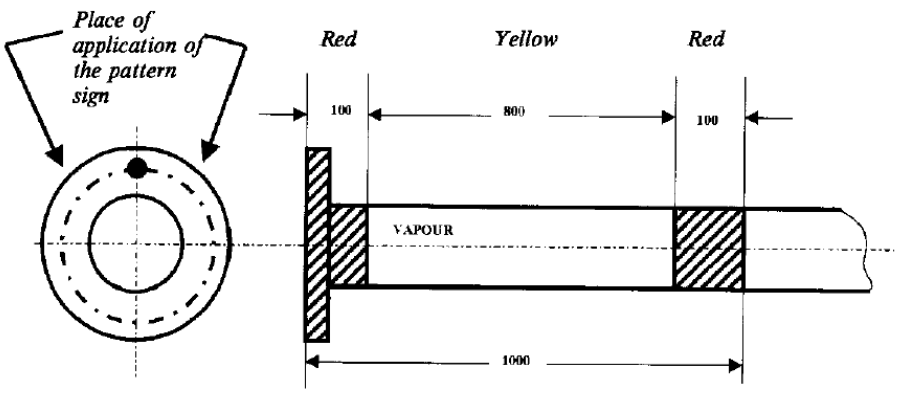


Fig. 6.1.12. Cargo vapour hose marking

6.2.3 Sleeves for cargo and fuel oil hoses of ice-class ships shall be subjected to cold endurance type tests.

For this purpose samples of the hoses shall be kept at the temperature of −40 °C during 4 h. In 4 h the sample shall be tested for elasticity by means of bending for 180° two times in the opposite directions around the adapter with a diameter of *R*, where *R* is a minimum bending radius, followed by visual examination. After freezing and bending no cracks shall appear on the internal and external surfaces of the sample. Where necessary, the sample may be cut along the axis for the internal surface inspection.

On agreement with the Register, another method for freeze resistance test with allowance made for special structural features may be accepted.

6.2.4 The sleeves of hoses intended for operation under ambient pressure conditions shall be vacuum tested with negative pressure of 85 kPa during 10 min. After the tests the hose shall be examined and rejected where deformation or flattening is found.

6.2.5 The samples manufactured as strip test pieces in accordance with the procedure approved by the Register (Fig. 6.2.5)

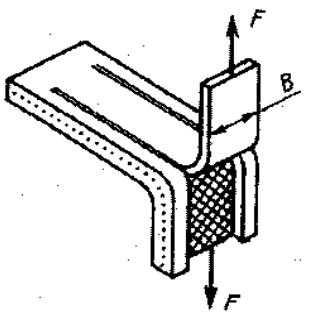


Fig. 6.2.5

are subject to adhesion test of all rubber sleeve layers. The adhesion strength of rubber contact faces is determined as a ratio of the mean force F originated at detachment, divided by the strip width B and shall be at least 3 N/mm.

6.2.6 Each hose after manufacturing shall be subjected to the following tests:

.1 determination of weight.

After weighing, the hose weight shall be recorded in the certificate. For floating hoses, the buoyancy reserve shall be defined according to 6.1.7;

.2 hydraulic tests by test pressure: $P_{test} = 1.5p_{work}$ (for p_{work} refer to 6.2.2), with determination of elongations;

.3 electrotechnical tests including:

measuring of resistance between flanges of hoses lacking electrical conductivity (the resistance shall not be less than 25,000 Ohm and not more than 10^6 Ohm);

conductivity test for electrically conductive hoses with the voltage of 4.5 V testing bulb.

6.2.7 The cargo hoses of oil tankers and hoses for taking on and transfer of fuel and oil shall undergo type tests at normal temperature for 15 cycles of pressure rise from zero up to 1.5 the maximum permissible working pressure.

After 15 cycles the sample shall be subjected to strength test by burst pressure according to 6.2.2.

6.2.8 Cargo hoses for transfer of chemical cargoes and liquefied gases shall undergo type tests at normal temperature for 200 cycles of pressure rise from zero up to twice the maximum permissible working pressure.

After 200 cycles the sample shall be subjected to strength test by burst pressure according to 6.2.2.

6.2.9 Hydrostatic tests of hoses with determination of elongation shall be carried out within the scope of hose type tests.

The test procedure shall be as follows:

.**1** the hose is arranged so that nothing prevents its elongation;

.2 the hose is filled with water, with air let out completely; the pressure is raised from zero to the rated value and reduced to zero for 15 times. The time for each operation is calculated based on the following ratio: 1 second per 50 mm of hose diameter;

.3 pressure is then raised to 0.07 MPa, and the total length of the hose is measured;

.4 pressure is raised up to the rated value within 5 min. and kept for 10 min. The hose is examined for the presence of leakage;

.5 with pressure on the same level, the total length of the hose is measured and tensile elongation is determined as percentage of the initial length of the hose measured at 0.07 MPa. The tensile elongation shall not exceed 2.5%;

.6 within 5 min. the pressure is reduced to zero. Then, not earlier than in 15 min., the pressure is raised to 0.07 MPa again, the total length of the hose is measured and residual elongation is determined as percentage of the initial length measured at 0.07 MPa. The residual elongation shall not exceed 0.7%.

6.2.10 The minimum hose bending radius shall be checked for each type and size fitted as follows: empty hose is bent 5-fold in the opposite directions at the

radius R equal to the minimum bending radius of the hose. Upon completion of the test, i. e. when the hose is straightened again, it shall show no permanent deformation like twisting or oval curves, and no cracks shall be present on the outer surface of the specimen. Where necessary, the sample may be cut along the axis for the internal surface inspection.

On agreement with the Register, another method for freeze resistance test with allowance made for special structural features may be accepted.

7. BILGE SYSTEM

7.1 PUMPS

7.1.1 Each self-propelled ship shall be provided with at least two power bilge pumps.

Centrifugal bilge pumps shall be of self-priming type, otherwise the system shall be equipped with an air sucking-off arrangement. It is recommended that one of the installed pumps is of piston type.

Independent ballast, sanitary or general service pumps of sufficient capacity may be used as bilge pumps, and in ships of 91.5 m in length and less, including special purpose ships carrying not more than 60 persons, one of the bilge pumps may be a pump driven by the propulsion machinery, as well as a water or steam ejector, provided the steam boiler is always in operation.

If fire pumps are used as bilge pumps, the requirement of 3.2.3.2, Part VI "Fire Protection" shall be met.

In cargo ships of less than 500 gross tonnage of restricted areas of navigation **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN,** one of the pumps may be driven by the propulsion machinery, and the other may be an ejector or a hand type.

In special purpose ships and all other ships having a subdivision distinguishing mark (and above) in its class notation (refer to 2 rt V "Subdivision"), the number and arrangement of bilge pumps shall be specially considered by the Register in each case.

7.1.2 Passenger ships and special purpose ships carrying more than 60 persons shall be fitted with at least three power pumps connected to the bilge main; one of these pumps may be driven by the propulsion machinery. Where the bilge pump numeral is 30 or more, one additional independent power pump shall be provided.

Independent ballast, sanitary and general service pumps of sufficient capacity may be used as bilge pumps.

Where a water fire extinguishing system is used in ships intended for the carriage of motor vehicles, where necessary, an increase in the bilge pump capacity or in the number of bilge pumps may be required by the Register.

7.1.3 The bilge pump numeral shall be calculated as follows:

when P_1 is greater than P:

$$\textit{bilge pump numeral} = 72\,[(M + 2P_1)/(V + P_1 - P)];$$

in other cases:

$$\textit{bilge pump numeral} = 72\,[(M + 2P)/V],$$

where M = the volume of the machinery spaces below the bulkhead deck with the addition thereto of the volume of any permanent oil fuel bunkers which may be situated above the inner bottom and forward of, or abaft, the engine room, m^3. The

volume of the machinery space shall include the volume between watertight boundaries of spaces containing the main propulsion plant, auxiliary machinery, including boilers, generators and electric motors generally intended for providing the propulsion plant operation;

P = the full volume of the passenger and crew spaces below the bulkhead deck, which are provided for the accommodation and use by passengers and crew, excluding baggage, store, provision and mail rooms, m^3;

V = full volume of the ship below the bulkhead deck, m^3;

$P_1 = KN$,

where $K = 0.056L$

L = the length of the ship as defined in the Load Line Rules for Sea-Going Ships, m;

N = the number of passengers for which the ship shall be certified.

However, if the value of KN is greater than the sum of P and the full volume of the actual passenger spaces above the bulkhead deck, the figure to be taken as P_1 is that sum or two-thirds of KN, whichever is greater.

7.1.4 On passenger and special purpose ships carrying more than 60 persons 91.5 m and more in length or having a bilge pump numeral of 30 or more (refer to 7.1.3), the arrangements shall be such that at least one power bilge pump is available for use in all flooding conditions which the ship is to withstand. This requirement is considered to be satisfied if one of the required bilge pumps is an emergency pump of a reliable submersible type having a source of power situated above the bulkhead deck; or the bilge pumps and their sources of power are so distributed throughout the length of the ship that at least one pump in an undamaged compartment is available.

7.1.5 It is recommended that in passenger ships and special purpose ships not specified in 7.1.4 and in ships having a subdivision mark in the class notation, bilge pumps, where practicable, be placed in different watertight compartments with the system so arranged that requirements of 7.3.6 are met.

The bilge system of passenger ships with the length, as defined in 1.2.1 of the Load Line Rules for Sea-Going Ships, of 120 m or more or having three or more main vertical zones shall comply with the requirements of 2.2.6.7.5, 2.2.6.8 and 2.2.7.4, Part VI "Fire Protection".

7.1.6 Each bilge pump under 7.1.1 and 7.1.2 shall have a capacity Q, in m^3/h, not less than that determined from the formula

$$Q = 5.65 \cdot 10^{-3} \cdot d_1^2, \qquad (7.1.6)$$

where d_1 = inner diameter of the main determined in accordance with 7.2.1, mm.

The bilge pump may be replaced by two pumps with a total capacity not less than that specified above.

For passenger ships, each bilge pump shall have a capacity determined on the assumption that the rated speed of water through the internal diameter required in 7.2.1 shall not be less than 2 m/s.

7.1.7 For drainage of non-propelled ships having no power-driven machinery, at least two hand pumps of reciprocating type shall be installed, and these shall have a total capacity not less than specified in Table 7.1.7.

In each case D is measured up to the bulkhead deck only.

In a ship having an enclosed cargo space on the bulkhead deck, which is drained in accordance with 7.6.12.2 and which extends for the full length of the ship, D shall be measured to the next deck above the bulkhead deck.

Table 7.1.7

$0.8L \times B \times D$[1], m^3	Total pump capacity, m^3/h
Up to 100	4
101–600	8
601–1100	10
1101–1800	12

[1] *L*, *B*, *D* (side length, width and height, m) are defined in Part IV "Stability".

Where the enclosed cargo spaces extend to a lesser length, *D* shall be taken as the depth to the bulkhead deck plus *lh/L*, where *l* and *h shall* mean total length and height of enclosed cargo spaces, respectively.

The pumps shall be arranged above the bulkhead deck and shall have a sufficient suction head.

In non-propelled ships provided with power sources, it is recommended that power pumps be fitted, the number and capacity of which shall comply with the requirements for the hand pumps.

7.1.8 In ships with twin hulls, provision shall be made for an independent bilge system for each hull, which shall comply with the requirements of the Subsection.

7.1.9 In berth-connected ships, at least two bilge pumps shall be installed, power-driven and each having a capacity not less than 11.0 m^3/h, whereas the design water speed in the branch bilge suctions shall not be less than 2 m/s under normal service conditions.

The pumps shall ensure drainage of any space below the bulkhead deck, and their drives shall be so arranged along the ship length that at least one of the pumps installed in an intact compartment can drain a flooded space.

In case where a berth-connected ship serves its direct service without shore power supply and the ship is not provided with a propulsion plant, the power-driven bilge pumps may be omitted, and the bilge system shall meet the requirements of 7.1.7.

7.1.10 Ships with distinguishing marks **FF1, FF1WS, FF2, and FF2WS** in the class notation shall have bilge pumping arrangements for pumping water out of flooded compartments of ships in distress.

Such arrangements may include pumps (fixed and/or portable) and ejectors.

The type, number and capacity of the pumps shall be specified by the Designer and agreed upon with the Customer and the Register.

Ejectors are permitted where special provisions are made for the elimination of twisting of both feeding and suction sleeves.

7.1.11 In passenger ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS** and **D-R3-S**, **D-R3-RS** in the class notation, bilge pumps shall be provided depending on the number of passengers for which the ship is certified, in the quantity as follows:

up to 250 passengers: one pump driven by the propulsion machinery and one pump driven from the power source, which is located outside of the machinery space;

more than 250 passengers: one pump driven by the propulsion machinery and two pumps driven from the power source one of which is located outside of the machinery space.

The bilge pump driven from the propulsion machinery may be replaced with one pump driven from the power source.

If main engines, auxiliary machinery and boilers are located in two or more watertight compartments, pumps which may be used as for drainage shall be distributed between these compartments, where practicable.

Bilge pumps may not be installed forward of the collision bulkhead, except for pumps intended for servicing spaces located forward of the collision bulkhead.

The drainage of very small compartments may be dealt with movable hand pumps.

7.1.12 Provision shall be made for devices for measuring suction and discharge pressure of every bilge pump.

7.2 PIPING DIAMETERS

7.2.1 The internal diameter d_1, in mm, of the main bilge line and that of bilge suctions directly connected to the pump, except in 7.2.3, shall be determined by the formula

$$d_1 = 1{,}68\sqrt{L(B + D)} + 25. \quad (7.2.1\text{-}1)$$

In vessels of dredging fleet having hopper spaces, the diameter of the bilge main and the direct bilge suctions directly connected to the pump may be obtained from the formula

$$d_1 = 1{,}68\sqrt{L(B+D) - l_1(b+D)} + 25, \quad (7.2.1\text{-}2)$$

where l_1 = length of the hopper space;
b = mean width of the hopper space;
L, B, D — refer to 7.1.7.

In cargo ships of less than 500 gross tonnage navigating in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN** the internal diameter of the bilge main and of direct bilge suctions directly connected to the pump may be obtained from the formula

$$d = 1{,}5\sqrt{L(B + D)} + 25. \quad (7.2.1\text{-}3)$$

7.2.2 The internal diameter d_0, in mm, of the branch bilge suctions connected to the bilge main, and that of the hand pump suction, shall be determined by the formula

$$d_0 = 2{,}15\sqrt{l(B + D)} + 25, \quad (7.2.2\text{-}1)$$

where l = the length of the drained compartment measured along the bottom, in m;

for B, D refer to 7.1.7. In the case of ships with twin hulls, B is assumed to be the width of one hull.

In cargo ships of less than 500 gross tonnage navigating in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN** the internal diameter d, in mm, of branch bilge suctions connected to the bilge main and the diameter of the hand pump suction may be obtained from the formula

$$d = 2{,}0\sqrt{l(B + D)} + 25. \quad (7.2.2\text{-}2)$$

7.2.3 The internal diameter of the main bilge line and that of bilge suctions as determined from Formulae (7.2.1-1) and (7.2.2-1) shall be at least 50 mm, and that determined from the Formulae (7.2.1-3) and (7.2.2-2) shall be at least 40 mm.

The internal diameter of pipes directly connected to the pump in all cases shall be at least equal to the diameter of the bilge pump tube assembly.

7.2.4 The cross-sectional area of the pipe connecting the distribution chest with the bilge main shall not be less than the total cross-sectional area of two largest branch bilge suctions connected to that chest, but not greater than the sectional area of the bilge main.

7.2.5 In oil tankers and other ships in which the bilge pumps are intended for draining of the engine room only, the cross-sectional area of the bilge main shall not be less than twice the cross-sectional area of the branch suction, the diameter of which is determined from Formula (7.2.2-1).

7.2.6 The diameter of the emergency bilge suction in the engine room shall be determined in compliance with 7.4.6.

7.3 PIPING LAYING

7.3.1 The bilge lines and their branch suctions shall be so arranged as to enable any watertight compartment to be drained by one of the pumps required in 7.1.1, 7.1.2 and 7.1.11. This requirement does not apply to the spaces of ammonia refrigerating machinery, the peaks, the pump rooms and cofferdams of oil tankers, drained by individual pumps, as well as to the tanks intended for storage of liquids only.

Drainage of spaces not connected to the bilge system shall be carried out by the drain pipes laid to the drained spaces or by hand pumps; compliance with the requirements of 7.12.2 shall also be provided.

7.3.2 The system shall be arranged so as to prevent the possibility of sea water passing inside the ship, or from one watertight compartment into another, in case of pipe break or any other pipe damage in any other compartment because of collision or grounding. For this purpose the suction valves of the drainage pipes open ends, connected directly to the chests, and valves of the branch suctions connected directly to the main, shall be of screw-down non-return type.

In case a single general pipeline system for all pumps is available, the provision shall be made for the possibility to control the required valves servicing suction branch pipes from the places above the bulkhead deck. Other equivalent arrangements are allowed.

7.3.3 The arrangement of the bilge pipes shall be such as to ensure the possibility of draining the engine rooms through the suctions directly connected to the pump, other compartments being simultaneously drained by other pumps.

7.3.4 The arrangement of the bilge pipes shall be such as to enable one of the pumps to be operated in case the rest of pumps are inoperative or are used for other purposes.

All suction bilge pipes throughout the entire length to the pumps shall be separated from other pipelines.

7.3.5 The bilge suction pipes, where they are at any part situated nearer to the ship's side than one-fifth of the width of the ship (measured at right angles to the centre line at the level of the deepest subdivision load line), as well as when passing in duct keel or within double bottom, shall have non-return valves fitted to their branch suctions in each watertight compartment.

7.3.6 On passenger ships of more than 91.5 m in length, special purpose ships carrying more than 60 persons and in passenger ships having a bilge pump numeral of 30 or more, all distribution chests, cocks and valves associated with the bilge pumping system shall be so arranged that in the event of flooding one of the bilge pumps may be operative on any flooded compartment.

Moreover, damage of a pump or its pipe connecting to the bilge main out-

board of a line drawn at one-fifth of the width of the ship shall not put the bilge system out of action.

Where there is only one system of pipes common to all pumps, the necessary cocks and valves for controlling the bilge suctions shall be fitted with means enabling them to be controlled from above the bulkhead deck.

In the places of their installation they shall be provided with the controls with clear indication of their purpose and also means for indicating whether they are open or closed.

Where, in addition to the main bilge pumping system, an emergency bilge pumping system is provided, it shall be independent of the main system and shall be so arranged that a pump is capable of operating on any compartment under flooding conditions. In this case, only the cocks and valves required for emergency system control need be suited to be operated from above the bulkhead deck, while the pump and associated suction pipes shall be situated farther from the ship's side than one-fifth of the width of the ship.

7.3.7 In general, the bilge pipes shall be laid outside the double bottom. Where these pipes need be laid through the tanks for storage of fuel oil, lubricating oil, boiler feed water and drinking water, the pipes shall meet the requirements of 5.2.1.

Where the pipe is laid within the double bottom, the bilge suctions in each watertight compartment shall be fitted with non-return valves.

7.3.8 Oily-water separating and filtering equipment shall be used for purification of water before discharging overboard. The installation and operation of such equipment shall not interfere with normal working of the bilge and ballast systems indicated in 13.1.2.

7.3.9 Measures shall be taken to prevent accidental flooding with sea water of deep tanks with bilge and ballast suctions where these tanks contain cargo, or pumping through the bilge line, when the tanks contain ballast water or fuel.

7.3.10 All bilge pumping system distribution chests and valves that are manually driven shall be located in areas allowing full access under normal conditions.

7.4 DRAINAGE OF MACHINERY SPACES

7.4.1 Where the engines and boilers are located in the same compartment and the double bottom extends either the full length forming bilges at the wings, or the full length and breadth of the compartment, two bilge suctions shall be provided at each side near the bulkheads in the compartment, one of which shall be connected directly to an independent bilge pump.

7.4.2 Where the engines and boilers are located in the same compartment with no double bottom, and the rise of floors is not less than 5°, two bilge suctions shall be provided, one of which shall be direct-connected to an independent bilge pump; where the rise of floor is less than 5°, additional bilge suctions connected to the bilge main shall be provided, one at each side.

7.4.3 Where the engines and boilers, as well as the auxiliaries or electric propulsion motors, are located in separate watertight compartments, the number and position of bilge suctions therein shall be as set forth in 7.6.

In ships having in the class notation a mark of subdivision, each of these compartments shall be fitted with an additional bilge suction direct-connected to an independent bilge pump.

In passenger ships each of the independent power bilge pumps, located in machinery spaces, shall have direct suctions in these spaces. No more than two suctions are required for these spaces. Where two or more suctions are fitted, at least one of them shall be located on the port and the other on the starboard side. Bilge pumps not associated with each other, located in other spaces may have direct suctions in these spaces.

7.4.4 Where the machinery space is situated at the after end of the ship, bilge suctions shall be fitted in the forward wings of the space. On agreement with the Register, one or two suctions shall be provided depending on the shape of the aft end.

7.4.5 Suctions for bilge drainage of machinery spaces and tunnels shall be fitted with readily accessible mud boxes. The pipes between the mud boxes and bilges shall be as straight as practicable. The lower ends of these pipes need not be fitted with strum boxes. Mud boxes shall have covers that may be easily opened.

In small ships, instead of the mud boxes, strum boxes may be used, provided they are accessible for cleaning.

7.4.6 In all self-propelled ships provision shall be made for emergency bilge drainage of the engine rooms, in addition to the suctions required by 7.4.1 to 7.4.4. For this purpose any of the main circulating pumps in steam ships, and the cooling pump of maximum capacity in motor ships, shall be fitted with direct suction pipe at the drainage level of the engine room and fitted with non-return stop valve. The diameter of this direct suction shall be at least two-thirds of that of the pump suction in steam ships, and shall be of the same size as the suction branch of the pump in motor ships.

No strum boxes or strainers shall be fitted on the suction for emergency bilge drainage.

Where the pumps specified above are not suitable for operation as bilge pumps, a direct emergency bilge suction shall be laid from the drainage level of the engine room to the largest available power pump, which is not a bilge pump. The capacity of this pump shall exceed that required in 7.1.6 by an amount satisfactory to the Register. The diameter of the emergency bilge suction shall not be less than that of the pump suction branch.

The spindles of the screw-down non-return valves fitted to the suction branches shall extend above the engine room floor plates to a sufficient height and shall have nameplate “For emergency use only”.

The use of fire pumps for emergency bilge drainage of machinery spaces shall be in accordance with 3.2.3.2, Part VI “Fire Protection”.

In cargo ships of less than 500 gross tonnage navigating in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN,** which have no independent pump of a capacity exceeding that of the bilge pump, the emergency drainage system of machinery spaces may be operated by an attached sea-water cooling pump.

If side and bottom valves in accordance with 4.3.2.9 are installed between the emergency bilge drainage valve and the side, the requirements of 4.3.2.9 need

not apply to the emergency drainage shut-off valve of non-return type.

7.4.7 Where there is a double bottom, the machinery spaces shall be fitted with bilge wells of a capacity not less than 0.2 m^3.

7.4.8 Additional bilge suctions shall be laid in the log and echo sounder trunks, and also to the double-bottom bilge wells under the machinery and in other places, which may accumulate water.

7.4.9 In ships having an electric propulsion plant, the arrangements shall be such that the bilge wells under the propulsion motors are properly drained and automatic alarms are fitted to give warning when the permissible level in the wells is exceeded.

Automatic drainage of bilge wells is recommended.

7.4.10 The ammonia refrigerating machinery space shall have an independent bilge system. Where a water spraying system is provided in this space, the capacity of the bilge pump shall be sufficient for the water consumption during the operation of that system. The discharge pipe of the bilge system shall be laid directly overboard.

The space for freon refrigerating machinery may be drained through the bilge main of the ship.

7.4.11 The spindles of the valves fitted to the suction branches shall extend above the engine room floor plates to a sufficient height.

7.5 DRAINAGE OF TUNNELS

7.5.1 Each shaft tunnel and each accessible pipe tunnel shall be drained by a bilge suction situated in the after part of the tunnel.

Where required, additional suctions shall be provided in the fore part of the tunnel. The bilge suctions of the shaft tunnel shall be made in compliance with the requirements set forth in 7.4.5.

7.6 DRAINAGE OF CARGO SPACES

7.6.1 Each cargo space, where the double bottom forms bilges at the wings, shall have at least one bilge suction in the after part of the hold at each side of the ship.

7.6.2 Where the inner bottom plating extends over the full width of the space, bilge wells shall be arranged in the after part of the hold, one at each side.

The capacity of the wells shall comply with the requirements of 7.4.7.

7.6.3 In spaces where the inner bottom plating has an inverse camber, provision shall be made also for suctions at the centre line, in addition to the suctions situated at the wings. Where a bilge well extends over the entire width of the space and the inverse camber exceeds 5°, one branch suction may be laid to this well.

7.6.4 Where manholes for access to bilge wells are provided, they shall be arranged as near to the suction strums as practicable.

7.6.5 Where there is no double bottom and the rise of floor in the space exceeds 5°, one bilge suction may be fitted near the centre line. If the rise of floor is less than 5°, at least two suctions shall be fitted, one at each side of the hold.

7.6.6 Where the length of a hold exceeds 35 m, the bilge suctions shall be fitted in the fore and after parts of this hold, with the requirements of 7.6.1 to 7.6.5 complied with.

7.6.7 At narrow ends of cargo spaces, one bilge suction is allowed.

7.6.8 The drain pipes from spaces located below the bulkhead deck and communicating with the cargo space in the same compartment may be laid into the wells of that hold.

Drainage into the wells of cargo spaces from spaces located in other watertight compartments below the bulkhead deck is not permitted.

The requirements for drainage into the bilges of refrigerated cargo spaces are given in 7.8.

7.6.9 Where a ceiling or removable covers is fitted over the bilges or wells in cargo spaces, provision shall be made for free access of water into the bilges or wells.

7.6.10 Branch bilge suctions shall be fitted with strum boxes or strainers having perforations 8 to 10 mm in size. The total area of these perforations shall not be less than twice the clear area of the given suction pipe.

The strum boxes and strainers shall be removable, or provision shall be made for cleaning them without having to disassemble the suction.

7.6.11 The bilge system in bulk carrier cargo spaces shall be so designed that its operability is not affected when bulk cargo is carried.

7.6.12 For the drainage of enclosed cargo spaces located on the bulkhead deck of a passenger or cargo ship that is assigned a subdivision distinguishing mark in its class notation, and on the freeboard deck of other cargo ships, the arrangements specified under 7.6.12.1 and 7.6.12.2 shall be provided.

For the drainage of special category spaces located below the bulkhead deck, the arrangements specified under 7.6.12.2 shall be provided.

7.6.12.1 Where the freeboard up to the bulkhead deck or the freeboard deck height is such that the deck edge is immersed when the ship heels more than 5°, the drainage shall be by means of scuppers discharging directly overboard.

The scuppers and drain pipes shall be arranged and fitted according to 4.3.2.6 or 7.12.4.

The scuppers from special category spaces of passenger ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS** and **D-R3-S**, **D-R3-RS** in the class notation, arranged with reliable opening devices controlled from above the bulkhead deck, shall be open when the ship is at sea.

7.6.12.2 Where the freeboard height is such that the edge of the deck is immersed when the ship heels 5° or less, the drainage of the enclosed cargo spaces on this deck shall be laid to suitable spaces of adequate capacity having a high water level alarm and suitable arrangements for discharge overboard. In such cases it shall be ensured that:

.1 the number, size and disposition of the scuppers are such as to prevent unreasonable accumulation of free water;

.2 the pumping arrangements for the drainage of cargo spaces provide water drainage with any fixed water fire extinguishing systems, including spraying systems, that are required for passenger and cargo ships, respectively.

The bilge system (refer to 7.1) shall have a capacity not less than 125 per cent of the total capacity of the water fire main and water-spraying system pumps with due regard for the required number of fire nozzles, and shall be calculated

considering the requirements of IMO MSC.1/Circ.1320[2];

.3 valves of the drainage arrangements shall be controlled from a position outside the space protected, located nearby the water-spraying system controls.

Bilge wells shall have sufficient capacity and be arranged in the vicinity of the side plating not more than 40 m apart in each watertight compartment. Water contaminated with petrol or other dangerous substances shall not be drained to machinery spaces or other spaces containing sources of ignition;

.4 where the enclosed cargo space is protected by a fire smothering system the deck scuppers are fitted with means to prevent the escape of gas.

7.6.12.3 On all ships, for closed vehicles and ro-ro spaces and special category spaces, where fixed pressure water-spraying systems are fitted, means shall be provided to prevent the blockage of drainage arrangements, taking into account the requirements of IMO MSC.1/Circ.1320.

An easily removable grating, screen or other means shall be installed over each drain opening in the protected spaces to prevent debris from blocking the drain. The total open area ratio of the grating to the attached drain pipe shall be at least 6 to 1.

The grating shall be raised above the deck or installed at an angle to prevent large objects from blocking the drain. Dimensions of the individual openings in the grating shall not exceed 25 mm.

A clearly visible sign or marking shall be provided not less than 1500 mm above each drain opening stating:

"Drain opening — do not cover or obstruct".

The marking shall be in letters at least 50 mm in height.

7.6.13 The bilge system of cargo holds with weathertight hatch covers above the superstructure deck outside the positions 1 and 2 (refer to 7.1.4, Part III "Equipment, Arrangements and Outfit" of these Rules and 3.2.1 of the Load Line Rules for Sea-Going Ships) shall have the pumps of an increased capacity with regard to additional water ingress due to:

.1 the stable amount of precipitation equal to 100 mm/h, which penetrates through the total area of gaps between closures sections;

.2 the consumption of water by a sprinkler system (if fitted), whichever is greater.

The internal diameter of a bilge main shall be increased in compliance with an increased pump capacity.

Each cargo hold shall be fitted with a limit water level alarm system in bilge wells.

7.6.14 On container ships, holds fitted with weathertight closures and intended for dangerous cargoes shall be considered open-type container holds in accordance with paragraphs 10 and 11 of MSC/Circ.608/Rev. 1.

7.6.15 The cargo spaces of bulk carriers and single-hold cargo ships shall be provided with alarms in compliance with the requirements of 2.4, Part XV "Automation", located on the navigating bridge, as well as 7.10, Part XI "Electrical Equipment".

[2] Refer to IMO MSC.1/Circ.1320: Guidelines for the drainage of fire-fighting water from closed vehicle and ro-ro spaces and special category spaces of passenger and cargo ships.

The alarm system detectors shall be positioned at two levels:

0.5 m above the inner bottom;

15 per cent of the depth of cargo space but not more than 2 m above the inner bottom.

The visual signals of each cargo space and each level shall be clearly distinguishable.

For cargo holds which are used for water ballast, an alarm-overriding device may be installed to be activated when ballast is loaded therein.

7.7 DRAINAGE OF CARGO PUMP SPACES OF OIL TANKERS

7.7.1 The cargo pump rooms of oil tankers shall be drained by separate pumps or ejectors arranged in these rooms. Stripping pumps may be used as bilge pumps, provided non-return shut-off valves are fitted at the open ends of the bilge suctions and a shut-off valve is arranged on a pipe connecting the valve box and the stripping pump.

The pump rooms in oil tankers of up to 500 gross tonnage may be drained by hand pumps.

Construction of the pumps shall preclude the possibility of spark formation to a maximum.

Arrangement of the driving machinery of the pumps shall meet the requirements of 4.2.5, Part VII "Machinery Installations".

The cargo pump rooms shall be provided with a visual and audible high bilge water level alarm to give warning to the cargo control station and navigation bridge.

7.8 DRAINAGE OF REFRIGERATED CARGO SPACES

7.8.1 Provision shall be made for drainage of water from all the spaces, trays, chutes and other places, which may accumulate water.

7.8.2 Drain pipes from non-refrigerated spaces shall not be laid into the bilges of refrigerated spaces.

7.8.3 Each drain pipe of refrigerated cargo spaces shall be fitted with a liquid sealed trap or with another equivalent arrangement. The head of liquid shall be such that the arrangement operates effectively under any conditions of service.

The liquid sealed traps shall be placed in accessible positions outside the insulation. Where drain pipes from the 'tween-deck spaces and the hold are laid into a common bilge well, non-return valves shall be fitted to the open ends of the drains from the hold.

7.8.4 No shut-off valves shall be fitted on the drains from refrigerated spaces.

7.9 DRAINAGE OF FORWARD SPACES OF BULK CARRIERS

7.9.1 These requirements apply to the means for draining and pumping ballast tanks forward of the collision bulkhead, and bilges of dry spaces, any part of which extends forward of the foremost cargo hold, except the enclosed spaces the volume of which does not exceed 0.1 per cent of the ship maximum displacement volume and the chain lockers.

7.9.2 The means for draining and pumping ballast tanks forward of the collision bulkhead, and bilges of dry spaces, any part of which extends forward of the cargo hold, shall be operated from the navigation bridge or propulsion machin-

ery control position or from an enclosed space easily accessible from the navigation bridge or propulsion machinery control position without traversing exposed freeboard or superstructure decks.

A pipe trunk or a similar means of access shall not be considered a "readily accessible enclosed space".

7.9.3 The drainage arrangements shall be such that when they are in operation, other systems essential for the safety of the ship including fire-fighting and bilge systems remain available and ready for immediate use.

The systems for normal operation of electric power supplies, propulsion and steering shall not be affected by the operation of bilge systems.

It shall be also possible to start fire pumps immediately and have a readily available supply of water as well as to be able to configure and use the ship's bilge system for any compartment.

7.9.4 The drainage arrangements shall be such that any accumulated water can be drained directly by a pump or ejector. The drainage arrangements shall be designed to remove water at a rate of not less than $320 \times A$, m^3/h,

where A is the cross-sectional area in m^2 of the largest air or venting pipe leading from the exposed deck to the space that is required to be drained.

7.9.5 Bilge wells shall be provided with gratings or strainers that will prevent blockage of the bilge system with debris.

7.9.6 Where pipes serving tanks or bilges mentioned in 7.9.2 pass through the collision bulkhead, as an alternative to the valve control specified in 5.1.3, valve operation by means of remotely operated actuators is accepted, provided that the location of such valve controls complies with 7.9.2.

7.9.7 Where the piping of bilge system for closed spaces is connected to the piping arrangements for the drainage of water ballast tanks, two non-return valves shall be provided to prevent the ingress of water into dry spaces from the water ballast tanks. One of these non-return valves shall be fitted with shut-off isolation arrangement. The non-return valves shall be located in readily accessible positions.

The valve control position shall meet the requirements of 7.9.2.

In addition, the valve shall comply with the requirements of 4.1.1.2 and 4.1.2.2.

7.9.8 Any dry spaces or cofferdams other than chain lockers, the volume of which does not exceed 0.1 per cent of the ship maximum displacement volume, fully or partly located forward of the foremost cargo hold, shall be fitted with water level detectors giving audible and visual alarms at a water level of 0.1 m above the deck.

7.9.9 The cargo spaces of bulk carriers, except as mentioned in 7.9.8, any part of which extends forward of the first cargo hold, shall be provided with alarms in compliance with the requirements of 7.6.15.

Ballast tanks installed forward of the collision bulkhead shall be provided with an alarm system with limit sensors to indicate filling up to 10% of the tank's capacity. Alarm systems of such tanks may be shut down where the tanks contain ballast water.

7.10 DRAINAGE OF COFFERDAMS

7.10.1 Cofferdams filled with water shall be provided with drainage means. The arrangement of branch suctions shall comply with the requirements of 7.6.

In oil tankers and combination carriers, the filled cofferdams adjoining cargo tanks or slop tanks shall have automatic drain arrangements.

7.11 FORE AND AFT PEAK DRAINAGE

7.11.1 Where the peaks are not used as water ballast tanks or otherwise, they may be drained by their own hand pumps or water ejectors.

For draining of fore compartments in oil tankers, other than cargo compartments, provision shall be made for a separate pump or ejector, which may also be used for filling and draining of water ballast tanks only.

7.12 DRAINAGE OF OTHER SPACES

7.12.1 Chain lockers and boatswain's stores may be drained by means of hand pumps, water ejectors or other means.

7.12.2 Steering engine rooms and other compartments situated above the after peak may be drained by hand pumps or water ejectors, as well as through drain pipes laid into the bilges of shaft tunnels or engine rooms.

The drain pipes shall be fitted with readily accessible self-closing valves and shall be not less than 39 mm in inner diameter.

In passenger ships, drain pipes shall not be used for drainage of the above-mentioned spaces.

7.12.3 Drain pipes shall not be laid into the bilges of engine rooms and shaft tunnels from the spaces situated in other watertight compartments below the bulkhead decks (except for cases specified in 7.12.2).

Drain pipes from these spaces may be laid into the engine rooms and shaft tunnels only if terminated in closed drain tanks.

Where several watertight compartments have a common drain tank, the drain pipes from these compartments shall be fitted with non-return valves to prevent the passage of water from one compartment into another in the event of flooding.

The drain tank may be discharged through the bilge main, provided a non-return valve is fitted on the branch suction or the distribution chest.

7.12.4 Drain pipes from enclosed superstructures and deckhouses may be laid into the bilges (wells) of the engine room or the holds.

In ships with a mark of subdivision in the class notation, these pipes shall be fitted with valves controlled from a place above the bulkhead deck to prevent penetration of water in the above-mentioned spaces shall the engine room or hold become flooded.

7.12.5 Drain pipes for drainage of storerooms for explosives shall be fitted with valves controlled from locations outside these rooms.

7.12.6 Drainage facilities in way of helidecks shall be constructed of steel and shall lead directly overboard independent of any other ship's systems. No drains shall pass into any other parts of the ship.

7.12.7 Where passenger and crew spaces in passenger ships are fitted with a sprinkler system and a fire-fighting system, these shall have an adequate number of scuppers to allow drainage of water which passes into the spaces through sprinklers and two fire hoses. Scuppers shall be located in the most effective positions, i. e. in every corner.

7.12.8 Bilge system of gas fuel storage spaces

7.12.8.1 The bilge system of gas fuel storage spaces shall be an independent system not connected to the bilge systems of other ship's spaces.

7.12.8.2 The bilge system of gas fuel storage spaces shall met the requirements of 7.6.1 to 7.6.7.

7.12.8.3 Level and temperature sensors shall be installed in the bilge well (refer to 7.23.1.4, Part XI "Electrical Equipment").

7.13 DRAINAGE OF FLOATING DOCK COMPARTMENTS

7.13.1 Machinery spaces and dry compartments shall be provided with draining means.

The requirements of this Section, except for 7.3.2 and 7.3.9, shall not apply to the bilge system of floating docks.

7.14 DRAINAGE OF SPACES INTENDED FOR THE CARRIAGE OF DANGEROUS GOODS

7.14.1 Enclosed cargo spaces and cargo spaces of container ships of open type intended for the carriage of flammable liquids with flash point below 23 °C or toxic liquids of subclass 6.1 specified in 7.2.4 and Table 7.2.4-3, Part VI "Fire Protection" shall be equipped with the fixed bilge system located outside the machinery space.

The self-contained bilge system shall meet the following requirements:

.1 the capacity of the self-contained bilge system shall be not less than 10 m^3/h when one space is drained and not less than 25 m^3/h when two or more spaces are drained;

.2 the use of pipelines of the ship's main bilge system located in these spaces is allowed, if measures are taken to prevent pumping of flammable or toxic liquids through the pipelines and pumps of the engine room through installation of a blank flange or a shut-off valve;

.3 cargo spaces may be drained by gravity overboard or into a closed drainage tank located outside the engine room.

The tank shall have an air pipe led to the safe position on the open deck and protected by flame screen;

.4 cargo spaces may be drained into bilge wells located below spaces intended for the carriage of dangerous goods;

.5 enclosed spaces with pumps of the self-contained bilge system shall be provided with ventilation arrangements in compliance with the requirements of 12.7.1.

7.14.2 The drainage and pumping arrangements servicing spaces intended for the carriage of explosives shall prevent the build-up of free water surfaces when fire-extinguishing systems are used.

The capacity of the bilge system shall be 1.25 times greater than the combined capacity of water spraying system pumps and fire hose nozzles specified in 7.2.5.2, Part VI "Fire Protection".

The drainage system valves shall be operable from outside the protected space

at a position in the vicinity of the extinguishing system controls.

8. BALLAST, HEEL AND TRIM SYSTEMS

8.1 PUMPS

8.1.1 The ballast system shall be served by at least one pump. The capacity of the ballast pump shall be such as to ensure the speed of water of not less than 2 m/s, with the suction pipe diameter taken from Formula (8.2.1) as for the largest ballast tank.

For each hull of a ship with twin hulls, an independent ballast system shall be provided.

8.1.2 General service pumps of sufficient capacity, as well as a bilge, fire or standby cooling pump, may be used for ballasting (refer to 8.1.3).

Fire pumps may be permitted subject to compliance with 3.2.3.2 and 3.2.3.4, Part VI "Fire Protection".

8.1.3 Where the fuel oil tanks are generally used as ballast tanks, a standby cooling pump or a fire pump shall not be used for ballasting, nor shall the ballast pump be used as a fire pump or a standby cooling pump.

8.1.4 The pumps used for pumping out ballast water from the double-bottom tanks shall be of self-priming type and comply with 5.2.4, Part IX "Machinery".

8.1.5 In passenger ships, ballast tanks shall not, generally, be intended for the carriage of fuel oil.

Possible deviations from this requirement shall be specially considered by the Register in each case (refer also to 13.1.2).

8.1.6 In oil tankers emergency ballast discharge by stripper and cargo pumps is allowed, provided the requirements of 9.10.2 are complied with.

8.1.7 The ballast system of passenger ships with length, as defined in 1.2.1 of the Load Line Rules for Sea-Going Ships, of 120 m or more or having three or more main vertical zones shall comply with the requirements of 2.2.6.7.5 and 2.2.6.8, Part VI "Fire Protection".

8.2 PIPING DIAMETERS

8.2.1 The internal diameter d_{int}, in mm, of the ballast pipes for separate tanks shall be determined from the formula

$$d_{в} = 18\sqrt[3]{v}, \quad (8.2.1)$$

where v = ballast tank capacity, m^3.

The diameter may be adopted by the nearest standard size.

8.2.2 The diameter of the ballast main shall not be less than the maximum diameter of the suction determined by Formula (8.2.1).

8.3 PIPING LAYING

8.3.1 The arrangement of the suctions shall be such as to ensure pumping of the water from any of the ballast tanks, whether the ship is on even keel or listed 5°.

8.3.2 In icebreakers and ships with ice strengthening of **Ice4** to **Ice6** categories, the fore and after peaks, as well as structural wing tanks for water ballast, located above the waterline and in way of cargo holds, shall be provided with heating arrangements.

The double-bottom tanks in way of cargo holds, intended for water ballast,

are recommended to be fitted with heating coils.

8.3.3 The suction and discharge pipes of segregated ballast tanks shall not communicate with sea chests and pipelines servicing cargo tanks.

8.4 BALLAST SYSTEM OF FLOATING DOCKS

8.4.1 The ballast system shall be so designed that at least two pumps are available at any ballast compartment.

8.4.2 In floating docks intended for service under negative temperatures, the pumps and valves shall be located in warmed spaces of the dock or shall be provided with local heating.

8.4.3 If the valves of the ballast system are controlled from a power source, the sea inlet and discharge valves at sides shall have manual emergency driving means led to above the safety deck. In this case, the distributing valves are recommended to be fitted with a device automatically closing them, should supply from the power source be interrupted.

8.5 HEEL AND TRIM SYSTEMS

8.5.1 The heel and trim systems shall be in compliance with 8.3.2 and 8.3.3.

8.5.2 A valve or a shutter shall be fitted on the cross-flow line in the heeling system and stabilization system which is automatically locked in case of loss of power supply.

8.6 BALLAST SYSTEM OF BULK CARRIERS

8.6.1 Each water ballast tank forward of the collision bulkhead shall be provided with a water level detector giving audible and visual alarms when the liquid in the tank reaches a level not exceeding 10 per cent of the tank capacity.

8.6.2 On bulk carriers, the means for draining and pumping ballast tanks forward of the collision bulkhead shall comply with 7.9.

8.7 BALLAST SYSTEMS FOR BALLAST WATER EXCHANGE AT SEA

The requirements of this Section are mandatory for ships having the Ballast Water Management Plan.

8.7.1 Permissible methods of ballast water exchange at sea:

.1 refill method is a process where a ballast tank or hold is first emptied of at least 95 per cent of its volume and then refilled with replacement ballast water;

.2 flow-through method is a process where replacement ballast water is pumped through the ballast tank or hold allowing the water to overflow or flow through other arrangements. At least 3 times the tank or hold volume shall be pumped through the tank or hold;

.3 dilution method is a process where replacement ballast water is filled in the ballast tank or hold through the tank top with simultaneous discharge of the same water quantity and maintaining a constant level in the tank or hold.

At least 3 times the tank or hold volume shall be pumped through the tank or hold.

8.7.2 Ballast water system shall provide pumping in and out any ballast tank and hold under any environmental conditions permitted by the Ballast Water Management Plan.

8.7.3 Where the flow-through method of water ballast exchange is

used, overpressure in the tank or hold more than designed pressure shall be avoided.

8.7.4 Every ballast tank or hold shall be provided with shut-off valves for pumping in or out.

8.7.5 To ensure that the movement of ballast water only takes place as required, shut-off valves for the ballast tanks or holds shall be permanently closed, except for the water ballast handling.

As a rule, the shut-off valves shall be of self-closing spring type or equivalent.

8.7.6 The relative positions of ballast water intake and discharge openings shall be such as to preclude as far as practicable the possibility of contamination of replacement ballast water by water that is pumped out.

8.7.7 The ballast system intended for ballast water exchange shall be served by at least two pumps. Where the ship's Ballast Water Management Plan permits the use of the r e f i l l m e t h o d, each pump shall be capable of providing ballast water exchange of the largest ballast water tank or group of tanks as per the ship's Ballast Water Management Plan within 3 h.

8.7.8 Ballast water exchange of cargo holds used for the carriage of water ballast may require an extended period of time but not more than 24 h by one pump.

8.7.9 The ballast system design shall permit the ballast water exchange operations with the minimum number of operational modes.

8.7.10 The internal arrangements of ballast tanks as well as ballast water piping inlet and outlet arrangements shall permit the complete ballast water exchange and the cleaning of any sediments.

8.7.11 The design of sea suction line strainers shall be such as to permit cleaning of strainers without interrupting the water ballast handling.

8.7.12 Ballast pumps and all valves to be operated during ballast water exchange shall be provided with a means of remote control from a central ballast control station. Furthermore, the ballast pumps shall be provided with a means of local control.

8.7.13 A manually operated independent means of control of all valves required for ballast water exchange shall also be provided for emergency operation in the event of main centralized remote control failure. Where the valves are located inside tanks or other hard-to-reach spaces, the manually operated independent means of control may be achieved by connections to the control lines of individual valves.

8.7.14 The central ballast control station shall include the following:

a valve position indicating system;

a current tank level indicating system;

a draught indicating system;

a means of communication between the central ballast control station and those spaces containing the means of local control for the ballast pumps and the manually operated independent means of control.

8.7.15 The centralized remote control system shall be arranged so that the failure of any one of the control system components does not cause the loss of operation to the pumps or valves or other systems.

8.7.16 The design of ballast tanks shall permit, where necessary, taking samples of the ballast water and sediments. Fitting of a tank hatch in addition to conventional manhole is recommended for this purpose. Spaces below any tank opening shall be kept free of obstructions that could impede taking samples or free access.

8.7.17 The capability of the ballast water system to provide ballast water exchange by the flow-through method without the risk of overpressure in the ballast tanks shall be demonstrated by calculations and testing on board.

8.7.18 The flow-through method with water flowing over the upper deck is not permitted. The use of collecting pipes, internal overflow pipes or interconnecting pipe/trunk arrangements between tanks may be allowed to avoid water flowing over the upper deck.

8.7.19 Where dilution method is used, the following arrangements shall be provided:

special arrangements automatically maintaining the constant ballast water level. These arrangements shall provide for a manual emergency stop of the ballast pump in case of valve failure or incorrect control actions;

high and low water level alarms in tanks where the ballast water level will significantly change affecting the safety of the ship during water ballast handling.

9. SPECIAL SYSTEMS OF TANKERS AND COMBINATION CARRIERS

9.1 APPLICATION

9.1.1 The requirements of this Section apply to ships with the descriptive notation **"Oil tanker"**.

For the ships with the descriptive notation "**Oil tanker (> 60 °C) (> 60 °C)**" and "**Bilge water removing ship**" compliance with 9.2.1 to 9.2.8, 9.3.1 to 9.3.3, 9.3.5, 9.3.6, 9.4.1, 9.4.4, 9.4.5, 9.5.1, 9.5.2, 9.5.6, 9.6, 9.7.1 to 9.7.3, 9.7.5, 9.7.7, 9.7.9, 9.7.13, 9.7.15, 9.7.17, 9.10.1, 9.10.2 is mandatory. Compliance with the other paragraphs of the Section is recommended for the above ships.

9.2 GENERAL REQUIREMENTS FOR PIPING IN CARGO AREA

9.2.1 Remote-controlled valves shall comply with the requirements of 4.1.1.2 to 4.1.1.4.

9.2.2 The spindles used to operate the valves placed inside the cargo tanks shall be carried to the open deck in gas-tight sealing glands. Replacement of the sealing shall be made from the open deck. The drives shall have arrangements showing whether the valve is open or closed. The drive shall be constructed as to prevent accumulation of oil residues in them. Where the rubbing parts of the valve drives pass inside cargo tanks and cofferdams, as well as on the cargo deck, precautions shall be such as to preclude spark formation.

9.2.3 In enclosed spaces inside the cargo area, the temperature of steam or heating medium shall not exceed 220 °C.

9.2.4 The pipe flanges and fastening pieces intended for hose connections from shore installations shall be made of materials precluding spark formation.

9.2.5 The piping on deck and in cargo tanks shall be efficiently secured and fitted with thermal compensators.

Where thermal expansion is compensated by pipe bends, the radii of pipe bends shall comply with the requirements of 2.2.

9.2.6 All pipe lengths interconnected by flanges shall have reliable electric connection. At least at one place, electric earthling to the hull shall be made as required in 2.5, Part XI "Electrical Equipment".

9.2.7 To prevent the passage of flame into cargo holds, in the structure of valves of cargo pipes and venting arrangements, covers of manholes and hatches of cargo tanks, use of materials, which easily lose their properties under the effect of heat, is not permitted.

9.2.8 In combination carriers, provision shall be made for devices in the form of blank flange to isolate slop tanks from cargo tanks.

9.2.9 All piping on board, through which communication between liquid-free spaces of cargo tanks is possible, shall be equipped with a flame arrester.

9.2.10 To keep cargo spills within the cargo area, provision shall be made for a permanent continuous coaming on the upper deck, of at least 300 mm in height and extending from side to side.

9.3 CARGO OIL SYSTEM

9.3.1 Cargo piping shall not pass through the tanks not intended for cargo storage and shall not be connected to other tanks or piping including the fuel oil pipes of the propulsion plant.

Cofferdams shall have no connections to cargo tanks. No by-pass valves are permitted in cofferdams.

The piping, by means of which hazardous mixing of different types of cargo or watering of cargo can take place, shall have a double number of shut-off valves.

9.3.2 The terminations of the filling pipes of cargo tanks shall be laid, as far as practicable, as near to the tank bottom as possible, but not nearer than 1/4 of the pipe inner diameter.

9.3.3 The slop tanks of oil tankers shall be generally served by independent piping systems. Where no such systems are provided, all suction and discharge pipes of slop tanks shall be equipped with spectacle flanges or other blocking arrangements.

9.3.4 In combination carriers, reliable means shall be provided for isolating the piping connecting the pump with the slop tanks.

The means of isolation shall consist of a valve followed by a spectacle flange or a spool piece with appropriate blank flanges. This arrangement shall be located adjacent to the slop tanks, but where this is unreasonable or impracticable, it may be located within the pump-room directly after the piping penetrates the bulkhead.

In combination carriers, under deck cargo piping shall be located in special ducts provided with ventilating and draining arrangements.

9.3.5 In combination carriers where the ship is in the dry cargo mode, a permanently installed system shall be provided for discharging the contents of the slop tanks directly to the open deck. This system shall generally have no connection to other systems. Its connection to other systems by means of spool pieces shall be subject to special consideration by the Register in each case.

The manifold for slop tank contents installed on the open deck shall be equipped with a shut-off valve and a blank flange.

9.3.6 Where cargo hoses are connected to cargo manifolds, provision shall be made for a tray, in which cargo oil residues would accumulate.

9.3.7 Irrespective of purpose, piping laid through dangerous zones and intended for hose connection from shore or from another ship, shall be provided with the following facilities to ensure intrinsic safety:

.1 insulating flange connections or nonconducting pipe lengths;

.2 insulating mats, pads and railing to prevent the contact between the metal components of hoses and the hull.

The measured resistance between the metal components of hoses and the hull shall not be less than 25 kOhm.

9.4 CARGO PUMPS

9.4.1 Cargo pumps and cargo stripping pumps shall serve only their direct purpose except as provided for in 7.7.1 and 9.10.2. These pumps shall not have any connections to tanks other than cargo tanks.

Cargo pumps and cargo stripping pumps shall be either installed in a separate space or they shall be submersible pumps.

9.4.2 The arrangement of driving machinery of cargo pumps and cargo stripping pumps shall comply with the requirements of 4.2.5, Part VII "Machinery Installations".

9.4.3 The design of pumps, valves and their drives shall be such as to preclude spark formation to the maximum extent possible.

Structural measures shall be taken to limit the zero delivery time of submersible cargo pumps.

9.4.4 Devices shall be provided to stop cargo pumps and cargo stripping pumps from the top flat of the pump room at main deck level or from a readily accessible location on deck.

Where a cargo control station is provided, the pump stopping arrangements shall be installed at the cargo control station as well.

The stopping arrangements of electrically driven pumps shall comply with the requirements of 19.2.4.5, Part XI "Electrical Equipment".

9.4.5 The pressure gauges of the cargo oil discharge and cargo stripping mains shall be fitted next to pumps and on the top flat of the pump room, or at the cargo control station.

9.4.6 Where any machinery (both electric and hydraulic) used to drive cargo and ballast pumps, as well as the arrangements used to supply and control the pumps and valves of the cargo and ballast systems are integrated, the requirements of 19.2.7, Part XI "Electrical Equipment" shall be met.

9.5 BOW AND AFT LOADING SYSTEM

9.5.1 Bow and aft cargo piping of an oil tanker shall be permanently installed. Where necessary, the connections of such piping may be detachable.

9.5.2 Bow and aft cargo piping shall be laid outside accommodation and service spaces, and outside machinery spaces adjacent to accommodation spaces and control stations.

9.5.3 Bow and aft cargo piping shall be connected by welded joints. If neces-

sary, expansion joints may be used. Within the hazardous zone, piping may have detachable joints.

For pipe-to-valve connections, flange connections, as mentioned in 2.4, may be used. Such cargo piping shall be marked, and provision shall be made for its disconnection from the cargo main either by two valves installed in the cargo area, fitted with arrangements for sealing when closed (allowing for a closing efficiency check), or by one valve combined with a spool piece or a spectacle flange.

9.5.4 The pipe section used as shore connection shall be fitted with a shut-off valve and a blank flange, and provided with a tray. In case a special coupling is used, the blank flange may be omitted. The area of 3 m around the manifolds shall be considered a hazardous Zone 1 (refer to 19.2.3, Part XI "Electrical Equipment").

9.5.5 In cargo piping, arrangements for the discharge of cargo residues shall be provided. Outside the hazardous zone, cargo piping shall be fitted with arrangements to make it clear of cargo and purge it with inert gas. Between cargo piping and inert gas system, an isolating device shall be fitted.

9.5.6 In oil tankers equipped with a bow loading system intended for cargo-handling operations at point berths carried out to sea, an emergency high-speed device shall be installed for cargo hose disconnection.

The design of such device shall be specially considered by the Register in each case (refer to Part VIII, "Requirements for the Equipment of Oil Tankers Used in Cargo Operations at Sea" of the Guidelines for the Prevention of Pollution from Ships).

9.6 CARGO HEATING SYSTEM

9.6.1 As a heating medium for heating of cargo in tanks, the use of steam, hot water and thermal oil is permitted.

Application of other fluids is subject to special consideration by the Register in each case.

9.6.2 Upstream from each steam heating coil, a non-return stop valve shall be fitted, and upstream to stop valves at the outlet the gauge valve for checking the condensate quality shall be installed.

9.6.3 The return of condensate from the heating system shall be performed via the check tank.

The air pipes of the check tank for heating steam condensate from the cargo tanks containing the cargoes with the flash point below 60 °C shall be provided with flame arresters and be lead to a safe place.

9.6.4 Cargo heating systems using thermal liquid as a heating medium shall comply with 20.11.

9.6.5 In ships with the descriptive notations "**Oil tanker (> 60 °C)**" and "**Oil/ore carrier (> 60 °C)**" in the class notation, the maximum heating temperature shall be at least 15 °C lower than the flash point of the carrying cargo.

9.3.6 The cargo heating system shall be equipped with the facilities for cargo temperature control in the tanks. Control of the current temperature in tanks, as well as light and audible alarms of the maximum permissible cargo temperature exceeded or on cargo flow velocity loss when pumped through the heaters, shall be provided.

9.7 VENTING SYSTEM

9.7.1 The venting system shall ensure gas exchange and safe pressure in

cargo tanks during the loading, discharging and carriage of liquid cargo. For this purpose, the system shall include one or more devices to limit the following:

.1 pressurization above cargo tank test pressure during loading or ballasting with the maximum specified output;

.2 pressure drop below 7 kPa during unloading with the maximum cargo pump delivery.

9.7.2 The venting systems of cargo tanks shall be entirely independent from the air pipes of other compartments.

The design and arrangement of the outlets of venting arrangements shall be such as to minimize the possibility of flammable vapours being admitted to enclosed spaces containing a source of ignition or collecting in the vicinity of deck machinery and equipment.

9.7.3 The venting system shall include arrangements to provide for:

.1 free flow of small volumes of vapour, air or inert gas mixtures caused by thermal variations in the cargo tank;

.2 free flow of large volumes of vapour, air or inert gas mixtures during cargo loading and ballasting, or during discharging.

9.7.4 Vent outlets for free flow of vapour mixtures, intended for compensation of thermal pressure variations, shall be arranged:

.1 not less than 2 m above the cargo tank deck;

.2 not less than 5 m from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery and equipment, which may constitute an ignition hazard, such as anchor windlass and chain locker openings.

9.7.5 The venting arrangements in each cargo tank may be independent or combined with other cargo tanks and may be incorporated into the inert gas piping. Inert gas system may be used for integration of the venting systems. Where the arrangements are combined with other cargo tanks, pressure/vacuum, valves may be mounted on the inert gas mains.

9.7.6 Where the arrangements are combined with other cargo tanks, a stop valve and a flame arrester shall be provided to isolate each cargo tank. Where stop valves are fitted, they shall be provided with locking arrangements which shall be under the control of the responsible ship's officer.

A clear visual indication of the operational status of the valves shall be ensured. Where tanks have been isolated, it shall be ensured that relevant isolating valves are opened before cargo loading or ballasting or discharging of those tanks is commenced.

Flame arresters shall be located so as to render the penetration of cargo oil impossible under any navigational conditions, rolling included.

9.7.7 Any isolation of venting arrangements shall continue to permit the flow caused by thermal variations in a cargo tank in accordance with 9.7.3.1.

9.7.8 The system for the venting of vapours displaced from the cargo tanks during loading, discharging and ballasting shall consist of either one or more mast risers, or a number of high-velocity vents permitting to discharge of the vapour mixtures with a velocity of not less than 30 m/s. The vapour mixture shall be discharged vertically upwards.

9.7.9 The vent outlets of pipes required under 9.7.3.2 shall be designed on the basis of the maximum designed load-

ing rate multiplied by a factor of at least 1.25.

When determining the capacity of venting systems equipped with flame arresters, the pressure drop as the gases pass through the flame arrester shall be considered. In any case, the adopted pressure drop value shall be 50 per cent greater than that for a flame arrester in the clean condition.

The internal diameter of vent pipes shall not be less than 80 mm, and that of mains, not less than 100 mm.

9.7.10 Where the method is by free flow of vapour mixtures, the vent outlets of the venting system pipes shall not be less than 6 m above the cargo tank deck or fore and aft gangway, if situated within 4 m of the gangway, and not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery, which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard.

9.7.11 Where the method is by high-velocity discharge, the vent outlets shall be located at a height not less than 2 m above the cargo tank deck and not less than 10 m measured horizontally from the nearest air intakes and openings to closed spaces containing a source of ignition and from deck machinery, which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard.

9.7.12 In each cargo tank a secondary means to allow full flow relief of vapour, air or inert gas mixtures to prevent overpressure or underpressure in the event of failure of the arrangements mentioned in 9.7.3.2 shall be fitted.

As an alternative secondary means, pressure sensors with continuous indication for each tank equipped as required under 9.7.3.2 may be installed at the cargo control station or in spaces from which cargo operations are controlled. In this case, an alarm shall be provided to indicate overpressure or vacuum in the tank.

Pressure/vacuum-breaking devices fitted on the inert gas system main may be utilised as the required secondary means of allowing full flow relief of vapour, air or inert gas mixtures where the cargo is homogeneous or for multiple cargoes where the vapours are compatible and do not require isolation.

For ships that apply pressure sensors in each tank as an alternative secondary means of flow relief of vapour, air or inert gas mixtures, the overpressure alarm actuation setting shall be above the pressure setting of the pressure/vacuum-valve and the underpressure alarm actuation setting shall be below the vacuum setting of the pressure/vacuum-valve. The alarm actuation settings shall be within the design pressures of the cargo tanks. The actuation settings of pressure and vacuum detectors in cargo tanks shall be fixed and not arranged for blocking or adjustment in operation. An exception is permitted for ships that carry different types of cargo and use pressure/vacuum valves with different settings, one setting for each type of cargo.

9.7.13 Permanent arrangements shall be provided to drain the venting arrangements and vent lines to a cargo tank.

9.7.14 The venting system shall be provided with devices to prevent the passage of flame into the cargo tanks.

The design, testing and location of flame arresters shall comply with the re-

quirements based on ISO 15364, IMO MSC/Circ. 677 as amended (MSC/Circ. 1009 and MSC/Circ.1325).

9.7.15 The hatches and other openings of cargo tanks used for measuring temperature, ullage, sampling, gas analysis, except for openings for permanently installed gauges, shall be provided with self-closing covers or valves. Flame arresters and screens are not required in these openings.

The above covers and/or valves shall not be used for pressure equalization in the spaces above the cargo surface.

9.7.16 Arrangements, required in 9.7.1.1, may be provided with a bypass arrangement when they are located in a vent main or masthead riser. Where such an arrangement is provided, there shall be suitable indicators to show whether the bypass is open or closed.

9.7.17 In combination carriers, the arrangements for isolating venting systems of slop tanks containing oil or oil residues shall consist of blank flanges, which will remain in position at all times when cargoes other than liquid cargoes are carried.

9.7.18 The venting systems of oil tankers designed to carry boiling oily products, the Reid vapour pressure of which exceeds atmospheric pressure, shall be subject to special consideration by the Register in each case.

9.8 PURGING AND GAS FREEING OF CARGO TANKS

9.8.1 On ships fitted with an inert gas system, arrangements may be provided for purging and gas freeing empty tanks in addition to the venting arrangements specified in 9.7.10 and 9.7.11, which would ensure an exit vertical velocity of at least 20 m/s when any three tanks are simultaneously supplied with inert gas.

The purge pipe outlets shall extend not less than 2 m above the deck level.

9.8.2 On ships not fitted with an inert gas system, special fans, which may be portable, shall be provided for purging and gas freeing empty tanks.

During gas freeing operations, in addition to the arrangements specified in 9.7.10 and 9.7.11, hydrocarbon vapours may be vented through special pipes, which shall comply with the following requirements:

the pipe outlets shall extend not less than 2 m above deck level;

gas exit velocity of at least 30 m/s in the vertical direction shall be maintained;

the pipe outlets shall be arranged horizontally not less than 10 m away from openings to enclosed spaces containing sources of ignition, from air intakes, deck machinery and other equipment which may present ignition hazard.

Gas exit velocity may be reduced to 20 m/s, provided the device is fitted to prevent the passage of flame, as required by 9.7.14.

9.8.3 On individual cargo tanks, the gas outlet pipe shall be positioned as far as practicable from the inert gas/air inlet.

The inlet of such outlet pipes may be located either at deck level or at not more than 1 m above the bottom of the tank.

9.8.4 Each gas outlet shall be fitted with suitable blanking arrangements.

9.9 CARGO VAPOUR DISCHARGE SYSTEM

9.9.1 If a ship is equipped with the cargo vapour discharge system, the distinguishing **VCS** mark may be added to

the character of classification. (refer to 2.2.16, Part I "Classification"). In addition to the requirements of this Section, in order to assign the distinguishing **VCS** mark to the ship, the requirements for the overflow prevention and cargo tank level control specified in 9.11.1 shall be complied with, and the level gauging system shall be closed as specified in 9.11.2.

Fulfilment of the above requirements and assignment of the above distinguishing mark confirm compliance of the system with the requirements of IMO MSC/Circ.585.

9.9.2 The cargo vapour discharge system shall be arranged in such a way that it does not interfere with the normal operation of the venting system.

The cargo vapour discharge system shall be designed based on the maximum loading capacity. The pressure drop in the cargo vapour discharge piping, obtained by means of hydraulic calculation, shall not exceed 80 per cent of the opening pressure of any venting system discharge valve specified in 9.7.1.1.

9.9.3 The instructions approved by the Register shall be constantly kept on the ship, proceeding from which the allowable loading speed of different cargoes may be defined, taking into consideration the requirements of 9.9.1 and 9.9.2.

9.9.4 Vapours of incompatible cargoes shall not be mixed when passing the vapour discharge system.

9.9.5 When the inert gas distribution piping is used to collect cargo vapours, measures shall be taken to insulate inert gas pipes from the cargo vapour discharge system.

9.9.6 Provision shall be made for elimination of condensate, which may be accumulated in the system.

9.9.7 Piping of the system shall be electrically continuous and have safety earthing.

9.9.8 Cargo vapour discharge manifolds shall be fitted with a pressure sensor and alarm system to produce alarm signals at high-pressure level (but not higher than that at which the high-speed venting device is actuated) and for vacuum (but not lower than the pressure, at which the vacuum valve is actuated).

This requirement may be dispensed with if each cargo tank is fitted with an overpressure/under-pressure sensor under 9.7.12.

9.9.9 In the area of the adapter sleeve of the cargo vapour discharge manifold, the easily accessible check valve with manual control shall be installed.

9.9.10 Hoses used in the vapour discharge system shall comply with the requirements of 6.1.12.

9.9.11 To exclude false connection of vapour discharge piping to onshore terminal liquid cargo piping, studs with a diameter of 12.7 mm and length of at least 25.4 mm shall be mounted on the vapour discharge manifold connecting flanges at the upper point of the coupling bolts line, as shown in Fig. 9.9.11-1. The vapour discharge manifold marking shall comply with Fig. 9.9.11-2.

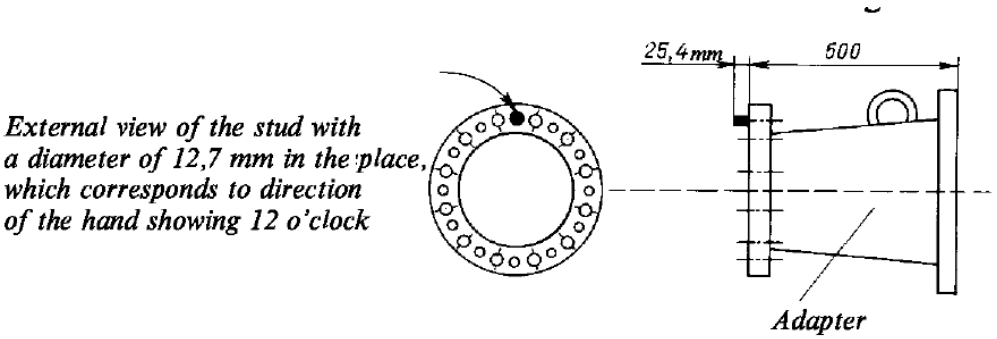


Fig. 9.9.11-1

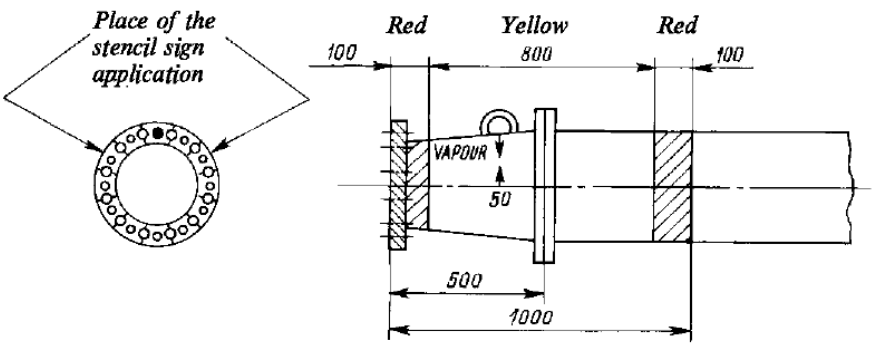


Fig. 9.9.11-2

9.10 SHIP SERVICE SYSTEMS IN CARGO AREA

9.10.1 Ballast, sounding and air pipes of segregated ballast tanks shall not pass through cargo tanks. Cargo and similar pipes intended to serve cargo and slop tanks shall not be laid through segregated ballast tanks. This requirement may be dispensed with in the case of shorter pipes, provided they are fully welded or equivalent, with thick flanged connections, the number of which shall be kept to a minimum. Thermal expansion of the pipes shall be compensated by the pipe bends. The bend radii shall be in accordance with the requirements of 2.2.1.

In Fig. 9.10.1, the recommended design of an air pipe is shown as an example.

Piping shall be seamless and shall be made of steel. The pipe wall thickness shall not be less than indicated in Table 9.10.1. The use of another pipe material is subject to special consideration by the Register in each case.

9.10.2 Emergency ballast discharge may be affected by means of connection to a cargo pump through a spool piece, which shall be mounted in a conspicuous,

readily accessible position in the pump room. To prevent the passage of petroleum products into the ballast tanks, a non-return valve shall be fitted on the segregated ballast connections.

The ballast pump shall be located in the cargo pump room or another space with the safety level equivalent to that of a cargo pump room not containing sources of ignition.

9.10.3 The fore peak tank may be ballasted with the system serving other ballast tanks within the cargo area, provided:

.1 the fore peak tank is considered as hazardous;

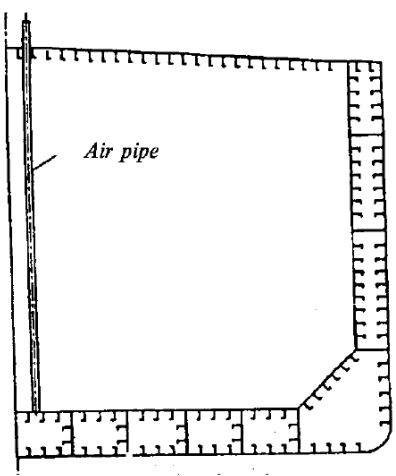


Fig. 9.10.1

.2 the vent pipe openings are located on open deck 3 m away from sources of ignition or in accordance with 19.2.3, Part XI "Electrical Equipment";

.3 means are provided, on the open deck, to allow measurement of flammable gas concentrations within the fore peak tank by a suitable portable instrument;

.4 the sounding arrangement to the fore peak tank is direct from open deck;

.5 the access to the fore peak tank is direct from open deck. Alternatively, indirect access from the open deck to the fore peak tank through an enclosed space may be accepted provided that:

.5.1 the enclosed space is separated from the cargo tanks by cofferdams, the access is through a gas tight bolted manhole located in the enclosed space,

and a warning sign shall be provided at the manhole stating that the fore peak tank may only be opened after it has been proven to be gas free; or any electrical equipment which is not certified safe in the enclosed space is isolated;

.5.2 in case the enclosed space has a common boundary with the cargo tanks and is therefore hazardous, the enclosed space shall be well ventilated in accordance with 12.12 (at least as a Zone 2 space under 12.12.6).

9.10.4 In oil tankers, the open ends of air pipes of cofferdams, fuel oil and lubricating oil tanks adjoining cargo and slop tanks shall be laid to the open deck where the vapours displaced from the above tanks do not present a fire hazard and where flame arresting fittings of a Register-approved type are available. The flow area of the fittings shall not be less than the air pipe area.

9.10.5 Steaming pipes of cargo tanks shall be equipped with non-return/shut-off valves.

9.11 LEVEL AND OVERFLOW CONTROL OF CARGO TANKS

9.11.1 Provision shall be made to prevent liquid rising in the venting system to a height, which would exceed the design head of cargo tanks. This shall be

accomplished by high-level alarms or overflow control systems.

The overflow control system shall be two-level and independent of tank level gauging devices, it shall give visible and audible high- and limit-level alarms in cargo tanks to the ship operator and to the cargo control room (if any), give an alarm for deenergization of the system or level sensors, and shall be able to check the alarm circuit prior to cargo operations.

For the purpose of this regulation, spill valves are not considered equivalent to an overflow system.

Internal diameter, in mm	up to 50	up to 100	up to 125	up to 150	150 and more
Minimum wall thickness, in mm	6.3	8.6	9.5	11.0	12.5

9.11.2 Each oil tanker equipped with a fixed inert gas system shall be provided with closed measurement devices for taking ullages of cargo and slop tanks.

In oil tankers, semiclosed or closed measurement devices for taking ullages of cargo and slop tanks shall be used. Open sounding devices are admitted in oil tankers with the descriptive notation "**Oil tanker (> 60 °C)**" and as a reserve means in oil tankers not equipped with the inert gas system.

9.11.3 The cargo tank sounding pipes shall be so designed as to include hermetic self-closing valves and covers fitted on pipes laid to the open deck; the pipe laid to the deck shall be as high as to prevent cargo spillage onto the deck during sounding.

9.11.4 In oil tankers intended for the carriage of cargoes with flash point below 60 °C, the sounding rods shall be made of a non-sparking material.

9.11.5 In oil tankers each cargo tank shall be provided with an overflow prevention system to meet the following requirements:

.1 be separated of the sounding system of cargo tanks;

.2 give visible and audible high- and limit-level alarms in cargo tanks to ship's operator and to cargo handling room;

.3 give an alarm on de-energization of system or level sensors;

.4 be able to check the alarm circuit prior to cargo operations;

.5 give a code signal for sequential switch-off of shore pumps and valves, or both, and valves shall be switched off by ship's operators.

Alarms, pumps and valves shall be disconnected by ship's operators. The use of automatically closed valves is allowed only upon the permission and agreement with Port Administration.

9.12 CARGO TANK WASHING SYSTEM

9.12.1 Crude oil tankers of 20,000 t deadweight and above shall be equipped with a crude oil washing system for tanks. This system shall fully comply with the requirements of Regulation 33 of Annex I to MARPOL 73/78.

If a ship is provided with a crude oil washing system in compliance with the requirements of the above regulation, regardless of its deadweight, the distinguishing mark **COW** shall be added to the character of classification (refer to 2.2.18, Part I "Classification"). Where a crude oil washing system is provided on board, the ship shall be fitted with an inert gas system in compliance with the requirements of 9.16.

Piping of crude oil washing systems, associated equipment and appliances (pipes, washers, pumps, stripping systems) shall meet the requirements of 3.2.3, Sect. 3, Part I "Requirements for the Design of Ships and Related Equipment for the Prevention of Oil Pollution" of the Guidelines for the Prevention of Pollution from Ships.

9.13 STATIC ELECTRICITY PROTECTION

9.13.1 Cargo hoses, compressed air hoses, tank washing hoses and other hoses used in the cargo area shall comply with the requirements of Section 6, shall be electrically conductive over the entire length, including joints and flanges (except for shore connections), and shall be properly earthed to remove electrostatic charges.

9.13.2 Portable pumps and ventilators to be used in the cargo area shall be equipped with devices for electrostatic earthing prior to operation.

9.13.3 The cargo system shall enable regulation of the intensity of loading each particular tank so that the flow velocity does not exceed 1 m/s at suction pump outlet in the tank at the initial stage of loading. The above flow velocity may be increased if cargo tanks are fitted with special suction wells to reduce the level of tank atmosphere electrostatic charging, which design shall be approved by the Register.

For maximum loading intensity, the flow velocity shall not exceed 7 m/s.

The requirements of this paragraph are not mandatory if cargo tanks are inerted during cargo-handling operations.

9.14 MONITORING OF ATMOSPHERIC COMPOSITION IN CARGO AREA

9.14.1 Oil tankers and combination carriers shall carry at least two portable instruments for measuring oxygen and flammable vapour concentrations (refer to item 15 of Table 5.1.2, Part VI "Fire Protection").

9.14.2 Structural measures shall be taken to facilitate flammable vapour concentration measurements in all spaces of the cargo area. The above measurements shall be possible from open deck or readily accessible locations.

Where the atmosphere in double hull spaces may be reliably measured using flexible gas sampling hoses, such spaces shall be fitted with permanent gas sampling lines. Where plastic pipe material are used, they shall be electrically conductive.

9.14.3 In cargo pump rooms and in ballast pump rooms fitted with the equipment containing cargo, a system for continuous monitoring of the concentration of hydrocarbon gases shall be fitted. Sampling of atmosphere for analysis shall be carried out in succession (including the exhaust vent). The interval between measurements shall be as short as possible.

Detector heads of gas analysers shall be located in the areas with limited air circulation (at recesses and remote angles).

When the hydrocarbon gas concentration reaches a pre-set level, which shall not be higher than 10 per cent of the lower flammable limit, a continuous audible and visual alarm signal shall be automatically effected in the pump-room, main machinery control room, cargo control room and navigation bridge to alert personnel of the potential hazard.

In combination carriers, such system, in addition to the cargo pumprooms, shall be installed in cofferdams and pipe tunnels adjacent to the settling tanks.

9.14.4 Where fixed gas analysers are fitted outside the cargo area, the following conditions shall be met:

.1 sampling pipes shall be provided with flame arresters and gas samples shall be vented to the atmosphere through a special pipe mounted at a safe location;

.2 sampling pipe assemblies at gastight bulkhead penetrations shall be type-approved and their fire resistance shall be equal to that of the bulkhead;

.3 each sampling pipe shall be provided with a manual insulation valve fitted on the gas-safe side of the gastight bulkhead;

.4 instruments and equipment for gas analysis shall be arranged inside a special hermetic steel cabinet and one of the sampling points shall be located in the cabinet. One of the measuring points shall be located inside the cabinet. When the dangerous gas concentration inside the cabinet reaches 30 per cent of the lower flammability limit, the gas supply to the gas analyser shall be automatically stopped;

.5 sampling lines shall not normally be laid through spaces outside the hazardous area. Where it is not possible to install the gas analysis cabinet on a gastight bulkhead, the sampling pipes shall be as short as practicable, they shall be made of steel or an equivalent material and shall have no detachable joints except for joints with the gas analysis cabinet and insulating valves on the gastight bulkhead.

9.14.5 In oil recovery ships and bilge water removing ships the sampling arrangements or the atmosphere monitoring system detectors shall be located as follows:

.1 next to the forced ventilation openings;

.2 at least at two locations at the open deck at a height not more than 1 m above the deck;

.3 in machinery spaces of A category;

.4 in air locks;

.5 in cofferdams adjacent to cargo tanks.

9.14.6 Oil tankers of 20,000 t deadweight and above shall be provided with a fixed hydrocarbon gas detection system for all double hull spaces in compliance with the Fire Safety Systems Code and the IMO Circular MSC.1/Circ.1370.

.1 This system shall perform periodical measurements of hydrocarbon gas concentrations in all ballast tanks and void spaces adjacent to the cargo and slop tanks (among others, to those which form a cruciform (comer to comer) contact), including the forepeak tank and any other tanks and spaces under the bulkhead deck adjacent to cargo tanks.

.2 As a rule, the gas detection system shall be arranged with a single sampling line from each sampling point. Sampling lines in the same space may be combined above deck level with manually operated three-way valve arrangements provided with clear local indication of which sampling point is active. In ballast/partial ballast condition, the upper sampling point is to be active; for empty tank the lower sampling point is to be active.

.3 Hydrocarbon gas concentration measurement systems shall also be pro-

vided in ballast pump rooms and bow thruster rooms located under the bulkhead decks as well as in any void spaces adjacent to cargo and slop tanks. In such spaces one sampling point may be arranged at the lower part.

.4 No fixed hydrocarbon gas detection equipment is required in the spaces of oil tankers fitted with permanently operated inert gas system for such spaces.

.5 Cargo pump rooms in compliance with the requirements of 9.14.3 and 9.14.4 are not covered by the requirements of this paragraph.

9.15 OIL RECOVERY SYSTEM OF OIL RECOVERY SHIPS

9.15.1 The system and devices for the recovery and transfer of oil shall be installed outside machinery spaces and accommodation spaces.

9.15.2 The system shall ensure both the recovery and transfer of the oil recovered.

9.15.3 Where, in multi-purpose ships, a fixed oil recovery system is incompatible with the cargo of the cargo system installed, relevant isolating arrangements shall be provided.

9.15.4 Where the ship is fitted with portable oil recovery equipment, not more than two suctions connected by piping to all oil collecting tanks shall be provided on the upper deck for connecting to the discharge hoses of the oil recovery equipment.

The arrangement of suctions on the upper deck shall make it possible to simultaneously connect two oil recovery systems installed on the opposite sides of the oil recovery ship.

Pipes connecting suctions to tanks shall not pass through accommodation spaces or spaces located as high as the open deck.

Laying of pipes through enclosed intrinsically safe spaces (refer to 19.2.3.4, Part XI “Electrical Equipment”) shall be subject to special consideration by the Register in each case.

9.16 INERT GAS SYSTEM

9.16.1 General requirements

9.16.1.1 Oil tankers of 20,000 t deadweight and above intended for the carriage of flammable liquids with a flash point of 60 °C and below, as well as oil tankers provided with the crude oil washing system shall be equipped with a fixed inert gas system in compliance with the requirements of 9.16.8, 9.16.9 or 9.16.12, with a capacity specified in 9.16.2.

Where a ship is equipped with an inert gas system in compliance with the requirements of this Section, one of the distinguishing marks shall be added to the character of classification as specified in 2.2.17, Part I “Classification”, as follows: **IGS-IG, IGS-NG or IGS-Pad**.

.1 IGS-IG — where a fuel combustion inert gas generator serves as an inert gas source, provided that requirements of 9.16.9 are met;

.2 IGS-NG — where a nitrogen generator serves as an inert gas source, provided that requirements of 9.16.12 are met;

.3 IGS-Pad — where inert gas system is only intended for producing a pad in cargo tanks provided that requirements of 9.16.11 are met.

9.16.1.2 Inert gas system may serve as a means to prevent fire by producing and maintaining nonflammable atmosphere in cargo tanks, except where the

tanks are to be gas free. The system shall ensure:

.1 maintaining the atmosphere in any part of any cargo tank with an oxygen content not exceeding 8 per cent by volume and at a positive pressure at all times in port and at sea except where the tank is to be gas free;

.2 eliminating the need for air to enter a tank during normal operation except where the tank is to be gas free;

.3 purging empty cargo tanks with inert gas and air.

9.16.1.3 Inert gas with an oxygen content not exceeding 5 per cent by volume shall be delivered to the cargo tanks.

9.16.1.4 The temperature of the inert gas supplied to cargo tanks shall be:

.1 for cargo tanks — not more than 65 °C;

.2 for dry-cargo holds — not more than 50 °C.

9.16.1.5 Treated flue gas from main or auxiliary boilers or separate gas generators may serve as inert gas.

The Register may accept systems using flue gases from other sources or any combinations thereof provided an equivalent standard of safety is achieved.

Each source of flue gas shall be provided with automatic combustion control to provide compliance with the requirement of 9.16.1.3.

Carbon dioxide smothering system due to the risk of ignition of the mixture of vapours of flammable liquids with air from static electricity discharges generated during carbon dioxide supply shall not be used for inertisation.

9.16.2 Capacity

9.16.2.1 For ships specified in 9.16.1.1 and bearing the distinguishing mark **IGS-IG** or **IGS-NG,** the inert gas system shall have a capacity of not less than 125 per cent of the maximum total capacity of cargo pumps during discharging the ship.

9.16.2.2 For ships not specified in 9.16.1.1 and bearing the distinguishing mark **IGS-Pad,** the inert gas system shall have a capacity sufficient to produce pad in cargo tanks, perform inertisation, where necessary, of spaces adjacent to cargo tanks, replace the inert gas loss during voyage, or provide an appropriate quantity of the inert gas in cylinders on board the ship.

9.16.3 Equipment

9.16.3.1 A flue gas scrubber shall be fitted to effectively cool the volume of gas and remove solids and sulphur combustion products. The cooling water shall be delivered by an independent pump. Provision shall be made for an alternative supply of cooling water from a stand-by pump without interfering with any essential services on the ship.

9.16.3.2 The gas scrubber shall be designed so that the capacity of the system does not drop for more than 3 per cent and the gas temperature at the outlet does not rise more than 3 °C as against the design values under all normal conditions of heel and trim.

9.16.3.3 Provision shall be made in the gas scrubber housing for inspection holes and sight glasses made of impact-, and heat-resisting material for inspections and maintenance.

9.16.3.4 At least two blowers shall be fitted which together are capable of delivering at least the volume of gas required by 9.16.2; and, where possible, equal supply for each blower shall be established, but at any rate it shall not be

less than 1/3 of aggregate required supply for each blower.

9.16.3.5 Provision shall be made for inspection holes in the blower casing.

9.16.3.6 Interior surfaces of the scrubber and blowers shall be made of corrosion-resistant materials or lined with a coating material.

9.16.3.7 Filters or equivalent devices shall be fitted to minimize the amount of water and solid particles carried over to the inert gas blowers.

9.16.4 Cargo tank protection against pressure/vacuum

9.16.4.1 The inert gas system shall be so designed that the maximum pressure which it can exert on any cargo tank does not exceed the test pressure of any cargo tank.

9.16.4.2 One or more devices for braking pressure/vacuum in cargo tanks shall be provided on the inert gas supply main if they are not fitted on the gas venting system or individually in each tank. Control and location of these arrangements shall comply with the requirements of 9.7.

9.16.4.3 A positive pressure not exceeding 21 kPa shall be maintained in the cargo tanks when they are filled or being filled with inert gas under normal working conditions.

9.16.5 Non-return devices

9.16.5.1 At least two non-return devices shall be fitted in the inert gas supply main in the cargo area on deck. One of these shall be a deck water seal, and the other — a non-return valve or an equivalent device fitted forward of the deck water seal. They shall be located between the automatic valve required under 9.16.6.5 and the aftermost connection to any cargo tank or cargo pipeline.

9.16.5.2 The deck water seal shall be supplied by two separate pumps, each of which shall be capable of maintaining an adequate supply at all times and automatically starting each pump feeding the water seal and automatically filling the seal with water upon inert gas supply failure (for half-dry and dry water seals).

A drain pipe of the deck water seal shall not pass through machinery spaces. Discharge pipes shall be laid directly overboard.

9.16.5.3 Provision shall be made to ensure that the water seal is protected against freezing in such a way that the integrity of the seal is not impaired by overheating.

9.16.5.4 The deck water seal and all loop arrangements shall be capable of preventing return of hydrocarbon vapours at a pressure equal to the test pressure of the cargo tanks.

9.16.5.5 The non-return valve (refer to 9.16.5.1) may be of non-return shut-off type or of non-return type with a shut-off valve additionally fitted in the inert gas supply main forward of the non-return valve.

9.16.5.6 A water loop or other approved arrangement shall be fitted to each associated water supply and drain pipe and each venting or pressure-sensing pipe leading to gas safe spaces[3]. Means shall be provided to prevent such loops from being emptied by vacuum.

9.16.5.7 Provision shall be made in the deck water seal for sight holes and glasses for water level monitoring and inspections.

[3] Gas safe spaces are spaces where hydrocarbon vapour supply may cause an ignition or toxicity hazard.

9.16.5.8 Materials used in non-return devices shall be resistant to the effect of acids generated during cooling, cleaning and by gases coming through the pipes.

9.16.6 Pipes

9.16.6.1 The inert gas main may be divided into two or more distributing pipes forward of the non-return devices required under 9.16.5.1.

9.16.6.2 The distribution inert gas supply pipes shall be fitted with branch piping leading to each cargo tank. Branch piping for inert gas shall be fitted with either shut-off valves or equivalent means of control for isolating each tank.

Where shut-off valves are fitted, they shall be provided with locking arrangements to prevent the control of the valves by unauthorized persons.

The control system operated shall provide positive indication of the operational status of the shut-off valves.

9.16.6.3 In combination carriers the arrangement to isolate the inert gas system from the slop tanks shall consist of blank flanges.

9.16.6.4 Pipe outlets discharging inert gas into the cargo tanks shall be located in the upper part.

9.16.6.5 A gas regulating valve shall be fitted in the inert gas supply main. It shall enable automatic regulation the flow of inert gas to the cargo tanks as referred to in 9.16.8 unless means are provided for automatic control of the speed of the inert gas blowers.

9.16.6.6 If a connection is fitted between the inert gas supply main and the cargo system, arrangements shall be made to ensure an effective isolation with regard to the large pressure difference which may exist between the systems.

It shall consist of two shut-off valves, the valve on the cargo main being of a non-return type, and an arrangement to vent the space between the valves in a safe manner or an arrangement consisting of a spool-piece with associated blanks.

9.16.6.7 Piping systems shall be so laid as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

9.16.6.8 Suitable arrangements shall be provided for the safe venting of the line section between the valves referred to in 9.16.5.5 and 9.16.6.5 in case when the first of these valves is closed.

9.16.6.9 The diameter of the pipes shall be such as to ensure the gas flow rate in any section of the piping is not more than 40 m/s.

9.16.6.10 The piping from the gas scrubber to the blowers and recirculation lines as well as drain pipe of gas scrubbing and cooling system shall be lined with corrosion-resistant coating.

9.16.6.11 An arrangement shall be provided to connect the inert gas main to the external supply of inert gas.

The arrangement shall consist of a branch with a flange joint DN 250 mm fitted forward of the non-return valve specified in 9.16.6.5.

Flange design shall comply with the requirements of 2.4.3.

9.16.6.12 The inert gas supply main may be used for the venting of the cargo tanks.

9.16.7 Instruments and alarms

9.16.7.1 On the discharge side of gas blowers, instruments shall be provided for continuous indication of the inert gas temperature and pressure.

9.16.7.2 Instrumentation shall be fitted for continuous indication and recording during the inert gas supply:

.1 of pressure of the inert gas supply main forward of the non-return devices required under 9.16.5.1;

.2 of oxygen content of the inert gas in the inert gas supply main on the discharge side of the gas blowers.

These devices shall be placed in the cargo control room. Where no cargo control room is provided, they shall be placed in a position easily accessible to the officer in charge of cargo operations.

9.16.7.3 In addition to the requirements of 9.16.7.2, the following meters shall be fitted:

.1 in the navigation bridge for continuous pressure indication (refer to 9.16.7.2.1) and for the indication of pressure in the slop tanks of combination carriers, where those tanks are isolated from the inert gas supply main;

.2 in the main machinery control room or in the machinery space to indicate the oxygen content (refer to 9.16.7.2.2).

9.16.7.4 Suitable arrangements shall be provided on each cargo tank for measuring oxygen and hydrocarbon vapour concentration using portable instruments.

9.16.7.5 Suitable means shall be provided for the zero and span calibration of both fixed and portable gas concentration measurement instruments referred to in 9.16.7.2 and item 15 of Table 5.1.2, Part VI "Fire Protection".

9.16.7.6 Audible and visual alarms shall be provided to indicate:

.1 low water pressure or low water flow rate to the flue gas scrubber;

.2 high water level in the scrubber;

.3 increase of gas temperature; this alarm is operated when the temperatures referred to in 9.16.1.4 are reached;

.4 failure of inert gas blowers;

.5 oxygen content more than 14 per cent by volume in cargo holds;

.6 oxygen content in the inert gas main more than 8 per cent by volume;

.7 failure of the power supply to the automatic control system for the gas regulating valve and to the indicating devices referred to in 9.16.7.2;

.8 low water level in the deck water seal referred to in 9.16.5.1;

.9 gas pressure less than 1 kPa in the inert gas main. The alarm arrangement shall be such as to ensure that the pressure in slop tanks in combination carriers can be monitored at all times;

.10 high gas pressure (when the pressure reaches 10 kPa);

.11 insufficient fuel supply (if inert gas generators are available);

.12 failure of power supply to the generator (if inert gas generators are available);

.13 failure of power supply to automatic generator control system (if inert gas generators are available).

9.16.7.7 Indicating units of the alarms required under 9.16.7.6.3, 9.16.7.6.4, 9.16.7.6.6 and 9.16.7.9 shall be placed in the machinery space and in the cargo control room, where provided, but in any case they shall be placed in a position where the alarm may be immediately received by responsible members of the crew.

9.16.7.8 Audible and visual alarms indicating the low water level in the water seal of half-dry and dry type shall operate on failure of the inert gas supply.

9.16.7.9 Additional audible alarms independent of the alarms required under 9.16.7.6.9 or automatic shut-down of the cargo pumps shall be provided to operate when the pressure in the main drops to 0.5 kPa.

9.16.8 Systems using flue gas of boilers (these requirements supplement the requirements of 9.16.1 to 9.16.7)

9.16.8.1 The flue gas scrubber and blowers shall be located aft of all cargo tanks, cargo pump rooms and cofferdams separating these spaces from machinery spaces of category A.

The design and location of scrubber and blowers with relevant piping and valves shall prevent the gas leakages into enclosed spaces.

9.16.8.2 Suitable shut-off arrangements shall be provided on the suction and discharge connections of each blower. Arrangements shall be provided to enable the functioning of the inert gas plant to be stabilized prior to cargo discharge.

9.16.8.3 Shut-off valves shall be fitted in the inert gas supply mains between the boiler uptake and the flue gas scrubber to indicate whether the valve is open or closed. Provision shall be made to ensure gastightness of the valves and to prevent dirtying of valve seats with soot.

Arrangements shall be provided to ensure that boiler soot blowers cannot be operated when the corresponding flue gas valve is open.

9.16.8.4 If the blowers shall be used for gas freeing, their air inlets shall be provided with blanking arrangements.

9.16.8.5 A shut-off valve (refer to 9.16.8.3) shall be of a material capable of withstanding the flue gas temperature and resistant to the corrosive action of the gas.

9.16.8.6 The piping between the shut-off valve and the scrubber shall be made of corrosion-resistant steel.

9.16.8.7 An additional water seal or other effective means of preventing flue gas leakage shall be fitted between the shut-off valve (refer to 9.16.8.3) and the scrubber.

9.16.8.8 The valve referred to in 9.16.6.5 shall be located at the forward bulkhead of the forwardmost gas safe space through which the inert gas supply main passes.

9.16.8.9 Automatic shutdown of the inert gas blowers and gas regulating valve shall be arranged when predetermined limits are reached as defined in 9.16.7.6.1, 9.16.7.6.2 and 9.16.7.6.8. Automatic shutdown of the gas regulating valve shall also be arranged in case of blower failure.

9.16.9 Inert gas generator system (the requirements for the system described below supplement the requirements of 9.16.1 to 9.16.7).

9.16.9.1 In inert gas generators (the equipment system including blowers, combustion chamber, scrubber, fuel oil pumps, burner, instrumentation and control instruments) use shall be made of fuel oil meeting the requirements of 1.1.2, Part VII “Machinery Installations”.

9.16.9.2 The generators shall be located in category A machinery spaces.

9.16.9.3 In ships in which toxic substances may be carried, gas generators shall not be located in the machinery spaces and shall be located in a compartment reserved solely for their use according to the requirements of 9.16.8.1.

Such a compartment shall be separated from the machinery spaces at least by a gastight steel bulkhead without doors or other openings, and from the accommodation spaces and cargo area by open decks, cofferdams or similar spaces.

Adequate positive pressure type mechanical ventilation shall be provided for such a compartment. Access to such compartments shall be only from an open deck outside the cargo area. Access shall be provided on the end bulkhead of the superstructure or deckhouse, not facing the cargo area and/or on the outboard side of the superstructure or deckhouse at a distance of at least L/25, but not less than 3 m from the end of the superstructure or deckhouse facing the cargo area.

The inert gas supply main shall not be located in, or have any connection with systems located in machinery spaces, accommodation spaces and service spaces.

9.16.9.4 Irrespective of the provisions of 9.16.3.4, the Register may permit only one blower if it is capable of delivering to the protected cargo spaces the total volume of gas required under 9.16.2, provided sufficient spares for the air blower and its prime mover are carried on board to ensure any failure of the air blower and its prime mover is rectified by the ship's crew.

9.16.9.5 Two fuel oil pumps shall be fitted to the inert gas generator. The Register may permit only one fuel oil pump, provided sufficient spares for the fuel oil pump and its prime mover are carried on board to ensure any failure of the pump and its prime mover is rectified by the ship's crew.

9.16.9.6 Where more than one inert gas generator is provided, suitable shut-off arrangements shall be fitted on the discharge outlet of each generator plant.

9.16.9.7 Arrangements shall be made to vent the inert gas to the atmosphere during starting-up or in case of equipment failure.

9.16.9.8 Where the inert gas generator is served by positive displacement blowers, a pressure relief device shall be provided to prevent excess pressure being developed on the discharge side of the blower.

9.16.9.9 Audible and visual alarms shall be provided to indicate:

.1 insufficient fuel oil supply;

.2 failure of power supply to the generator;

.3 failure of power supply to the automatic control system for the generator.

9.16.9.10 The gas regulating valve shall be automatically controlled to close and to interrupt the fuel oil supply to the generator when predetermined limits are reached as specified in 9.16.7.6.1 and 9.16.7.6.2.

Automatic shut-down of the gas regulating shall also be arranged in respect of 9.16.9.9.2.

9.16.10 Inertisation of oil tankers double hull spaces

9.16.10.1 On tankers where the inert gas system is required, inertisation of space in double hull may be accomplished through detachable branch pipes connected with the inert gas system of cargo tanks or via stationary pipelines.

9.16.10.2 If detachable branch pipes are used, connection arrangements on the system main shall be provided.

9.16.10.3 If stationary pipelines are used, a separate deck gate and shut-off valve shall be provided.

9.16.11 System for producing pad in cargo tanks

9.16.11.1 To produce pad in cargo tanks, use may be made of a system with inert gas supplied from cylinders, as well as a system using inert gas generators and nitrogen generators, if their capacity is less than that specified in 9.16.2.1.

The quantity of gas in the cylinders shall be sufficient for producing pad in cargo tanks, inerting, where necessary, of spaces adjacent to cargo tanks and for replacing the inert gas loss during voyage.

9.16.11.2 The inert gas shall be stored in special cylinders or pressure vessels meeting the requirements of Part X "Boilers, Heat Exchangers and Pressure Vessels".

The pressure vessels may be installed on the open deck or in a special space meeting the requirements of 3.1.3.2, Part VI "Fire Protection", located aft of the collision bulk-head and provided with ventilation meeting the requirements of 12.9.

9.16.11.3 Pipelines from pressure vessels and from each group of cylinders shall be fitted with reducing valves downstream of which safety valves shall be provided. In addition, two non-return valves placed in tandem shall be provided.

Otherwise, all connections of the system to protected spaces and pipelines shall be provided with detachable components. Shut-off valves shall be provided upstream and downstream of these components.

9.16.11.4 Cargo tanks and the spaces to be inerted (as specified in 9.16.10.1) shall be equipped with devices for measuring pressure and gas atmosphere.

9.16.12 Nitrogen generator system

9.16.12.1 These requirements apply to the system in which the inert gas (nitrogen) originates due to separation of compressed air to the basic gases while passing through the nitrogen generator (group of empty fibres of semipermeable membranes or through adsorbent placed in hermetic casing).

In addition to the requirements of this paragraph, the system shall also comply with the requirements of 9.16.2.1, 9.16.4, 9.16.6.1 to 9.16.6.3, 9.16.6.12 (applicable to 9.16.12.8), 9.16.7.4, 9.16.7.5, 9.16.7.9 (applicable to 9.16.12.14.7) and 9.16.8.8 (applicable to 9.16.12.8).

9.16.12.2 Air compressor and nitrogen generator shall be placed in the machinery space or in a separate room which is then referred to other machinery spaces (refer to 2.4.2, Part VI "Fire Protection"). It shall be located outside the cargo area and shall have no direct access to the accommodation, service spaces and control stations.

9.16.12.3 The system shall produce inert gas with at least 95 per cent content of nitrogen and no more than 5 per cent of oxygen.

The system shall be fitted with an automatic device to enable emission of gas into the air during preparation of the system for the specification level and even during faults.

9.16.12.4 The system shall have two air compressors of equal capacity. The system may have one compressor provided there are enough spare parts aboard for repair by the crew.

9.16.12.5 Equipment for processing of air supplied into the generator (air

cooler, air heater, separator, filters) shall clean it from moisture, particles and oil, and maintain specification temperature.

9.16.12.6 The nitrogen receiver may be installed in the cargo area. The room where it is installed shall have exit to the open deck, the door is to open outwards.

9.16.12.7 The oxygen-enriched air from the nitrogen generator is to extend outside rooms to the safe locations on the open deck outside of hazardous areas, situated not within 3 m of areas traversed by personnel and not within 6 m of air intakes for machinery (engines and boilers) and all ventilation inlets.

The nitrogen-enriched gas from the protective devices of the nitrogen receiver is to extend outside rooms to the safe locations on the open deck, situated not within 3 m of areas traversed by personnel and not within 6 m of air intakes for machinery (engines and boilers) and all ventilation inlets/outlets.

9.16.12.8 At the outlet from the nitrogen generator devices to maintain permanent pressure of the inert gas shall be installed.

9.16.12.9 A shut-off valve shall be installed between the nitrogen generator and receiver.

9.16.12.10 At least two non-return shut-off devices shall be fitted in the inert gas system, one with a double interlock and a purging device, and the other with a local shutoff. They shall be installed on the main in the cargo area upstream of the branch pipes specified in 9.16.6.2.

9.16.12.11 Instruments for the permanent temperature and pressure indication shall be mounted on the compressor delivery side; on the nitrogen generator intake side.

9.16.12.12 Instruments shall be mounted for the permanent indication and registration during system operation:

.1 of oxygen content in the inert gas at the nitrogen generator output;

.2 of pressure in the main upstream of the non-return sealing valve under 9.16.12.10.

9.16.12.13 Instruments specified in 9.16.12.12 shall be fitted in the cargo control room, if any. If there is no cargo control room onboard, the instruments shall be fitted in a space where alarm may be received by the responsible crew members.

9.16.12.14 Audible and visual alarm shall be provided to indicate:

.1 low air pressure in the compressor under 9.16.12.11;

.2 high air temperature under 9.16.12.11;

.3 high water level in the separator under 9.16.12.5;

.4 breakdown of electrical heater (where fitted) under 9.16.12.5;

.5 high oxygen content under 9.16.12.3 and 9.16.12.12;

.6 loss of energy supply of instruments under 9.16.12.12;

.7 gas pressure drop under 9.16.12.12;

.8 gas pressure increase under 9.16.12.12.

9.16.12.15 Automatic stop of compressor shall take place if alarm turns on as specified in 9.16.12.14.1 to 9.16.12.14.5 and 8.16.12.14.8.

Automatic compressor protection shall comply with the requirements of 4.5, Part XV “Automation”.

9.16.12.16 Automatic locking of arrangements specified in 9.16.12.14.8

shall take place if power is disconnected from the compressor.

9.16.12.17 Alarm required under 9.16.12.14 shall be installed in the engine room and cargo control room, where provided, but in any case in a room where alarm may be immediately received by the responsible crew member.

10. AIR, OVERFLOW AND SOUNDING PIPING

10.1 AIR PIPES

10.1.1 Each tank intended for the storage of liquid and each filled cofferdam, as well as the ice boxes and sea chests, shall have air pipes.

The air pipes of ice boxes and sea chests shall have shut-off valves fitted directly on them.

The air pipes of double-bottom tanks and of tanks adjoining the shell plating, as well as the air pipes of ice boxes and sea chests, shall be laid to positions above the bulkhead deck.

10.1.2 The air pipes shall be fitted at the highest part of the tank and, as a rule, at a place that is at a maximum distance from the filling pipe. The number and arrangement of the pipes shall be selected depending on the shape and size of the tank.

If the air pipes of fuel tanks are used as overflow (air/overflow) pipes, the requirements of 10.2.4 shall be complied with.

10.1.3 The tanks extending from side to side of the ship shall be fitted with air pipes at either side. The air pipes shall not be used as filling pipes, except when the tank is fitted with more than one air pipe.

The air pipes of tanks carrying liquids of different kinds may not be laid into a common line.

10.1.4 The height of the air pipes laid to the open deck measured from the deck to the point where water may have access below shall not be less than: 760 mm on the freeboard deck; 450 mm on superstructure decks.

Where such height is an obstacle to operations on board a smaller height may be approved, provided the availability of closing arrangements or other circumstances make this substitution reasonable. Besides, in ships of restricted areas of navigation **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, **R3-IN, A-R2, A-R2-S**, **A-R2-RS, B-R3-S, B-R3-RS C-R3-S, C-R3-RS**, **D-R3-S**, and **D-R3-RS** the above pipe heights may be reduced on agreement with the Register. However, they shall not be less than 600 and 380 mm, accordingly.

The minimum wall thicknesses of the air pipes above deck shall be:

for $d \leq 80$ mm — 6 mm,

for $d \geq 165$ mm — 8.5 mm.

Intermediate sizes shall be determined by linear interpolation.

Air pipes shall be located in safe spaces where the possibility of damage of the pipes during handling is excluded.

The arrangement and structure of air pipes for daily tanks as well as fuel oil and lubricating oil settling tanks shall be such as to prevent rain or sea water from entering the tanks in case of their breakdown.

10.1.5 The upper end of each air pipe shall have a bend with its opening facing downwards or shall have another design agreed upon with the Register.

10.1.6 The open ends of air pipes of fuel oil and lubricating oil tanks shall be laid to

positions on the open deck where the vapours that issue from the tanks may not cause a fire hazard.

The open ends of air pipes of these tanks on oil tankers and combination carriers shall be in compliance with the requirements of 9.10.4.

The air pipes of fuel oil tanks with heating arrangements shall meet the requirements of 13.3.5.

10.1.7 The air pipes of independent lubricating oil storage tanks may terminate in spaces where the tanks are installed if precautions are taken to preclude spillage of oil onto electrical equipment or heated surfaces in case of tank overflow.

10.1.8 The outlets of air pipes situated on the open freeboard deck and superstructure deck of the first tier (refer to 1.2.5, Part III "Equipment, Arrangements and Outfit"), as well as the outlets of the air pipes on the decks of higher tiers within the area limited by the angle of flooding (refer to 1.2, Part IV "Stability") shall have permanently attached self-closing covers to prevent sea water from entering the tanks, but to allow free access of air and liquids.

Closing devices shall meet the requirements of 4.4.

10.1.9 The total cross-sectional area of the air pipes in gravity tanks shall not be less than the total sectional area of the filling pipes of these tanks.

10.1.10 The total cross-sectional area of the air pipes of tanks filled by the ship's pumps or shore pumps shall not be less than 1.25 times the cross-sectional area of the filling pipe of these tanks.

The cross-sectional area of a common air pipe from several tanks shall be at least 1.25 times the area of the common filling pipeline of these tanks, provided the requirements of 10.2.3 are met.

10.1.11 Where a tank filled by shipboard pumps or from shore pumps is fitted with an overflow pipe, the total cross-sectional area of the air pipes of the tank shall not be less than one-third of the filling pipe area.

Where the air pipes from several tanks fitted with overflow pipes are combined, the cross-sectional area of the common air pipe shall be at least one-third of the area of the common filling pipe of these tanks, provided the requirements of 10.2.3 are met.

10.1.12 The air pipe internal diameter shall be at least 50 mm under all conditions. This requirement does not apply to the air pipes indicated in 10.1.9.

10.1.13 The arrangement of the air pipes shall prevent the formation of hydraulic seals in the pipes.

10.1.14 The air pipes of fuel oil and lubricating oil tanks in way of accommodation and refrigerated cargo spaces shall not have detachable connections.

10.1.15 Nameplates shall be affixed to the upper ends of all air pipes.

10.1.16 The air pipes from crankcases of internal combustion engines shall comply with the requirements of 2.3.4, Part IX "Machinery" and 11.1.9 of this Part.

10.1.17 The air pipes from ballast compartments of floating docks shall be laid to a height not less than 300 mm above the margin line.

It is permitted to lay air pipes through the plating of wing walls.

Other requirements of this Subsection do not apply to the air pipes of the ballast compartments in floating docks.

10.1.18 In passenger ships, the open ends of air pipes terminating in the superstructure shall be located 1 m above the waterline of the ship inclined up to 15° or the maximum angle of heel determined by calculations during intermediate flooding, whichever is greater.

As an alternative, air pipes of tanks, other than fuel oil and lubricating oil tanks, may be laid through the superstructure side.

10.1.19 The open ends of the cargo tank air pipes of oil recovery ships shall be laid to positions on the open deck where the vapours that issue may not cause a fire hazard and shall be protected with flame-arresting fittings.

The clear area through the fitting shall not be less than the open flow area of the air pipe.

10.1.20 Test tank air pipes of cargo heating system condensate shall meet the requirements of 9.6.3.

10.2 OVERFLOW PIPES

10.2.1 Fuel oil tanks shall be provided with overflow pipes to direct fuel to an overflow tank or storage tank, the capacity of which shall be increased by a value not less than the overflow tank capacity as stipulated by 10.3.1, and which shall be equipped in accordance with 10.3.2.

No overflow pipes need be fitted where the fuel oil system is so designed that no spilling overboard may occur during the loading and transfer of fuel.

Besides fuel oil tanks, the overflow pipes shall be fitted on lubricating oil tanks specified in 14.4.4 and 20.4.3.

10.2.2 The cross-sectional area of overflow pipes shall not be less than 1.25 of the filling pipe area. The cross-sectional area of the common overflow pipe of several tanks shall not be less than 1.25 of the common filling pipe area.

10.2.3 Where the overflow pipes from several integrated tanks located in different watertight compartments are laid to a common header or pipe, this header or pipe shall be located above the deepest damage waterline in ships having a subdivision mark in the class notation and above the deepest load waterline in other ships.

10.2.4 Where air pipes are simultaneously used as overflow pipes, they shall not be connected to the air pipes of overflow tanks. In this case, overflow pipes or a common overflow pipe shall be connected directly to the tank.

10.2.5 Where a tank is used alternatively for the carriage of fuel oil, water ballast or liquid and dry cargoes, then in the case of a common overflow system the overflow pipes shall be so arranged as to prevent the flow of liquid from one tank into another and the entry of liquid cargo vapours into dry cargo tanks. In such cases, upon approval by the Register, the overflow pipes may be fitted with shut-off valves, provided such pipes are not used as air pipes.

10.2.6 The overflow pipes of daily tanks and of fuel oil and lubricating oil settling tanks shall be laid to overflow tanks located below the tanks mentioned above.

10.2.7 A sight glass shall be fitted on vertical overflow pipes at a readily visible and accessible location, or an alarm device shall be provided to give warning when the

predetermined level is reached in the overflow tank (refer also to 10.3.2).

10.2.8 The minimum overflow pipe bore shall be 50 mm.

10.2.9 Overflow pipes shall be extended up to the bottom of the overflow tanks with a minimal clearance. The flow area in the clearance shall not be less than the sectional area of the overflow pipe.

10.3 OVERFLOW TANKS

10.3.1 The capacity of an overflow fuel tank shall not be less than the maximum capacity of the fuelling and fuel transfer system within 10 min.

10.3.2 An overflow tank shall be provided with audible and visual alarms operating whenever the tank filling reaches 75 per cent.

10.4 SOUNDING ARRANGEMENTS

10.4.1 Every tank intended for the storage of liquid, cofferdams and void spaces with bilge connections, as well as bilges and bilge wells in spaces, which are not accessible at all times, shall be provided with sounding pipes for level management, as a rule, extended to the open decks. In tanks, other sounding arrangements may be used, with design approved by the Register.

Sounding pipes of independent tanks need not be laid to the open deck.

Upper ends of the sounding pipes of the fuel oil and lubricating oil tanks shall not be laid to the spaces with the risk of ignition of leakage from the sounding pipes.

Laying of the sounding pipes of fuel tanks to accommodation and service spaces is prohibited.

10.4.2 Other oil-level gauges may be used instead of the sounding pipes, provided that they meet the following requirements:

.1 in passenger ships the installation of such means shall not require penetration below the top of the tank and their failure or overfilling of the tanks shall not permit release of fuel;

.2 in cargo ships the failure or overfilling of the above measuring instruments shall not cause release of fuel. The level indicators may be used with flat glass and self-closing cocks fitted between the level indicators and the fuel tanks.

When the upper part of the indicator is connected to the top of the tank, the upper self-closing valve need not be installed.

The use of glass pipes in the level indicators is not permitted.

10.4.3 Where the double bottom forms bilges at the wings, or the ship has a flat bottom, the sounding pipes shall be installed at each side. These pipes shall be laid to positions above the bulkhead deck, which are at all times accessible for taking soundings.

The sounding pipes shall be as straight as practicable and shall not prevent taking soundings with a sounding rod.

10.4.4 As a rule, the sounding pipes of fuel and oil tanks shall not terminate in machinery spaces. Where this requirement is impracticable, termination of sounding pipes in machinery spaces may be permitted provided the following requirements are met:

.1 in passenger ships, such pipes shall not require penetration below the top of the tank and their failure or overfilling of the tanks shall not cause release of fuel. An additional fuel oil level indicator shall be installed in compliance with 10.4.2.1;

.2 in cargo ships, the failure of such pipes or overfilling of the tank shall not cause release of fuel;

.3 the sounding pipes shall terminate in locations remote from ignition hazards or they shall be screened;

.4 terminations of sounding pipes shall be fitted with self-closing blanking devices and with a small-diameter self-closing control cock located below them;

.5 structural measures shall be taken to prevent the spillage of fuel or oil on heated surfaces from the blanking device;

.6 the pipes shall terminate at least 0.5 m above the plating.

10.4.5 The sounding pipes of the double-bottom water storage tanks may be laid into spaces below the bulkhead deck that are located above them and are accessible at all times. Such pipes shall not be used as air pipes and shall be fitted with self-closing cocks.

10.4.6 Provision shall be made under the open ends of the sounding pipes for welded striking plates or other strengthening to protect the bottom plating from damage by a sounding rod.

In case of slotted sounding pipes with closed ends, adequate closing plugs shall be provided.

10.4.7 The internal diameter of sounding pipes shall be at least 32 mm, and for ships of restricted areas of navigation **R3-S**, **R3-RS**, **R3**, **R3-IN, C-R3-S, C-R3-RS**, **D-R3-S, and D-R3-RS,** at least 25 mm.

Sounding pipes, which pass through refrigerated cargo spaces, in which the temperature may be reduced to 0 °C and below, as well as sounding pipes of oil storage tanks in oil recovery ships shall have an internal diameter of not less than 50 mm.

10.4.8 Nameplates shall be affixed to the upper ends of the sounding pipes.

10.4.9 The ends of the sounding pipes laid to the exposed decks shall be fitted with tight plugs meeting the requirements of 2.1.8.

The use of closings of a different type shall be specially considered by the Register in each case.

If the sounding pipes project above the open deck, they shall be located at such positions where they cannot be damaged, otherwise they shall have appropriate guards.

10.4.11 In floating docks the sounding pipes of ballast compartments shall be laid to the top deck of the side walls.

11. EXHAUST GAS SYSTEM

11.1 EXHAUST GAS PIPING

11.1.1 The exhaust gas pipes shall, as a rule, be laid to the open decks.

11.1.2 Where the exhaust gas pipes are laid through the shell plating in the vicinity of load waterline or below it, provision shall be made for arrangements precluding the possibility of sea water entering the engine.

11.1.3 In oil tankers, oil recovery tankers, timber carriers, supply vessels, ships adapted for the carriage of explosive and fire hazardous cargoes, as well as in ships servicing or towing the above-mentioned ships, the uptakes of boilers,

exhaust pipes of main and auxiliary engines, incinerators shall be fitted with spark arresters of the design approved by the Register.

11.1.4 The exhaust gas pipes shall be laid at a distance not less than 450 mm from the fuel oil tanks.

11.1.5 Each main engine shall have an individual exhaust gas pipe. Where required, departures may be allowed, subject to special consideration by the Register.

Where three or more diesel generators are fitted, their exhaust gas pipes may be connected to a common exhaust line provided that the engine with the greatest output has an autonomous exhaust pipe. Moreover, the common exhaust line shall be fitted with reliable devices to preclude gases of the common line entering the pipes of the idle engines; damage of any of the engines when started.

In ships of restricted areas of navigation **R2**, **R2-SN**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, **R3-IN, A-R2**, **A-R2-S**, **A-R2-RS**, **B-R3-S, B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **and D-R3-RS** the exhaust gas pipes of the main and auxiliary engines may be connected to a common exhaust line, provided the foregoing precautions are taken.

The exhaust gas pipes from DF-engines shall comply with the requirements of 9.5.2, Part IX “Machinery”.

11.1.6 The waste boilers and the composite waste heat/oil fired boilers, which due to their structure may not be left without water while heated by exhaust gases, as well as the boilers mentioned in 3.2.16, Part X “Boilers, Heat Exchangers and Pressure Vessels”, shall be provided with a by-pass line and dampers to disconnect the boilers from exhaust gas supply, when necessary.

11.1.7 The uptakes of boilers, incinerators and the exhaust gas pipes of internal combustion engines shall be thermally insulated by suitable insulating material, double walls or screens.

Where an insulating material is used for thermal insulation, the requirements of 2.1.1.5, Part VI “Fire Protection” shall be taken into consideration.

Double walls or screens are permitted only in positions where they may not contact with fuel or lubricating oil leaks.

11.1.8 When the uptakes of main and auxiliary boilers are arranged to discharge into a common uptake, dampers are permitted, provided they have arrangements to be locked open.

Where required, manholes and vertical ladders shall be provided for inspection and cleaning of the uptakes and air ducts of boilers.

11.1.9 In oil recovery ships, the outlets of exhaust gas piping of main and auxiliary engines, uptakes of boilers, incinerators and other equipment containing sources of ignition as well as air pipe vent openings of crankcases in internal combustion engines shall be located at least 6 m above the deepest waterline, but in any case outside the hazardous zones as defined in 19.2.3, Part XI “Electrical Equipment”.

11.1.10 The exhaust gas piping of main and auxiliary internal combustion engines shall be fitted with non-disconnectable draining devices to prevent the entry of water into the engine. The devices shall be readily accessible for maintenance and clearing and shall have a drain pipe bore not less than 25 mm.

11.1.11 The exhaust gas pipes of engines shall be fitted with thermal compensators.

The exhaust gas piping shall have handholes and, where necessary, drain cocks.

11.1.12 Where waste heat boilers are available on board, structural arrangements shall be provided to prevent the ingress of water into the exhaust gas duct of the internal combustion engines during washing.

The draining pipes for the cleaning water shall be laid to the machinery space bilges and be provided with hydraulic seals.

11.2 SILENCERS AND SPARK ARRESTERS

11.2.1 The silencers and spark arresters shall be so arranged as to permit cleaning, for which purpose they shall be fitted with appropriate handholes, drain cocks or plugs.

11.2.2 Where spark arresters of the wet type are used, the requirements of 11.1.12 shall be met.

12 VENTILATION SYSTEM

12.1 VENTILATION DUCTS, HEADS AND AIR INLETS

12.1.1 Generally, ventilation ducts shall not be laid through watertight bulkheads below the bulkhead deck.

Where it is not practicable to avoid laying ventilation ducts through watertight bulkheads below the bulkhead deck, means of closure shall be provided at the penetrations to ensure watertightness and strength equal to that of the local ship's structures, operated from a position above the bulkhead deck.

Where ventilation ducts are laid through more than one watertight bulkhead, the closures of such openings shall be power operated and shall be closed from the main machinery control room situated above the bulkhead deck.

The design of closures shall be such as to ensure strength equivalent to the strength of ship's structures in places where these closures are installed.

12.1.2 Where trunkways and vertical ducts of the ventilation system pass through watertight decks, they shall be watertight and equivalent in strength to adjacent hull structures within a single watertight compartment below the bulkhead deck.

12.1.3 Ventilation ducts shall be adequately protected against corrosion or shall be constructed of corrosion-resistant materials.

12.1.4 Ventilation ducts for removal of explosion and fire-dangerous vapours and gases shall be gas-tight and shall not communicate with the ducts of other spaces.

12.1.5 Ventilation ducts laid to cargo spaces, machinery spaces and other spaces fitted with smothering facilities shall have closures in compliance with 3.1.2.3, Part VI "Fire Protection".

12.1.6 In places of possible sweating the ventilation ducts shall be properly insulated, while in areas where water may accumulate drain plugs shall be provided.

The inlets and outlets of the ventilation systems shall be provided with closing appliances fitted with drives for clos-

ing them from positions outside these spaces.

12.1.7 The ventilator heads of supply ducts and the air inlets of ventilation systems shall be so located that the risk of drawing in air contaminated by gas, oil vapours, etc., is minimized, and admission of sea water into the ventilation ducts is precluded.

In icebreakers and ships with ice strengthening precautions shall be taken to prevent entry of snow into the ventilation ducts. It is recommended to arrange the air intakes on both sides of the ship and to provide for heating arrangements.

12.1.8 The ventilator coamings shall have a height in accordance with 7.8, Part III "Equipment, Arrangements and Outfit".

12.1.9 The arrangement of ventilator heads in cargo spaces, special category spaces, open and closed spaces of ro-ro ships shall comply with the requirements of 2.1.4.7, Part VI "Fire Protection".

12.1.10 Access routes to the controls for closure of the ventilation system under 12.1.5 shall permit a rapid shutdown without regard to weather and sea conditions. For this routes:

.1 are clearly marked and are at least 600 mm wide;

.2 are provided with a single handrail or a wire rope lifeline not less than 10 mm in diameter, supported by stanchions not more than 10 m apart in way of any route which involves traversing a deck exposed to weather; and

.3 are fitted with appropriate means of access (such as ladders or steps) to the closing devices of ventilators located in high positions (i. e. 1.8 m and above).

Alternatively, remote closing and position indicator arrangements from the bridge or a fire control station for those ventilator closures are acceptable.

12.2 VENTILATION SYSTEMS OF CARGO SHIPS OF 500 GROSS TONNAGE AND UPWARDS, OIL TANKERS AND COMBINATION CARRIERS CARRYING PETROLEUM PRODUCTS WITH FLASH POINT 60 °C AND MORE, PASSENGER SHIPS CARRYING NO MORE THAN 36 PASSENGERS, SPECIAL PURPOSE SHIPS CARRYING NO MORE THAN 240 PERSONS, AND BERTH-CONNECTED SHIPS

12.2.1 The ventilation systems of accommodation spaces, service spaces and control stations shall comply with requirements of this Subsection.

12.2.2 The ventilation ducts shall be of steel or an equivalent material.

However, ducts with a cross-sectional area not exceeding 0.02 m^2 and a length not exceeding 2 m may be constructed of any material with low flame spread characteristics (refer to 1.6.3.5, Part VI "Fire Protection"), if the following conditions are met:

the ducts are used only at the end section of the ventilation system;

the ducts are at a distance of at least 0.6 m, measured along the duct, from the penetration of an A or B class division (refer to 2.1.2, Part VI "Fire Protection"), including continuous B class ceilings;

the ducts are made of heat resisting non-combustible material, which may be faced internally and externally with membranes with low flame-spread characteristics and, in each case, a calorific value not exceeding 45 MJ/m^2 of their surface area for the thickness used.

Flexible elbow elements of combustible material may also be used to connect fans to the ducting in air conditioning rooms.

12.2.3 Where the ventilation ducts with a free sectional area above 0.02 m^2 pass through A class bulkheads or decks, the opening shall be lined with a steel sheet sleeve unless the ducts passing through the bulkheads or decks are of steel in the vicinity of passage through the deck or bulkhead.

The ducts and sleeves in his area shall comply with the following:

.1 the sleeves shall be at least 3 mm thick and at least 900 mm long. When passing through bulkheads, this length shall be divided mainly into 450 mm sections on each side of the bulkhead.

In passenger ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **or D-R3-RS,** the sleeves shall be at least 200 mm long. This length shall be divided mainly into 100 mm sections on each side of the bulkhead; on decks, sleeves shall pass through the bottom side of the deck for the entire length.

These ducts, or sleeves lining such ducts, shall be provided with fire insulation. The insulation shall be at least of the same fire integrity as the bulkhead or deck through which the duct passes. Equivalent penetration protection may be provided to the satisfaction of the Register;

.2 ducts with a free cross-sectional area exceeding 0.075 m^2 shall be fitted with fire dampers in addition to the requirements of 12.2.3.1.

The fire damper shall operate automatically and shall also be capable of being closed manually from both sides of the bulkhead or deck. The damper shall be provided with the means to indicate whether it is open or closed. Manual closing from both sides of the bulkhead or deck may be effected by mechanical arrangements or by remote operation of the fire damper by means of failure-free electrical switches or by means of pneumatic damper drive through release of the compressed springs, etc.

The fire dampers shall be readily accessible. Where they are fitted behind the lining, the latter shall be provided with a sight hole, at which a plate bearing the fire damper number shall be secured. A similar plate with a number shall be secured to the proper remote control device. Fire dampers are not required, where ducts pass through spaces surrounded by A class divisions, without serving those spaces, provided those ducts are of the same fire integrity as the divisions which they pass through.

12.2.4 Galley ventilation systems shall be separate from the ventilation systems serving other spaces.

In cargo ships of less than 4000 gross tonnage and in passenger ships carrying no more than 36 passengers, supply galley ventilation may be provided by separate ducts from ventilation installation common with other spaces through an automatic fire damper fitted in the galley ventilation duct close to the ventilation installation and isolating, where necessary, all portions of the ventilation duct.

The galley ventilation ducts passing through accommodation and service spaces and control stations shall be:

1. made of steel with a thickness of at least 3 and 5 mm for ducts with the width and diameter up to and including 300 and 760 mm and above, respectively.

For ducts with the width or diameter between 300 and 760 mm, the thickness shall be determined by interpolation;

.2 suitably supported and stiffened;

.3 constructed of A class divisions with wall thickness in accordance with 12.2.4.1;

.4 insulated to A-60 standard throughout the accommodation and service spaces or control stations.

The above requirements apply also to ducts intended for ventilation of accommodation spaces, service spaces or control stations, which pass through category A machinery spaces, galleys, cargo spaces of roll-on/roll-off ships, car deck spaces and special-category spaces. If a ventilation duct is laid through the main vertical fire zone divisions, the requirements of 12.2.8 shall be met.

Ventilation systems of category A machinery spaces, galleys, vehicle spaces, cargo spaces of roll-on/roll-off ships, special-category spaces and other cargo spaces shall be separated from one another and from ventilation systems serving other spaces. When the above-stated ventilation ducts pass through accommodation and service spaces or control stations they are subject to the requirements of 12.2.4.1 to 12.2.4.4.

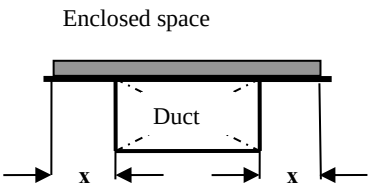


Fig. 12.2.4-1

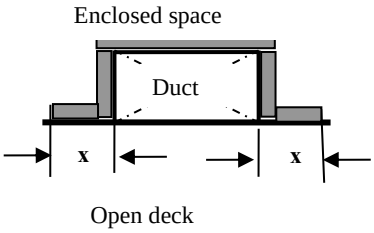


Fig. 12.2.4-2

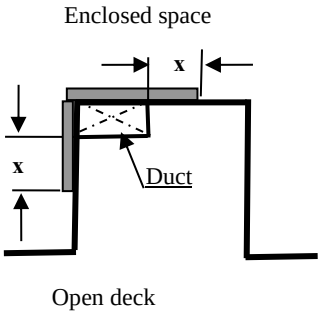


Fig. 12.2.4-3

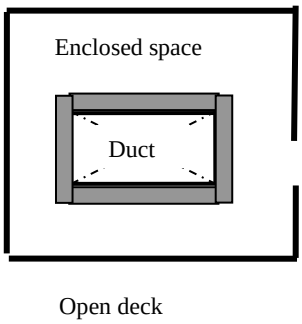


Fig. 12.2.4-4

When the above-stated duct is adjacent to accommodation or service spaces, fire insulation of the duct shall comply with Fig. 12.2.4-1 to 12.2.4-4,

where:

is the fire insulation

X = 450 mm

12.2.5 Where ventilation ducts with a cross-sectional area exceeding 0.02 м^2 pass through B class bulkheads, the openings shall be lined with steel sheet sleeves of 900 mm in length, unless the ducts are of steel for this length in way of the bulkhead. When passing through a B class bulkhead, this length shall be divided into 450 mm on each side of the bulkhead.

In passenger ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **and D-R3-RS,** ducts other than steel ducts passing through B class bulkheads shall be protected:

.1 with a device withstanding fire-resistance test, corresponding to the degree of fire integrity of the division and to the type of duct used; or

.2 with a steel sleeve at least 1.8 mm thick and at least 900 mm long for ducts with the diameter of 150 mm and more, and at least 600 mm for ducts with the diameter less than 150 mm (this length shall preferably be divided in half by the division).

The ducts shall be connected with the sleeve ends by means of flanged joints or equivalent joints.

12.2.6 All necessary measures shall be taken for permanent ventilation of the control stations outside the machinery spaces, to ensure visibility and absence of smoke to the extent required for normal operation of the equipment at control stations and for work of the attending personnel.

For the ventilation of these control stations two alternative and separate means of air supply shall be provided. The air supply ducts shall be fitted with fire or smoke dampers closed from within the control station so that, in the event of fire, smoke is kept from penetrating into the spaces.

These requirements need not be applied to the control stations situated on the open deck, to which they have a direct exit or where there are equally effective local closures of the control stations.

12.2.7 Galley ventilation systems shall be separate from the ventilation systems serving other spaces.

The exhaust ducts from galley ranges shall be constructed of A class divisions where they pass through accommodation spaces or spaces containing combustible materials.

Each galley ventilation duct passing through accommodation spaces or other spaces containing combustible materials shall be fitted with:

a grease trap readily removable for cleaning;

a fire damper located in the lower end of the duct and, in addition, a fire damper located in the upper end of the duct;

fixed means for extinguishing fire within the duct;

arrangements, operable from within the galley, for shutting off the exhaust fans (refer also to 5.8.2, Part XI “Electrical Equipment”).

12.2.8 Where in passenger ships it is necessary that a ventilation duct passes through a division of the main vertical fire zone, a failsafe automatic closing fire damper shall be fitted adjacent to the division. The damper shall be also capable of being manually closed from each side of the division. For the types of manual closing, refer to 12.2.3.2.

The position for operating the damper shall be readily accessible and be marked in red light-reflecting colour.

The duct between the division and damper shall be made of steel or equivalent material, and shall be provided with insulation corresponding to the degree of fire integrity of the division. At least at one side of the bulkhead the damper shall be fitted with a readily visible indicator showing whether the damper is open.

12.2.9 Provision shall be made for closing the inlets and outlets of all ventilation systems from outside the ventilated spaces. Manual closing arrangements shall be readily accessible and have indelible, readily visible marking, which shows whether the duct is open or closed.

12.2.10 The ventilation ducts and their passages through A or B class divisions in ships of less than 500 gross tonnage, as a rule, shall be constructed in compliance with the requirements of this Subsection. The deviations from these requirements are subject to special consideration by the Register in each case.

12.2.11 Mechanical ventilation shall have controls arranged so that all ventilators can be switched off at two positions located as far apart as possible. The controls of mechanical ventilation in machinery spaces shall be arranged so that the control can be effected at two positions one of which is outside the machinery spaces. These positions shall not be easily isolated in case of fire in the ventilated spaces.

The ventilators servicing the mechanical ventilation systems of cargo spaces shall be switched off at the safe position outside such spaces (refer also to 5.8.1 to 5.8.3, Part XI "Electrical Equipment").

12.2.12 The following arrangements shall be tested in accordance with the Fire Test Procedures Code (refer to 1.2, Part VI "Fire Protection"):

.1 fire dampers, including relevant means of operation; and

.2 duct penetrations through A class divisions. Where steel sleeves are directly joined to ventilation ducts by means of riveted, screwed or welded flanges, the test is not required.

12.2.13 Flange connection gaskets made of combustible material shall not be used in ventilation ducts constructed of A class divisions and in any ventilation ducts passing through A or B class divisions, within 600 mm from the opening, measured along the duct.

12.2.14 Fire dampers fitted on the ventilation ducts from galley ranges in compliance with 12.2.7 and 12.3.6 need not pass the test according to IMO resolution A.754(18), but shall be of steel and capable of stopping the draught, if necessary.

The requirements to A class divisions apply only to the part of the duct outside the galley.

12.3 VENTILATION SYSTEMS OF PASSENGER SHIPS CARRYING MORE THAN 36 PASSENGERS AND SPECIAL PURPOSE SHIPS CARRYING MORE THAN 240 PERSONS

12.3.1 The ventilation systems of accommodation spaces, service spaces and control stations shall comply with the requirements of 12.2, in addition to the requirements of this Subsection.

12.3.2 As a rule, the ventilation fans and ducts shall be disposed within the main vertical fire zone, which they serve.

12.3.3 Where the ventilation ducts are laid through the decks, measures shall

be taken to minimize the possibility of smoke and flammable gases passing from one 'tween-deck space to another. If necessary, the vertical ducts shall be insulated providing fire integrity as required by 2.2.1.3, Part VI "Fire Protection".

12.3.4 Except in cargo spaces, ventilation ducts shall be constructed of the following materials:

.1 ducts with a cross-sectional area more than 0.075 m^2 and all vertical ducts serving more than a single 'tween-deck space shall be constructed of steel or equivalent;

.2 ducts with a cross-sectional area less than 0.075 m^2, other than the vertical ducts mentioned in 12.3.4.1, shall be constructed of steel or equivalent; where such ducts penetrate A or B class divisions, due regard shall be given to ensuring the fire integrity of the divisions;

.3 short lengths of ducts, in general, not exceeding 0.02 m^2 in sectional area nor 2 m in length shall be constructed of materials mentioned in 12.2.2.

12.3.5 Ventilation systems of stairway enclosures shall be independent of other systems.

12.3.6 Exhaust ducts from galley ranges, in which grease or fat is likely to accumulate, shall meet the requirements of 12.2.4 and shall be fitted with:

.1 a grease trap readily removable for cleaning unless an alternative approved by the Register grease removal system is fitted;

.2 a fire damper located in the lower end of the duct, which is automatically and remotely operated, and in addition a remotely operated fire damper located in the upper end of the duct (the lower end of the duct means position where the duct is connected to exhaust hood at the galley range; the upper end of the duct means position where the duct is closed as it leaves the galley);

.3 fixed means for fire extinguishing within the duct;

.4 remote control arrangements for shutting off the exhaust fans and supply fans, for operating the fire dampers mentioned in 12.3.6.2 and for operating the fire-extinguishing system, which shall be placed in a position close to the entrance to the galley.

Where a multi-branch system is installed, means shall be provided to close all branches exhausting through the same main duct before an extinguishing medium is released into the system;

.5 hatches for inspection and cleaning arranged close to the fire dampers. One hatch shall be located nearby the exhaust fan, other hatches — in the lower part of ducts.

12.3.7 Where public spaces span three or more decks and contain combustibles such as furniture and enclosed spaces such as shops, bars and restaurants, such spaces shall be equipped with a ventilation activated by a smoke detection system and capable to ventilate the entire volume within not more than 10 min. Provision shall be made for manual control of the fans.

12.3.8 The requirement of 12.2.11 does not apply to switching-off of air-conditioner ventilators if they do not dispense an outside air to spaces serviced.

12.3.9 Ventilation systems of passenger ships shall comply with the requirements of 2.2.8.6, Part VI "Fire Protection".

The ventilation systems of safety zones of passenger ships with length, as defined in 1.2.1 of the Load Line Rules

for Sea-Going Ships, of 120 m or more or having three or more main vertical zones, shall additionally comply with the requirements of 2.2.6.10, Part VI "Fire Protection".

The ventilation system serving safety centres may be derived from the ventilation system serving the navigation bridge, unless located in an adjacent main vertical zone.

12.3.10 Exhaust ducts from ranges for cooking equipment installed on open decks shall comply with the requirements of 12.3.6, as applicable, when passing through accommodation spaces or spaces containing combustible materials.

12.3.11 Exhaust ducts from main laundries shall be fitted with:

.1 filters readily removable for cleaning purposes;

.2 a fire damper located in the lower end of the duct which is automatically and remotely operated;

.3 remote-control arrangements for shutting off the exhaust fans and supply fans from within the space and for operating the fire damper mentioned in 12.3.11.3;

.4 suitably located hatches for inspection and cleaning.

12.4 VENTILATION SYSTEMS OF OIL TANKERS AND COMBINATION CARRIERS CARRYING CRUDE OIL AND PETROLEUM PRODUCTS WITH FLASH POINT OF 60 °C AND BELOW

12.4.1 In addition to requirements of 12.1, 12.2, 12.6 and 12.9, the ventilation systems shall comply with the requirements of this Subsection.

12.4.2 The ventilation inlets of accommodation spaces, service spaces and control stations shall be located on the aft transverse bulkhead not facing cargo tanks, or on the side of the superstructure or deckhouse at a distance equal, at least, to 4 per cent of the ship's length, but not less than 3 m from the end of the superstructure or deckhouse facing cargo tanks. This distance, however, need not exceed 5 m.

The inlets and outlets of ventilation ducts for machinery spaces shall be situated as far aft as practicable. Special consideration shall be given to location of these vents in oil tankers equipped to load and discharge at the stem.

12.4.3 Cargo pump rooms shall be mechanically ventilated and discharges from the exhaust fans shall be laid to a safe place on the open deck.

The ventilation of these rooms shall have sufficient capacity to minimize the possibility of accumulation of flammable vapours. The number of air changes shall be at least 20 per hour, based upon the gross volume of the space. The air ducts shall be arranged so that all of the space is effectively ventilated. The suction ventilation shall be of mechanical type using fans of the non-sparking type. Input ventilation may be self-ventilation. Lighting shall be interlocked with ventilation in accordance with 19.2.4.5, Part XI "Electrical Equipment".

12.4.4 The inlets of exhaust ducts shall be situated so as to provide extraction of air from below the floor plates. The bottom framing, as well as the floor plates and gratings of the pump room shall be so constructed as not to impede the free flow of air to the inlets of the exhaust ducts.

Outside the pump room these ducts shall be gastight and, generally, shall not communicate with the ducts of other spaces.

The pump rooms shall also have an emergency ventilation operating in the event that lower inlets are flooded. For this purpose an emergency intake about 2 m above the lower grating shall be provided on the exhaust duct, with a damper to be operated from the main deck and from the lower grating of the space. The damper may be omitted if the areas of the inlets are such that at least 20 air changes per hour are ensured through the lower inlets, and at least 15 air changes per hour through the upper inlets in case the lower inlets are flooded.

Where the ventilation system of the pump room is used to ventilate the cargo line and the communicating cargo tanks, duplicate shut-off fittings shall be provided at the connections of the ventilation duct to the cargo line.

12.4.5 The construction of the ventilation fans in cargo pump rooms shall meet the requirements of 5.3, Part IX "Machinery", and the location of their driving motors shall meet the requirements of 4.2.5, Part VII "Machinery Installations".

12.4.6 The outlets of exhaust ducts for cargo pump rooms shall not be less than 2 m remote from any opening leading into ship spaces, which may contain a source as may ignite oil vapours, and shall be so located that no contamination of air entering the inlets of ventilation systems may occur.

The outlets of exhaust ducts shall be fitted with flame-arresting fittings.

The inlets of ventilation ducts shall be protected in accordance with 5.3.3.2 of Part IX "Machinery".

The air intakes shall be situated at least 2.4 m above the cargo deck and at least 5.0 m from any openings of the cargo tanks and outlets of the pressure/relief valves, and at least 10 m from the outlets of vent pipes that expel freely the vapour/air mixture or are fitted with high-speed devices.

12.4.7 In combination carriers, all cargo spaces and all enclosed spaces adjacent to the cargo spaces shall be capable of being mechanically ventilated. Ventilation may be provided by portable fans.

12.4.8 In oil tankers:

.1 double hull and double bottom spaces shall be fitted with suitable connections for the supply of air;

.2 if an inert gas system is required, spaces mentioned in 12.4.8.1 shall be connected to the fixed inert gas distribution systems; provision shall be also made for arrangements to prevent leakage of the hydrocarbon gas from the cargo tanks into such spaces through the inert gas distribution system.

Where these spaces are not connected permanently to the inert gas distribution sources, arrangements shall be provided to ensure such connection.

12.5 VENTILATION OF MACHINERY SPACES AND TUNNELS

12.5.1 The ventilation of machinery spaces of category A shall be such as to ensure that when the machinery and boilers therein operate at full load in all service conditions including heavy weather, a supply of air is maintained to the spaces

sufficient for the safety and comfort of the personnel and the operation of machinery.

The ventilation shall ensure removal of gases heavier than air from the lower zones of those spaces, from below floor plates, from where fuel system equipment, settling and supply tanks are installed.

Any other machinery spaces shall be adequately ventilated appropriate to the purpose of the machinery space.

The requirements for the ventilation of refrigerating machinery spaces are given in 3.1.6 and 3.1.7, Part XII "Refrigerating Plants".

12.5.2 Shaft tunnels shall be properly ventilated. The pipe tunnels laid in the double bottom shall have mechanical exhaust ventilation.

12.5.3 In the space containing emergency diesel-generator (automatically started), provision shall be made for an automatic arrangement to ensure an air supply sufficient for the emergency diesel-generator to run under full load in any service conditions when the space is closed.

12.5.4 In spaces mentioned under 4.2.7, Part VII "Machinery Installations", independent mechanical exhaust ventilation or a ventilation device separable from the machinery space ventilation shall be installed. The design of fans shall comply with the requirements of 5.3, Part IX "Machinery".

12.6 VENTILATION OF SPECIAL CATEGORY SPACES, SPACES FOR MOTOR VEHICLES WITH FUEL IN THEIR TANKS, AND ENCLOSED SPACES OF ROLL-ON/ROLL-OFF SHIPS

12.6.1 These spaces shall be fitted with a mechanical exhaust ventilation system separated from other ventilation systems, such as to operate at all times while motor vehicles are kept in such spaces.

Where a space has effective closures, there shall be separate ventilation ducts for each closure. Ventilators shall be operated from locations outside of the service spaces, and shall provide the number of air changes at least as follows:

.1 10 air changes per hour (the number of air exchanges shall be increased to 20 changes per hour during loading and unloading of vehicles):

in cargo spaces for motor vehicles with fuel in their tanks — in passenger ships carrying more than 36 persons;

in special category spaces in all passenger ships;

in closed ro-ro cargo spaces with electrical equipment in accordance with 19.3.4, Part XI "Electrical Equipment" in all ships;

.2 6 air changes per hour in all other ships.

12.6.2 The ventilation shall be such as to provide even distribution of air supply and shall prevent formation of trapped zones.

12.6.3 The ventilation system shall be equipped with devices indicating any loss or reduction of the ventilating capacity and operation of the fans.

These devices shall be installed in the wheelhouse.

Instead of these, the following means may be provided:

.1 light signalling of each ventilator operation;

.2 interlock to permit the electric motor of the fan to start only if the ventilation duct is open;

.3 sound signalling of spontaneous stop of electric motor of the ventilator.

12.6.4 The design of ventilation fans shall comply with the requirements of 5.3, Part IX "Machinery".

12.6.5 Arrangements shall be provided for effective closure of the ventilation system in case of fire and the requirements of 12.1.10 shall be met.

12.6.6 The ventilation ducts and their closures shall be made of steel.

The ventilator heads of exhaust ducts shall be installed in safe locations, with due account of the potential ignition sources.

12.6.7 Ducts intended for ventilation of special-category spaces, which pass through other special-category spaces, shall be constructed of steel. Where such ventilation ducts pass through special-category spaces, which do not form part of the same main horizontal zone, the ducts shall be insulated to A-60 standard. Ventilation ducts shall not pass through machinery spaces unless they are constructed of A-60 class divisions.

12.7 VENTILATION OF CARGO SPACES ADAPTED FOR THE CARRIAGE OF DANGEROUS GOODS[4]

12.7.1 Closed cargo spaces in cases mentioned in 7.2.4, Part VI "Fire Protection" shall have mechanical exhaust ventilation, separate for each such space, sufficient to give at least 6 air changes per hour, based upon the volume of an empty hold.

Supply ventilation of these spaces may be natural.

On agreement with the Register, mechanical supply and natural exhaust ventilation systems are permissible.

The number of air changes may be reduced with regard to the method of transportation (refer to Note 1 to Table 7.2.4-1, Part VI "Fire Protection").

12.7.2 For closed cargo spaces intended for the carriage of dangerous goods in bulk at least natural ventilation in accordance with 7.2.8.3, Part VI "Fire Protection" is required.

However, when conditions of carriage require a mechanical ventilation system, a stationary system may be dispensed with, provided that portable fans ensuring adequate effectiveness of the ventilation are used.

12.7.3 The ventilation shall be such as to provide uniform change of air within the cargo space and to prevent formation of trapped zones.

The ventilation system shall be such that vapours of dangerous goods are removed from upper or lower part of the space, with regard to density of the vapours in relation to air.

12.7.4 The design of ventilation fans shall comply with the requirements of 5.3, Part IX "Machinery".

The electric motors of the fans shall be of flameproof design. It is not recommended to arrange them in way of gas exhaust.

[4] For dangerous goods, refer to 7.1.2, Part VI "Fire Protection".

The inlets and outlets of ventilation systems shall be protected by screens with mesh size of 13 x 13 mm.

12.7.5 The ventilator heads of exhaust ducts from cargo spaces adopted for the carriage of dangerous goods emitting readily flammable and toxic vapours or gases shall be so located that the issuing vapours or gases do not enter other ship spaces.

12.7.6 Spaces for bilge pumps servicing cargo spaces for carriage of dangerous goods shall be provided with separate artificial exhaust ventilation sufficient to give at least 6 air changes per hour.

12.7.7 When goods capable of producing explosive mixtures with air, and goods susceptible to spontaneous ignition are carried, provision shall be made for two fixed or portable fans of flameproof design with a total capacity sufficient to provide 6 air changes per hour.

12.7.8 Ventilation system of ships carrying packaged irradiated nuclear fuel, plutonium and high-level radioactive wastes (INF cargo, refer to 7.1.2, Part VI "Fire Protection") shall comply with the following requirements:

.1 provision shall be made for adequate ventilation or cooling of closed cargo spaces so that at any time the mean ambient temperature within these spaces does not exceed 55 °C;

.2 ventilation or cooling systems serving cargo spaces intended for carriages of INF cargo shall be independent from similar systems serving other spaces; and

.3 necessary operating equipment, such as fans, compressors, heat exchangers, cooling liquid supply systems shall be duplicated for each cargo space.

12.7.9 The open top container holds shall be mechanically ventilated by means of special ducts from the lower parts of cargo holds. At least 2 air exchanges per hour shall be provided, based upon the volume of an empty hold below the open deck.

12.8 VENTILATION OF REFRIGERATED CARGO SPACES

12.8.1 The requirements to the ventilation of refrigerated cargo spaces are set out in 3.3.5 to 3.3.8, Part XII "Refrigerating Plants".

12.7.10 Where in accordance with the International Maritime Solid Bulk Cargoes Code (IMSBC) continuous ventilation of holds is required for transportation of dangerous goods, only such inlets and outlets shall be used as do not require closures as per Load Line Rules for Sea-Going Ships. Closures for ventilation inlets/outlets shall be provided in accordance with 12.1.6 for the purposes of fire safety, meeting the requirements regarding the height of location of the inlets/outlets that require no watertight closures under 7.8.2, Part III "Equipment, Arrangements and Outfit".

12.7.11 Where the enclosed space adjacent to the cargo hold is not separated from the hold by a tight hatch, such space shall be regarded as part of the hold, and the same ventilation requirements as to the cargo space shall apply thereto.

Where in accordance with the IMSBC two fans are required for transportation of dangerous goods, such spaces shall have a common ventilation system with two fans.

12.9 VENTILATION OF FIRE EXTINGUISHING STATIONS

12.9.1 The foam fire extinguishing and smothering stations, located below the upper deck or not accessible from the weather deck shall be equipped with efficient independent ventilation system with capacity sufficient to provide not less than 6 air changes per hour.

The carbon dioxide fire extinguishing stations shall be provided with an exhaust and supply ventilation independent from other ventilation systems. The inlets of exhaust ducts shall be located in lower part of the station.

12.9.2 The high-expansion foam fire extinguishing stations shall be equipped with devices ensuring air supply in an amount sufficient for the operation of foam generators.

12.10 VENTILATION OF ACCUMULATOR BATTERY ROOMS AND BOXES

12.10.1 The accumulator battery rooms and boxes shall be provided with independent ventilation system capable of removing air from upper part of the ventilated spaces.

The exhaust ducts shall be gastight.

12.10.2 The inlet air shall be supplied into the lower part of the ventilated space.

12.10.3 The outlets of ventilation ducts shall be so constructed as to preclude the admission of sea water, atmospheric precipitation and solids.

No flame-arresting fittings shall be installed.

The discharges of exhaust ducts shall be laid to places where the issuing gases do not present a fire hazard.

12.10.4 The boxes of accumulator batteries having a charging capacity not over $2.0 \cdot 10^2$ W may be ventilated through the openings in the lower and upper parts of the box to ensure removal of the gases.

12.10.5 The rate of air flow Q, in m^3/s, for the ventilation of an accumulator battery room or box shall not be less than that determined by the formula

$$Q = 3{,}06 \cdot 10^{-5} In \quad , \qquad (12.10.5)$$

where I = maximum charging current during gas emission, but not less than 0.25 of maximum current of the charging device, A;

n = number of battery cells.

12.10.6 The cross-sectional area F, in m^2, of a duct, in case of natural ventilation of accumulator battery rooms and boxes, shall not be less than determined by the formula

$$F = 1{,}04Q \quad , \qquad (12.10.6)$$

where Q = rate of air flow determined from the Formula (12.10.5),

but not less than 0.004 m^2.

12.10.7 Natural ventilation of the spaces may be used in the following cases:

.1 the required amount of air, calculated by Formula (12.10.5), is less than $2.36 \cdot 10^{-2}$ m^3/s;

.2 the angle of the duct deflection from the vertical is less than 45°;

.3 the number of bends of the duct does not exceed 2;

.4 the length of the duct does not exceed 5 m;

.5 the operation of ventilation system does not depend on the direction of the wind;

.6 the cross-sectional area of the duct shall be taken not less than that determined by Formula (12.10.6).

12.10.8 Where the rate of air flow determined by Formula (12.10.5) is 2.36 $\cdot 10^{-2}$ m^3/s and more, the accumulator battery room shall be provided with mechanical exhaust ventilation.

12.10.9 The internal surfaces of the exhaust ducts, as well as the ventilating fans shall be protected against the action of the electrolyte vapours.

12.10.10 The motors of the ventilating fans shall not be arranged in way of gas exhaust.

The design of ventilation fans shall comply with the requirements of 5.3, Part IX "Machinery".

12.10.11 Ventilation serving for battery rooms shall be equipped as follows:

.1 usually, open ends of ventilation ducts from battery rooms shall not have outlets directly to the open decks and they shall be fitted with means of closing.

Closing devices shall be provided if it is required by 3.2.1 of Load Lines Rules for Sea-Going Ships or premises equipped with a fixed gas fire extinguishing system;

.2 where an open outlet of battery room ventilator is fitted with a closing device, then a warning notice stating, for example, "This closing device shall be kept open and only closed in the event of fire or other emergency —

DO NOT CLOSE! EXPLOSIVE GAS",

shall be provided at the closing device to mitigate the possibility of inadvertent closing.

12.11 VENTILATION OF HANGARS FOR HELICOPTERS

12.11.1 Helicopter hangars, helicopter filling stations, as well as spaces where helicopter-handling equipment is located, shall be provided with mechanical exhaust ventilation with at least 10 air changes per hour.

Fans shall be of flameproof design and shall meet the requirements of 5.3.3, Part IX "Machinery" and 19.3.4, Part XI "Electrical Equipment".

12.12 VENTILATION OF SPACES IN OIL RECOVERY SHIPS

12.12.1 Ventilation systems serving dangerous and safe spaces shall be independent of each other. Spaces in zones belonging to different classes as listed under 19.2.3, Part XI "Electrical Equipment" shall be served by different systems.

12.12.2 Safe spaces and air locks shall be equipped with mechanical supply ventilation to ensure excessive pressure therein as compared to adjacent dangerous spaces.

12.12.3 Provision shall be made for automatic switch on of ventilators and signalling for loss of excessive pressure in safe spaces and air locks. Alternatively, the following may be provided:

.1 light signalling of each ventilator operation;

.2 blocking to ensure the electric motor of the ventilator is switched on only when the vent duct cover is open;

.3 sound signalling of spontaneous stop of electric motor of the ventilator.

12.12.4 The suctions of supply ventilation ducts shall be located outside dangerous spaces on open decks.

12.12.5 Exhaust duct openings shall be located outside dangerous spaces on open decks.

12.12.6 Dangerous spaces in Zone 1 shall be provided with mechanical exhaust ventilation to ensure at least 20 air changes per hour. Application of ventilation systems for 10 air exchanges per hour is allowed, provided the system is fitted with automatic switching for 20 air changes per hour, when the gas concentration of (20 ± 10) per cent of the lower limit of the explosive range is reached in the atmosphere of the space.

Dangerous spaces in Zone 2 shall be provided with ventilation to ensure at least 10 air changes per hour.

12.12.7 In dangerous spaces, the exhaust ventilation ducts shall be gas-tight, rigid enough and shall not pass through safe spaces (except where the ducts of the pressure part of ventilation are laid through safe spaces in gas-tight tunnels).

12.12.8 In spaces and air locks, the ventilation systems shall be equipped with instruments to monitor the operation of ventilators and other devices mentioned under 12.12.3 and 12.12.6.

12.13 VENTILATION OF SPACES INTENDED FOR INERT GAS EQUIPMENT

12.13.1 In spaces intended for the inert gas equipment of cargo tanks including generators, scrubbers, ventilators and their valves, provision shall be made for artificial exhaust ventilation which shall ensure at least six air changes per hour as determined proceeding from the empty space volume.

Input ventilation may be self-ventilation.

When the above equipment is installed in machinery spaces, the requirements of 12.5 shall be complied with.

12.13.2 For ventilating spaces mentioned under 9.16.9.3, Part VI “Fire Protection”, provision shall be made for artificial forced ventilation, which shall ensure the number of air changes not less than stipulated under 12.13.1.

12.14 VENTILATION OF SPACES FOR EQUIPMENT OF GAS FUEL SYSTEM FOR PROPULSION PLANT

12.14.1 Ventilation ducts serving spaces classified as dangerous zones shall be completely separated from ventilation ducts serving gas safe spaces.

Ventilation ducts serving gas compressor spaces, gas fuel storage spaces and machinery spaces shall be fitted with Class A-60 automatic closing fire dampers.

12.14.2 The design of fans in dangerous zones shall comply with the requirements of 5.3.3, Part IX “Machinery”.

Driving motors of fans in the dangerous zones shall be of fireproof design. Where driving motors of fans are installed inside ducts, they shall comply with the fireproof level required for spaces which they serve (refer to 19.12, Part XI “Electrical Equipment”).

12.14.3 Alarms shall be provided on ventilation shutoff in areas and spaces that require continuous ventilation (refer to 7.23.1, Part XI “Electrical Equipment”).

12.14.4 Provision shall be made in the ventilation system to eliminate trapped zones in spaces in which ventilation is installed.

12.14.5 Inlets of ventilation ducts that serve enclosed dangerous areas shall provide air intake from areas that would have been regarded safe if no inlets of the above ventilation ducts were available.

Inlets of ventilation ducts serving enclosed safe areas shall provide air intake from safe areas and shall be located at least 1.5 m from the boundaries of any dangerous zone.

Where an intake ventilation duct passes through a space regarded as a more dangerous zone as compared to the space served, the duct shall be pressurized with respect to this space so that in case of loss of tightness the air from the space does not enter the ventilation duct.

12.14.6 Outlets of ventilation ducts from spaces classified as safe zones shall not be located in dangerous zones.

12.14.7 Outlets of ventilation ducts from spaces classified as dangerous zones shall be located in areas which would have been regarded less dangerous or at least equivalent to the spaces served if no outlets of the above ventilation ducts were available.

12.14.8 Where spaces classified as safe zones have openings leading into dangerous zones, such openings shall be fitted with gastight closures and shall be pressurized with respect to the dangerous space.

The ventilation of pressurized areas shall operate as follows: following loss of gastightness, every fireproofed item of electrical equipment shall be de-energized until at least 5 air changes are provided by ventilation and the space is pressurized.

Continuous control of pressure in such spaces shall be provided, and in case of ventilation failure or loss of over-pressure alarm shall be activated with automatic shutoff of electrical equipment which is not fireproofed.

12.14.9 Gas fuel storage spaces shall have mechanical forced ventilation providing at least 30 air changes per hour.

12.14.10 Ventilation systems of machinery spaces with engines and boilers that utilize gas fuel shall be fully separated from ventilation systems of other spaces.

The requirement of 4.2.10, Part VII "Machinery Installations" shall be met.

12.14.11 Ventilation systems of gas-hazardous machinery spaces (refer to 4.7.6.3, Part VII "Machinery Installations") shall offer at least 30 air changes per hour, and provision shall be made for proper air circulation within the entire space with no trapped zones.

A single failure of the ventilation system and associated service equipment shall not cause over 50 per cent reduction in the system's capacity.

Ventilation capacity of at least 15 air changes per hour under normal conditions is accepted, and where gas is detected in the space, it shall be increased automatically to 30 air changes per hour.

12.14.12 Ventilation systems of gas compressor and pump spaces shall be of forced type and shall offer at least 30 air changes per hour, and provision shall be made for proper air circulation within the entire space with no trapped zones.

A single failure of the ventilation system and associated service equipment shall not cause over 50 per cent reduction in the system's capacity.

12.14.13 Gas compressor and pump spaces shall have continuous ventilation

at all times during gas compressors and pumps operation.

Continuous control of ventilation system operation shall be provided, and in case of ventilation shutdown alarm shall be activated in a permanently attended space.

In case of ventilation shutdown and prior to startup, at least 5 air changes shall be made in a gas compressor and pump space before the relevant fireproofed equipment available in this space is energized.

13. FUEL OIL SYSTEM

13.1 PUMPS

13.1.1 At least two pumps shall be provided for fuel transfer, one of which being a standby pump.

Any suitable pump, including the fuel oil separator pump, may be used for standby purpose. Standby fuel pump shall be started automatically regardless of the automation class of the ship for any unattended engine rooms.

For cargo ships of less than 500 gross tonnage navigating in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN** no standby pump is necessary.

In ships with a daily consumption of fuel less than 1 t, a hand pump is admissible.

13.1.2 Where the fuel oil tanks, including the deep tanks, are used also for water ballast, provision shall be made for reliable arrangements disconnecting the ballast system from these tanks when carrying fuel oil and the fuel oil system, when containing water.

In addition, the requirements of the Guidelines for the Prevention of Pollution from Ships shall be complied with.

13.1.3 The fuel oil and lubricating oil transfer pumps as well as the separator pumps, besides local hand control, shall be provided with stopping means operable from always accessible positions outside the space where the pumps are installed.

13.1.4 Shut-off valves shall be fitted on the pressure side and suction side of fuel oil and lubricating oil pumps.

Devices for measuring fuel oil temperature are recommended to be provided on the suction pipes of the fuel oil pumps.

This requirement is mandatory for installations with fuel oil flash point of less than 60 °C.

13.1.5 For ships intended to use Heavy Fuel Oil (HFO) or Marine Diesel Oil (MDO) in non-restricted areas and marine fuels with a sulphur content not exceeding 0.1% m/m and minimum viscosity of 2 sSt in emission control areas, the following arrangements should be provided in addition to 13.1.1:

.1 in non-restricted areas, ships provided with two fuel oil pumps that can each supply the fuel primarily used by the ship (i. e. HFO or MDO) at the required capacity for normal operation of the propulsion machinery;

.2 in emission control areas one of the following requirements shall be met:

— fuel oil pumps as in **13.1.5.1,** provided these are suitable for marine fuels with a sulphur content not exceeding 0.1% m/m and minimum viscosity of 2 sSt at the required capacity for normal operation of the propulsion machinery;

— when the fuel oil pumps in **13.1.5.1** are suitable to operate on marine fuels with a sulphur content not exceeding 0.1% m/m and minimum viscosity of 2 sSt, but one pump alone is not capable of delivering such fuel, then both pumps may operate in parallel. In this case, one additional (third) fuel oil pump shall be provided.

The additional pump shall, when operating in parallel with one of the pumps in **13.1.5.1,** be suitable for and capable of delivering marine fuels at the required capacity for normal operation of the propulsion machinery;

— in addition to pumps as in **13.1.5.1**, two separate fuel pumps shall be provided, each capable of and suitable for supplying marine fuels with a sulphur content not exceeding 0.1% m/m and minimum viscosity of 2 sSt at the required capacity for normal operation of propulsion machinery.

If a marine distillate grade fuel with a different maximum sulphur content is specified by regulation for the area of operation of the ship (e. g. ECA, specific port or local areas, etc.) then that maximum shall be applied.

Where electrical power is required for the operation of propulsion machinery, the requirements also apply to machinery for power generation when such machinery is supplied by common fuel supply pumps.

13.2 PIPING LAYING

13.2.1 In general, the fuel oil pipeline shall have no communication with other piping systems. Where the fuel oil tanks are used also for water ballast, the requirements of 13.1.2 shall be complied with.

13.2.2 Welded joints shall be generally applied for the assembly of piping for fuel oil with a flash point below 60 °C and for oil heated above 60 °C, whereas the number of detachable joints shall be reduced to a minimum. Such pipes containing oil under a pressure of 0.18 MPa and above shall not be placed in a concealed position, shall be readily accessible and their locations shall be adequately illuminated.

Heated liquid fuel means liquid fuel with the temperature above 60 °C or above the flash point, if below 60 °C.

When fuel with flash point below 60 °C but not less than 43 °C is used, additional requirements shall be met as follows:

.1 fuel temperature shall be measured in the suction pipe of the fuel oil pump;

.2 fuel filters shall be fitted with shut-off valves or cocks at inlet and outlet;

.3 piping shall be welded or shall have circular cone or spherical joints.

13.2.3 The fuel pipes shall not be laid above the internal combustion engines, turbines, exhaust gas pipes, steam pipes (except heating steam coils), steam boilers and boiler uptakes.

In exceptional cases, the fuel pipes may be laid above this equipment provided that in these positions the pipes have no detachable joints or are shielded and that in necessary places provision is made for trays preventing the spillage of fuel onto the equipment or other sources of ignition.

Provision shall be made to prevent the spillage onto the heated surfaces of fuel ejected from a pump, filter or a heater.

13.2.4 The fuel pipes which damage may cause fuel leakage from tanks, slop and supply service tanks of 500 l and more located above the double bottom shall be fitted with a tap or valve installed directly on a tank which can be closed from a safe position outside such space in case of fire in a space where such tanks are located.

In special cases when deep tanks are located in a propeller shaft tunnel, in a pipe tunnel or another similar space then the valves shall be located on deep tanks; however, there shall be an option to control the additional valve fitted on a pipeline or pipelines outside the tunnel or another similar space. If such additional valve is fitted in the machinery space, it shall be controlled from a position outside such space.

Remote control of the valve of the emergency diesel generator fuel tank shall be located in a separate space apart from the remote controls for other tank valves located in the machinery space.

Quick-closing valves are recommended to be fitted on daily tanks.

13.2.5 Where the fuel oil system is fitted with flow metering devices or similar metering instruments, they shall be provided with a by-pass fine and relevant shut-off valves for performing the maintenance and repair including cleaning of the built-in filters without interrupting the operation of the internal combustion engines (boilers).

13.3 HEATING ARRANGEMENTS FOR FUEL OIL

13.3.1 For fuel oil heating the heat-carrying agents listed in 9.6.1 may be applied. In case electric heating appliances for fuel oil heating are used, the requirements of 15.3, Part XI "Electrical Equipment" shall be met.

13.3.2 Heating coils and electric heating appliances shall be fitted as low as possible in the tanks.

13.3.3 In daily service tanks and settling tanks, the suction ends of fuel pipes shall be so positioned above the heating coils and electric heating appliances that the latter remain submerged as far as practicable.

13.3.4 When fuel oil and lubricating oil steam heaters or other heating medium heaters are used, except cases when the heated medium temperature does not reach a flash point, the system shall be fitted with a high temperature alarm or a flow drop alarm in addition to the system for temperature monitoring.

13.3.5 The maximum temperature of fuel oil heating in storage tanks shall be 15 °C below the fuel oil flash point.

Fuel oil in service tanks, settling tanks and any other tanks in the engine

and boiler supply system may be heated above this limit, provided:

.1 the length of air pipes of these tanks or the use of cooling devices permits to lower the temperature of escaping vapours below 60 °C or the outlets of air pipes are situated at least 3 m away from ignition sources;

.2 non-intrinsically safe electrical equipment is not located within a vapour space of fuel oil tanks;

.3 there are no openings from the vapour space of the fuel tanks into machinery spaces;

.4 enclosed spaces shall not be located directly over such fuel tanks, except for well-ventilated cofferdams;

.5 ends of air pipes shall be equipped with flame arresters.

13.4 DRAINAGE ARRANGEMENTS OF FUEL OIL TANKS

13.4.1 For draining water from the bottom of the daily service and settling tanks, these tanks shall be fitted with self-closing valves and pipes connected to drain tanks.

The drain pipes shall be fitted with sight glasses. Where trays are available, open funnels may be used instead of sight glasses.

13.5 ARRANGEMENTS FOR COLLECTION OF LEAKAGE FUEL

13.5.1 Tanks, pumps, filters and other equipment shall be fitted with drip trays where there is a possibility of fuel oil leakage.

13.5.2 Drain pipes from the drip trays shall be laid into fuel oil drain tanks.

Drainage of fuel oil into the bilges and overflow tanks is not permitted.

13.5.3 The internal diameter of the drain pipes shall be at least 25 mm.

13.5.4 The ends of the drain pipes shall be laid to the tank bottom with a gap not less than ¼ of the internal diameter of the pipe.

Where the drain tank is situated in the double-bottom space, structural measures shall be taken to prevent penetration of water into the machinery spaces through the open ends of the drain pipes in the event of damage to the shell plating.

Provision shall be made for an alarm device to give warning if the fuel oil reaches the upper predetermined level in the drain tank.

13.5.5 If drain pipes from drip trays fitted in different watertight compartments are laid into a common drain tank, structural precautions shall be made to prevent water from one flooded compartment to enter the other compartment via the open ends of drains.

13.6 FILLING OF FUEL STORAGE TANKS

13.6.1 The bunkering of the ship shall be carried out through a permanent pipeline, provided with the valves necessary for the filling of all the basic fuel storage tanks.

In ships with twin hulls, the filling pipes shall ensure the filling of the fuel tanks of any of the hulls as well as pumping of fuel from the tanks of one hull into the tanks of the other.

The end of the filling pipe shall be laid to the tank bottom with a gap not less than ¼ of the internal diameter of the pipe or by other means excluding foaming when filling the tank.

13.6.2 In passenger ships provision shall be made for bunkering stations, which are separated from other spaces, and fitted with drain pipes laid into fuel oil drain tanks.

13.6.3 The filling pipes of the tanks situated above the double bottom shall be connected to the tanks near the top.

Where this is impracticable, the filling pipes shall be fitted with non-return valves installed directly on the tanks.

Where the filling pipe is used as a suction pipe, the non-return valve shall be replaced by a remote-controlled shut-off valve operable from accessible position outside the space, in which the tank is located.

13.7 FUEL OIL TANKS

13.7.1 The structural elements of fuel oil tanks shall comply with the requirements of Part II "Hull".

13.7.2 The arrangement of the fuel tanks in the machinery spaces shall comply with the requirements of 4.3, Part VII "Machinery Installations".

13.7.3 The fuel tanks situated on weather decks and superstructure decks, as well as in other exposed positions shall be protected against sunlight.

13.7.4 In glass-reinforced plastic ships (refer to 2.8, Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats") the fuel tanks shall not directly adjoin the accommodation spaces. The air gap between the fuel tank and accommodation space shall be efficiently ventilated.

In general, the fuel tanks shall not be located in machinery spaces. If they are located in such spaces, they shall be constructed of steel or equivalent material (refer to 1.2, Part VI "Fire Protection").

13.7.5 Fuel oil tanks shall be separated from the feed water and vegetable oil tanks by cofferdams, the structural members of which shall comply with the requirements of Part II "Hull".

13.7.6 In ships of 400 gross tonnage and upwards, compartments situated forward of the collision bulkhead shall not be used for carriage of fuel oil or other flammable liquids.

13.7.7 In ships with a distinguishing mark for fire-fighting on other ships in their class notation, the fuel oil tanks shall contain fuel oil reserve sufficient to provide the operation of pumps of special fire-extinguishing systems during 24 h for ships with distinguishing mark **FF3WS** and 72 h for ships with distinguishing marks **FF1**, **FF1WS**, **FF2** or **FF2WS**.

13.8 FUEL OIL SUPPLY TO INTERNAL COMBUSTION ENGINES

13.8.1 The equipment of fuel system shall be capable of supplying fuel oil duly prepared and cleaned to the extent required for the given engine.

The main and auxiliary engines shall be supplied with fuel oil from two fuel oil service tanks for each type of fuel used on board.

The fuel oil service tank shall mean a tank containing only the fuel oil prepared for use, i. e. the fuel oil the grade and properties of which meet the requirements specified by the manufacturer of the equipment.

The fuel oil service tank intended for a particular fuel oil grade shall be marked accordingly and may not be used for other purposes.

Each fuel oil service tank shall have a capacity sufficient for 8 h (in passenger ships marked **C-R3-S, C-R3-RS, D-R3-S** and **D-R3-RS,** 4 h) operation of the main and auxiliary engines and boilers at maximum service loads.

The capacity of fuel oil service tanks in ships without the constant presence of the attending personnel in machinery spaces and/or in the main machinery control room, shall allow for the operation of the main machinery within the time specified in 4.1.4 and 5.1.5, Part XV "Automation", or shall provide for equivalent measures to comply with the above requirements.

The settling tank may not be used as a fuel oil service tank.

The equipment of the fuel oil system with two service tanks for each type of fuel used on board and equivalent arrangements meeting the requirements for the most commonly used fuel oil systems is shown in Figs.13.8.1-1 and 13.8.1-2.

The scheme shown in Fig.13.8.1-1(*b*) applies in cases when the main and auxiliary engines operate at all loads on heavy fuel oil; as applied to the main engines, heavy fuel oil may be used when starting and reversing.

The schemes shown in Fig.13.8.1-1(*b*) and in Fig.13.8.1-2(*b*) apply only in cases when arrangements and systems are used providing a quick switch from one fuel oil grade to another and capable of operating with two fuel oil grades at sea under all normal operating conditions.

Exemption from these requirements may be granted by the Register for fishing ships, ships of less than 500 gross tonnage, as well as for dredging ships, ships less than 24 m in length and berth-connected ships.

13.8.2 The filters fitted in the fuel oil supply lines to the engines shall be such that any filter can be cleaned without interrupting the operation of the engine. The design and construction of filters shall meet the requirements of 4.2.

13.8.3 When fuel oil is supplied to the engines, the following requirements shall be satisfied:

Heavy fuel oil service tank with a capacity for 8 h operation of main engines, diesel generators and auxiliary boilers	Heavy fuel oil service tank with a capacity for 8 h operation of main engines, diesel generators and auxiliary boilers	Diesel fuel oil service tank for low-temperature startup or repair of engines and boilers

a)

Heavy fuel oil service tank with a capacity for 8 h operation of main engines, diesel generators and auxiliary boilers	Heavy fuel oil service tank with a capacity for 8 h operation of main engines, diesel generators and auxiliary boilers

b)

Fig. 13.8.1-1. Heavy fuel oil service tanks for main and auxiliary engines as well as auxiliary boilers:

a **—** tanks required by SOLAS-74 Convention;

b **—** tanks equivalent to those required by the Convention

N o t e . Where auxiliary boilers are fitted with pilot burners, an additional diesel oil service tank with a capacity for 8 h operation may be required.

Heavy fuel oil service tank with a capacity for 8 h operation of main engines and auxiliary boilers	Heavy fuel oil service tank with a capacity for 8 h operation of main engines and auxiliary boilers	Diesel oil service tank with a capacity for 8 h operation of auxiliary engines	Diesel oil service tank with a capacity for 8 h operation of auxiliary engines

a)

Heavy fuel oil service tank with a capacity for 8 h operation of main engines and auxiliary boilers	Diesel oil service tank with a capacity for 4 h operation of main engines, diesel generators and auxiliary boilers, or with a capacity for 8 h operation of diesel generators and auxiliary boilers, whichever is greater	Diesel oil service tank with a capacity for 4 h operation of main engines, diesel generators and auxiliary boilers, or with a capacity for 8 h operation of diesel generators and auxiliary boilers, whichever is greater

b)

Fig. 13.8.1-2. Heavy fuel oil service tanks for main engines and auxiliary boilers and diesel oil service tanks for auxiliary engines:

a — tanks required by SOLAS-74 Convention;

b **—** tanks equivalent to those required by the Convention

.1 where one booster pump is fitted to serve the main engines, except where the machinery installation comprises two or more engines, each having its own booster pump, the arrangements shall be such that the engines are supplied with fuel oil in the event of damage to the booster pump;

.2 where fuel oil is supplied to engines forming part of machinery installations comprising two or more main engines supplied with fuel oil from a single source, arrangements shall be provided to cut off fuel oil supply to each individual engine. Cut off devices shall not interfere with the operation of other engines.

The cut off valves shall be remotely operated from the control station (refer also to 3.2.1.11, Part VII "Machinery Installations").

The Register may grant an exemption for cargo ships of less than 500 gross tonnage that navigate in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN**.

13.8.4 Where the engines operate on different grades of fuel, precautions shall be taken to prevent auxiliary engines and other consumers from being supplied with fuel that is unfit for their operation.

13.8.5 The diesel-generating sets intended for use as emergency units shall be supplied with fuel from an independent daily service tank situated in the emergency diesel generator room.

Consumption of fuel from this tank by other consumers is not allowed, except for cases specified in 9.4.2, Part XI "Electrical Equipment" and provided the requirements of 2.2.6, Part IX "Machinery" are met. The tank capacity shall be such as to ensure operation of the diesel generator for the period stated in 9.3.1 and 19.1.2.1, Part XI "Electrical Equipment".

When an emergency diesel generator is used for feeding consumers not in

an emergency condition during the ship's moorage as well as in case it is used as a means to ensure that the machinery is brought into operation from the dead ship condition (refer to 2.1.6, Part VII "Machinery Installations"), provision shall be made for automatic refilling of the emergency diesel generator daily service tank and for low-level alarm corresponding to the volume of the emergency diesel-generator daily service tank.

13.8.6 The fuel oil system shall be provided with inspection and measuring instruments in accordance with 2.12, Part IX "Machinery". Sight glasses on pipelines shall be heat-resistant.

13.8.7 Fuel system components and connections within fuel supply fines shall be designed with consideration for the maximum peak pressure to be expected in service including any high pressure pulses and hydraulic impacts, which are generated and transmitted back into the fuel supply and spill fines by the action of fuel injection pumps.

13.9 FUEL OIL SUPPLY TO BOILERS

13.9.1 The fuel oil supply system with mechanical atomization, serving the main boilers and the auxiliary boilers for essential services (refer to 1.2, Part X "Boilers, Heat Exchangers and Pressure Vessels") shall include at least two sets of fuel pumps, suction and discharge filters.

Each set of machinery shall be rated for the full steam generating capacity of the boilers served.

Apart from the local controls, the fuel pumps shall have means enabling them to be stopped from easily accessible positions outside the spaces in which they are situated.

As a rule, fuel oil shall be supplied to the main boilers from two tanks.

13.9.2 The pumps supplying fuel oil to the boilers shall not be used for other purposes.

13.9.3 The pipes conveying fuel oil to the burners of each boiler shall be fitted with a quick-closing valve operated by hand.

This requirement applies to boilers put into action by hand igniters and also to boilers with gravity feed of fuel oil to the burners.

13.9.4 Where fuel oil is fed to the burners by gravity, filters shall be fitted in the supply pipeline to the burners.

13.9.5 It shall be possible to bring the main boilers into operation without having to recourse to a source of power outside the ship.

13.9.6 If the fuel tanks of main and essential auxiliary boilers are used also as water ballast tanks, provision shall be made for settling tanks.

Where two daily service tanks are available, settling tanks need not be provided.

13.9.7 The oil burning installation of the boilers shall comply with the requirements of Section 5, Part X "Boilers, Heat Exchangers and Pressure Vessels".

13.9.8 Thermometers and pressure gauges shall be installed in suitable positions on the pipes supplying fuel oil to the burners.

13.10 FUEL OIL SUPPLY TO GAS TURBINES

13.10.1 The main gas turbine shall have at least two fuel feed pumps: main and standby, of which one may be driven

from the main turbine. The capacity of the standby pump shall not be less than that of the main pump.

Where there are two gas turbines or more, one independent standby pump will suffice.

13.10.2 The fuel oil system of a gas turbine shall comply with the requirements of 13.8 of this Part and 8.5.4, Part IX "Machinery".

13.11 USE OF CRUDE OIL OR SLOPS AS FUEL FOR TANKER BOILERS

13.11.1 In oil tankers crude oil or slops may be used as fuel for main and auxiliary boilers according to the following requirements.

For this purpose, all arrangement drawings of a crude oil installation with pipeline layout and safety equipment shall be submitted to the Register for approval.

13.11.2 Crude oil or slops may be taken directly from cargo tanks or flow slop tanks fitted in the cargo tank area. They shall be separated from nongas-dangerous areas by means of cofferdams with gastight bulkheads.

13.11.3 The design and workmanship of the boilers and burners shall be proved to be satisfactory in operation with crude oil.

The outer hood of the boilers shall be gastight separated from the engine room.

The boilers shall be tested for gastightness before use.

The aggregate system of pumps, strainers, separators and heaters, if any, shall be fitted in the cargo pump room or in another room, to be considered as dangerous and separated from engine and boiler room by gastight bulkheads.

Where crude oil is to be heated by steam or hot water, the outlet of the heating coils shall be laid to a separate observation tank installed together with the above-mentioned components.

This closed tank shall be fitted with a venting pipe laid to the atmosphere in a safe position according to the requirements of 10.1.6 for oil tankers. The outlet shall be fitted with easily removable flameproof wire gauze.

13.11.4 The arrangement of prime movers of pumps, separators, etc. shall comply with the requirements of 4.2.5, Part VII "Machinery Installations".

13.11.5 The pumps shall be fitted with a pressure relief bypass from delivery to suction side.

It shall be possible to stop them by a remote control placed in a position near the boiler fronts or main machinery control room and from outside the engine room.

13.11.6 When crude oil or slops need to be preheated, their temperature shall be automatically controlled and a high temperature alarm shall be fitted.

13.11.7 The piping for crude oil or slops and the draining pipes for the tray defined in 13.11.9 shall have wall thickness in compliance with column 5 of Table 2.3.8.

The number of connections for these pipes shall be kept to a minimum.

The pipe detachable connections shall be of flanged type and shall comply with the requirements of Table 2.4.3.3 for piping of Class I.

Within the engine room and boiler room these pipes shall be fitted within metal duct, which shall be gastight and

tightly connected to the fore bulkhead separating the pump room and to the tray specified in 13.11.9.

This duct (and the enclosed piping) shall be at an inclination rising towards the boiler so that the oil naturally returns towards the pump room in the case of leakage or failure in delivery pressure.

In addition, the duct shall be fitted at a distance from the ship's side of at least 20 per cent of the ship's beam amidships.

It shall be fitted with inspection openings with gastight doors in way of connections of pipes within it, with an automatic closing drain-trap placed on the pump room side, set in such a way as to discharge leakage of crude oil into the pump room.

In order to detect leakages, level position indicators with relevant alarms shall be fitted on the drainage tank specified in 13.11.9.

Also, a vent pipe shall be fitted at the highest part of the duct and shall be laid to the open deck in a safe position according to the requirements of 10.1.6 for oil tankers. The outlet shall be fitted with easily removable flameproof wire gauze.

The duct shall be permanently connected to the inert gas system or steam supply in order to enable:

injection of inert gas or steam in case of fire or leakage;

purging of the duct before work on the piping in case of leakage.

13.11.8 In way of the bulkhead, to which the duct defined in 13.11.7 is connected, delivery and return oil pipes shall be fitted on the pump room side with shut-off valves remotely controlled from a position near the boiler fronts or from the main machinery control room.

The remote control valves shall be interlocked with the hood exhaust fans mentioned in 13.11.10 to ensure that whenever crude oil is circulating the fans are running.

13.11.9 Boilers shall be fitted with a tray or gutterway of a height not less than 200 mm and be placed in such a way as to collect any possible oil leakage from burners, valves and connections.

Such a tray or gutterway shall be fitted with easily dismountable flameproof wire gauze in their upper part.

Delivery and return oil pipes shall pass through the tray or gutterway by means of a tight penetration and shall then be connected to the oil supply manifolds.

A quick closing master valve shall be fitted on the oil supply to each boiler manifold.

The tray or gutterway shall be fitted with a draining pipe discharging into a collecting tank in pump room. This tank shall be fitted with a venting pipe laid to the open deck in a safe position and with an outlet fitted with wire gauze easily dismountable for cleaning. The outlet shall be fitted with easily removable flameproof wire gauze.

This draining pipe shall be fitted with arrangements to prevent the return of fuel oil to the boiler or engine room.

13.11.10 The boilers shall be fitted with a suitable hood placed in such a way as to enclose as much as possible of the burners, valves and oil pipes, without preventing air inlet to the burner register.

The hood, if necessary, shall have means for inspection and access to oil pipes and valves placed behind it.

It shall be fitted with a duct laid to the open deck in a safe position, with the

outlet fitted with an easily dismountable flameproof wire gauze.

At least two mechanically driven exhaust fans with spark proof impellers shall be fitted so that the pressure inside the hood is less than that in the boiler room.

The exhaust fans shall be connected with automatic change-over in case of stoppage or failure of the fan in operation.

The exhaust fan prime movers shall be placed outside the duct and a gastight bulkhead penetration shall be arranged for the shaft.

Electrical equipment installed in gas dangerous areas or in areas which may become dangerous (i. e. in the hood or duct in which crude oil piping is placed), shall be of certified safe type.

13.11.11 When using fuel oil for delivery to and return from boilers fuel oil burning units in accordance with 13.9 of this Part and Section 5, Part X "Boilers, Heat Exchangers and Pressure Vessels" shall be fitted in the boiler room.

Fuel oil delivery to, and return from, burners shall be effected by means of a suitable mechanical interlocking device so that running on fuel oil automatically excludes running on crude oil or vice versa.

13.11.12 The boiler compartments shall be fitted with a mechanical ventilation plant designed in such a way as to avoid the formation of gas pockets.

Ventilation shall be particularly efficient in way of electrical plants and machinery and other plants which may generate sparks.

These plants shall be separated from those for service of other compartments and shall comply with the requirements of 12.4.

13.11.13 A gas detector plant shall be fitted with intakes in the duct mentioned in 13.11.7, in the hood duct (downstream of the exhaust fans in way of the boilers) and in all zones where ventilation may be reduced.

Visual and audible alarm shall be installed near the boiler fronts, in the machinery space and in the main machinery control room.

13.11.14 Means shall be provided for the boiler to be automatically purged before firing.

13.11.15 An additional fire extinguishing plant (refer to 3.1.2.8, Part VI "Fire Protection") independent of the fixed fire extinguishing system required for engine and boiler rooms shall be fitted in such a way that an approved fire extinguishing medium may be directed on to the boiler fronts and on to the tray specified in 13.11.9.

The emission of extinguishing medium shall automatically stop the exhaust fan of the boiler hood (refer also to 13.11.8).

13.11.16 A warning notice shall be fitted in an easily visible position near the boiler front. This notice shall specify that when an explosive mixture is signalled by the gas detector plant defined in 13.11.13, the watchkeepers shall immediately shut off the remote controlled valves on the crude oil delivery and return pipes in the pump room, stop the respective pumps, inject inert gas into the duct specified in 13.11.7 and turn the boilers to normal running on fuel oil.

13.11.17 The Register reserves the right to require installation of one pilot

burner in addition to the normal burning control.

13.12 USE OF NATURAL GAS (METHANE) AS FUEL

13.12.1 Gas fuel piping shall not be laid through control stations, accommodation and service spaces.

Laying of gas fuel pipelines through other spaces is allowed provided that the requirements of 13.12.2 or 13.12.3 are met. This applies to gas safe machinery spaces (refer to 1.2.1 and **4.7.6.2,** Part VII "Machinery Installations").

Gas fuel piping shall not be laid at a distance less than 760 mm from the shell plating.

13.12.2 The pipeline is 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 when the alarm system is actuated, the automatic valves mentioned in 13.12.5 and the main gas valve indicated in 13.12.6 shall be automatically closed before the inert gas pressure drops lower than the pressure of gas fuel, and vent valve stated in 13.12.5 shall be automatically opened;

.4 the system shall be arranged so 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.

13.12.3 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 and provide at least 30 air changes per hour.

The following conditions shall be met:

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

.2 a gas detector plant shall be fitted; when this plant or an alarm is actuated automatic valves under 13.12.5 shall be automatically closed before inert gas pressure drops below the gas fuel pressure, and vent (exhaust) valve stated in 13.12.5 shall be automatically opened;

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

.4 when the required air flow is not maintained by the ventilation system, the main gas valve specified in 13.12.6 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 the air intakes;

.6 provision shall be made for inertisation and degasification of gas fuel pipeline system section located in the machinery space.

13.12.4 For the machinery spaces of category A where gas fuel is used, beside the requirements of 13.12.2 and 13.12.3 the additional requirements to ventilation shall be met.

13.12.4.1 Machinery spaces shall be fitted with ventilation system precluding

gas pockets. Ventilation shall be particularly effective in the area of electrical equipment installation, machinery or other possible sources of spark formation.

The ventilation system shall be separated from ventilation of other spaces and shall meet the requirements of 12.14.

13.12.4.2 Machinery spaces shall be equipped with an effective gas detection system in the places of possible gas lock and leakage. Visual and audible alarms, as well as gas fuel supply mode based on the concentration reached, shall also be provided in accordance with 7.23.3.4, Part XI "Electrical Equipment".

13.12.5 Gas fuel supply system 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 (ventilation) 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 designed so that when:

the pressure in the gas fuel supply pipeline fluctuates from the set values;

energy for valve driving is lost;

the requirements of 13.12.2 and 13.12.3 are violated;

or engine stops for any reason, two valves installed in succession are closed automatically and the third valve (ventilation) is opened automatically.

As an alternative, one of the valves installed in succession and the ventilation valve may be combined in one body, provided they operate as described above.

All three valves shall be manually operated.

13.12.6 The main gas valve shall be installed outside the machinery space and be equipped with remote control to enable its closing from the machinery space.

This valve shall be automatically closed in the following cases:

leakage of gas fuel;

violation of the conditions stated in 13.12.2 and 13.12.3;

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

It is advisable that the main gas valve is automatically closed when interlocked gas valves are actuated (refer to Table 9.7.1, Part IX "Machinery").

13.12.7 Gas line shall have sufficient structural strength with regard to stresses caused by the mass of the pipeline, internal pressure, loads caused by bends of the ship's hull and accelerations.

13.12.8 The design of protective pipes or ducts of the ventilation system mentioned in 13.12.2 and 13.12.3 shall have strength sufficient to withstand fast increase of pressure in case of pipeline break. The number of detachable joints in protective pipes or ducts shall be kept to a minimum.

13.12.9 As a rule, gas pipelines shall be connected with complete-penetration butt welds and special means for provision of weld root quality and shall be radiographically tested.

All butt welds after welding are subjected to heat treatment depending on the material.

The use of other joints shall be specially considered by the Register in each case.

13.12.10 The installation for gas fuel supply and vessels for its storage shall comply with the following requirements:

.1 the design, controls and safety systems of gas compressors, pressure vessels and heat-exchangers incorporated in the gas fuel supply system, shall meet the requirements of the respective Parts of the Rules;

.2 during the design and calculations fatigue failure of gas pipelines due to vibration as well as fluctuation of pressure when gas fuel is supplied by the compressors, shall be taken into consideration.

.3 provision shall be made for signalling and proper gas fuel system control in accordance with 7.23, Part XI "Electrical Equipment".

13.12.11 Gas supply to dual-fuel engines and gas turbine engine shall meet the requirements of 8.10 and 9.8, Part IX "Machinery", and to liquid and gas fuel-fed boilers — the requirements of 3.6, Part X "Boilers, Heat Exchangers and Pressure Vessels".

13.12.12 Gas fuel filling stations

13.12.12.1 Gas fuel filling stations shall be arranged in open deck sections with reliable natural ventilation.

The use of enclosed or semi-enclosed spaces as gas fuel filling stations is subject to special consideration by the Register.

13.12.12.2 Provision shall be made to prevent damage to hull structures due to liquefied gas leakage.

In ships that run on gas fuel stored as liquefied gas (LNG), gas fuel filling stations shall be isolated from control stations and accommodation spaces, shall be fenced with coaming and provided with a stainless steel tray to collect possible leaks.

In addition, an overboard discharge pipeline shall be fitted. The leak discharge pipes shall pass from the outboard side to the waterline without reaching water.

The leak discharge pipes may be detachable, installed when fuel is filled.

13.12.12.3 The gas fuel filling station shall have an operator's work station protected against gas fuel leaks.

The operator's work station shall be fitted with fuel tank pressure and liquid level controls, alarms in case of overfill and emergency closing of filling valves, as well as the necessary communication means.

13.12.12.4 Gas fuel filling pipes in way of the filling flange shall be fitted with a shut-off valve operated manually and remotely from a safe readily accessible location.

13.12.12.5 Gas fuel filling system shall be arranged so that during gas fuel filling, no gas may leak into the atmosphere.

13.12.13 Gas fuel compressors

13.12.13.1 The design of gas compressors shall comply with the requirements of 5.5, Part IX "Machinery".

Gas compressors shall be equipped with devices and instruments as required for their proper operation.

At least the emergency alarm shall be fitted as follows: compressor operation alarm, low inlet and outlet gas pressure alarm, outlet gas overpressure alarm.

13.12.13.2 Gas compressors shall be equipped with emergency shutdown devices operated from spaces as follows:

— cargo control room (for cargo ships);

— navigation bridge;

— main machinery control room;

— fire extinguishing systems control station.

13.13 HELICOPTER FUEL STORAGE AND FILLING SYSTEMS

13.13.1 The ship's aviation fuel system shall meet the requirements in force of the civil aviation codes of the country of flag with regard to bunkering, storage, cleaning, quality control and fuelling, as well as the requirements of the respective parts of these Rules.

.1 The ship's system for supplying helicopters with fuel having a flash point below 43 °C shall ensure bunkering, long-term storage, preservation of quality and trouble-free use of fuel in the expected operating conditions.

.2 The system shall meet the requirements of this Part, 11.5.1, Part III "Equipment, Arrangements and Outfit", and 6.1, Part VI "Fire Protection".

.3 A fuelling station shall be provided for helicopter fuel bunkering and filling (refer to 6.1.2.5 Part VI "Fire Protection").

4 Helicopter fuel storage tanks shall be located in accordance with 11.5.1, Part III "Equipment, Arrangements and Outfit".

.5 Before use, fuelling equipment shall be certified (approved) for compliance with the requirements of civil aviation regulations of the country of flag.

13.13.2 A fuel oil pump shall take in fuel oil from one tank at a time only. Pipelines shall be made of steel or equivalent material, shall be short (where possible) and shall be protected against damages.

13.13.3 Fuel oil pumps shall be provided with shutdown means positioned in a remote safe place.

Service tanks shall be provided with quick-closing valves driven from outside the tank area.

13.13.4 Provision shall be made for fuel discharge from the tanks of a helicopter situated on helideck or in a hangar into an improper fuel tank.

Improper fuel shall be discharged into shore or ship's vessels.

Fuel tanks shall have arrangements for recovery and discharge of spilt fuel into the improper fuel tank.

13.13.5 A fuelling pipeline shall be provided with a safety device, which prevents the overpressure in a fuelling hose above the permissible value.

13.13.6 All pipelines and equipment of the system for bunkering, storage and fuelling shall be electrically continuous and shall be earthed to the ship's hull.

13.13.7 Each fuel oil tank shall be fitted with filling, outlet, sounding and air pipes. The end of a filling pipe shall not be more than 300 mm above the tank bottom. It is recommended to use closed-type flow-meters. The sounding pipe shall end 30 to 50 mm above the tank bottom and shall be laid to the open deck.

13.13.8 Air pipes of fuel oil tanks shall be laid to a height of at least 2.4 m above the open deck. Open ends of air pipes shall be spaced at a distance of at least 10 m from air in-takes and openings of enclosed spaces with ignition sources, and from a deck machinery and equipment, which may present an ignition hazard, and shall be fitted with flame-arresting meshes or other fittings approved by the Register.

13.13.9 Helicopter fuelling pipelines shall have no dead legs. Where a design is such that dead legs may not be avoided, provision shall be made to drain the pipelines by way of nitrogen purging or

other methods.

In low sections of the pipeline arrangements shall be provided to discharge sludge into the improper fuel tank.

13.13.10 The design of helicopter fuelling systems shall ensure easy access for inspection, routine maintenance, sampling and repair.

13.13.11 Helicopter fuelling stations shall meet the following requirements:

.1 a helicopter fuelling station shall meet the requirements of 6.1.2.6, Part VI "Fire Protection".

.2 arrangements for remote shutoff from a safe location of fuel supply from the tanks in case of fire shall be provided. Where a gravity fuelling system is installed, an equivalent fuel supply shutoff shall be provided;

.3 where several fuel tanks are available, provision shall be made in the fuel system to supply fuel to the helicopter from one tank at a time;

.4 spilt fuel shall be discharged into the improper fuel tank;

.5 fuel system pipelines shall be made of steel or equivalent material, shall be short (where possible) and shall be protected against damages;

.6 helicopter fuelling station shall be fitted with a measuring instrument to register the amount of dispensed fuel, a flexible discharge hose with a monitor and a self-closing valve, and a device to prevent overpressure in the fuel system.

13.14 LIQUEFIED GAS SYSTEM FOR DOMESTIC NEEDS

13.14.1 The use of gas meeting the requirements of current national standards is permitted.

13.14.2 Liquefied gas may be used for galley ranges, as well as for straight-through liquid heaters (including provision refrigerators) consuming not more than 1 kg of liquefied gas per hour.

The use of liquefied gas system in passenger ships and oil tankers is subject to special consideration by the Register in each case.

13.14.3 Only standard gas containers and gas-consuming appliances of type approved by competent technical supervision bodies may be installed on board the ship.

13.14.4 An automatic safety gas shut-off device shall be fitted on gas-consuming appliances, which operates in the event of flame failure.

For straight-through heaters this device shall have check flame.

13.14.5 Gas containers shall be stowed in a special compartment on the open deck, and shall meet the requirements of 2.1.5.3, Part VI "Fire Protection" with direct access to the open deck.

Where provision is made for stowage of not more than two gas containers, they may be arranged in an enclosed recess in the superstructure or deckhouse, or in a steel locker.

The stowage compartment for gas containers shall meet the following requirements:

.1 efficient natural ventilation shall be provided, with account of the provisions of 12.1.4 and 12.4.6.

In addition to natural ventilation, mechanical ventilation may be used, with account of the provisions of 12.1.4;

.2 where necessary, structural arrangements shall be made to maintain the temperature in the compartment not exceeding +50 °C;

.3 electric illumination and electrical equipment at a distance of 2 m from openings to the compartment shall comply with the requirements of 2.9, Part XI "Electrical Equipment";

.4 a warning notice recalling of the risk of explosion and prohibiting the use of naked flame and smoking shall be displayed on the door.

13.14.6 The installation of gas containers in the compartment shall comply with the following requirements:

.1 cylinders shall be installed with stop valves upwards and be secured with quick-detachable arrangements.

Other measures shall be taken to quickly release the containers;

.2 a reducing valve shall generally be fitted on the container head; in this case, a flexible hose of approved type may be used to connect the reducing valve to the liquefied gas pipeline;

.3 if a group of containers is connected to the manifold, only one reducing valve shall be fitted between each container and the manifold; in this case, containers shall be connected to manifold by copper pipes;

.4 where more than one container is connected to the manifold, shut-off valve or cock shall be fitted between each container and the manifold, and a warning notice shall be displayed in the space to prohibit use of more than one container at a time.

13.14.7 Compartments containing gas-consuming appliances shall be equipped in compliance with 2.1.5.2, Part VI "Fire Protection" and meet the following requirements:

.1 as a rule, they shall not be arranged below the upper deck and shall be provided with efficient natural ventilation for extraction of combustion products and air intake from the lower part of the compartment;

.2 where the compartment is partially below the open deck, it shall be provided with mechanical ventilation;

.3 straight-through gas-consuming appliances shall be provided with separate lines for removal of combustion products.

13.14.8 Pipes shall be of seamless steel or copper. Steel pipes shall be protected against corrosion.

13.14.9 The thickness of pipe walls shall meet the requirements of column 2 or 8, Table 2.3.8.

13.14.10 Pipes from gas containers to gas-consuming appliances shall be laid over the open deck and be protected against mechanical damages.

13.14.11 Pipe joints shall be welded. Threaded or flange joints are permitted only in places of connection of instrumentation lines, gas-consuming appliances and valves.

13.14.12 A shut-off valve or cock shall be fitted on the pipe where it passes through the bulkhead of the container compartment, this valve or cock being operated from outside the compartment.

The valve or cock shall be provided with a turning limiter and a plug position indicator.

13.14.13 Where more than one gas-consuming appliance is installed, a shut-off valve or cock provided with a turning limiter and a plug position indicator shall be fitted on branches from a common pipe line to each gas-consuming appliance.

Where these valves or cocks are fitted in the container compartment, provision shall be made for their operation

from outside the compartment; in this case, the installation of a cock or valve on the common pipe line may be omitted (refer to 13.14.12).

13.14.14 The reducing valve shall provide the pressure of not more than 5 kPa in the system.

13.14.15 The reducing valve or the pipe line downstream of this valve shall be provided with a safety valve with a setting pressure less than 7 kPa with gas outlets piped to a safe place of the upper deck.

Where the reducing valve is so designed that gas outlet to a low pressure pipe line is closed in case of failure or break of the diaphragm, the safety valve need not be provided.

13.14.16 Valves shall be of bronze, brass or another corrosion-resistant material.

13.14.17 Liquefied gas pipe lines from containers to reducing valves shall be tested:

in shop, by hydraulic pressure of 2.5 MPa;

in ship, by air pressure of 1.7 MPa.

Pipelines from reducing valves to gas-consuming appliances shall be tested by air pressure of 0.02 MPa after installation on board.

13.14.18 After use, liquefied gas containers shall be immediately placed in a space meeting the requirements of 2.1.5.3, Part VI "Fire Protection".

13.15 FUEL OIL SUPPLY SYSTEM FOR GALLEY EQUIPMENT

13.15.1 It is permitted to use fuel oil with a flash point not less than 60 °C for galley equipment.

13.15.2 The capacity of fuel oil service tanks located in galleys shall not exceed the daily consumption requirement.

13.15.3 A shut-off valve on the supply pipe shall be remotely controlled from a readily accessible place outside the galley.

It is recommended to use quick-closing type valves.

13.15.4 Tanks, fuel oil pumps and heaters shall be placed at least 2 m from the nearest point on the heating equipment, and at a 0.5 m distance from the same in the plan view of the place.

13.15.5 If the galley space is sufficiently large, fuel oil tanks, pumps and other appliances of the fuel oil system shall be placed in special enclosures.

13.15.6 All oil-fired equipment, burners included, shall be fitted with trays underneath (or an equivalent protection provided directly on the steel deck), with beads not less than 75 mm in height, extending not less than 100 mm outside the equipment perimeter.

14. LUBRICATION OIL SYSTEM

14.1 LUBRICATING OIL PUMPS OF INTERNAL COMBUSTION ENGINES, DRIVES AND COUPLINGS

14.1.1 Where one main engine is used, at least two circulation lubricating oil pumps of the same capacity shall be used, main and standby, with one of these engine-driven.

14.1.2 Where two or more main engines are available, one lubricating oil pump for each engine and one standby pump with an independent drive and with a capacity sufficient to feed both engines shall be provided.

A spare pump to be used as standby pump may be available on board, provided it is easily mounted in ship's conditions.

Combination of lubricating oil systems of the main engines is subject to special consideration by the Register in each case.

14.1.3 In cargo ships of less than 500 gross tonnage that navigate in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN,** irrespective of the number of main engines, no standby pumps are necessary.

This exception does not apply to tugboats with one main engine that navigate in restricted areas **R2**.

14.1.4 In lubricating oil systems of turbochargers of the main engines with autonomous electrically driven pumps, provision shall be made for a standby pump of equal capacity and for a gravity tank with adequate capacity for turbocharger lubrication during coasting in case of a sudden stop of the lube oil pump.

A low-limit alarm shall be fitted in the tank, and a means for automatic start of the standby pump when the main pump stops shall be provided.

A means for lubricating oil control in turbocharger bearings shall be provided.

14.1.5 Lube oil pumps of main gearing, as well as filling pumps for main hydraulic couplings shall meet the requirements of 14.1.1 to 14.1.3 for main engines.

14.1.6 Every auxiliary engine, as well as the emergency diesel generator engine (refer to 2.2.5, Part IX "Machinery") shall have an independent lube oil system.

Combination of lubricating oil systems of auxiliary engines is subject to special consideration by the Register in each case.

14.1.7 Lubrication of sternbush bearings that operate on oil lubrication shall meet the requirements of 5.6.3 and 5.6.4, Part VII "Machinery Installations".

14.2 OIL SUPPLY TO INTERNAL COMBUSTION ENGINES AND DRIVES

14.2.1 The design of drain and circulating lube oil tank and the operating level of oil therein, as well as the arrangement of pump suction pipes shall be such as to prevent oil supply at maximum permissible dynamic and static angles of heel and trim for a given type of ship. Terminations of the crankcase drain pipes into the drain and circulating lube oil tank shall be arranged so that they are oil-immersed at all times during engine

work. Drain pipes of two and more engines shall not be interconnected.

14.2.2 Lube oil system piping shall not be connected with other pipelines, except for separators as may be used for fuel separation provided that reliable devices to prevent oil and fuel mixing are used.

During oil separation provision shall be made to prevent mixing of oil of different brands.

14.2.3 Efficient oil purification shall be effected in a circulation lube oil system; the following means shall be fitted:

.1 on suction pipes of gear pumps, as a rule, — magnetic strainers;

.2 on suction pipes of the main engine pump — one coarse oil screen (mesh); on delivery pipes of the main engine pump — two parallel strainers or a single double switching strainer or a self-cleaning strainer.

Strainer design shall comply with the requirements of 4.2 and 13.8.2.

14.2.4 The capacity of each oil strainer shall be 10 per cent the maximum pump capacity.

14.2.5 Lube oil system shall be fitted with measuring instruments in accordance with 2.12, Part IX "Machinery".

A pressure gauge to indicate oil pressure downstream of the oil cooler shall be installed in the control station.

14.2.6 Where a common lube oil system for the engine and turbochargers is used, upstream of the turbocharger bearings fine gage strainers shall be fitted; strainer design shall allow their cleaning without stopping the circulation of oil. A pressure gauge shall be fitted downstream of the strainers.

14.3 LUBRICATING OIL PUMPS OF STEAM TURBINES AND DRIVES

14.3.1 Lubricating oil system of the main turbine installation shall be served by two lube oil pumps with an adequate capacity to enable lubrication of the turbine installation at full power condition. At least one of the pumps shall have an independent drive.

Where two main turbine installations are located in the same machinery space, one independently driven standby pump may be installed on both installations.

14.3.2 The design and arrangement of the pumps shall ensure their fail-safe start without prior filling.

14.3.3 Lubricating oil system of the main turbine installations, as a rule, shall be of gravity type. All necessary provisions shall be made for oil supply into the main turbine installation in case of failure of the main lube oil pump and during coasting of the turbines in case of loss of energy supply of drives of the lube oil pumps.

The use of a pressure lubricating oil system is subject to special consideration by the Register in each case.

14.4 OIL SUPPLY TO STEAM TURBINES AND DRIVES

14.4.1 Circulation pipes including branches to the consumers shall be made of copper, duplex metal, copper-nickel alloy or equivalent material.

14.4.2 Lubricating oil system of the main turbine installation may supply oil to control, regulating and protecting gear and to the main thrust bearing only.

14.4.3 Lubricating oil systems shall be fitted with visual and audible alarms to be actuated in case of oil pressure drop, led into the control station of the main turbine installation.

Alarms in a gravity-type system shall be actuated at such oil level in the pressure tank that the time left until the tank is emptied is enough for the protecting gear to switch on the standby pump.

14.4.4 The capacity of the pressure tank within the gravity lubrication system shall provide for at least 5 min. oil flow at rated turbine installation power condition.

The tank shall be fitted with an overflow pipe and a sight glass with proper lighting, readily visible from the control station. The cross-sectional area of the pipe shall be at least 1.25 times the cross-sectional area of the pressure pipeline downstream of the pump.

Provision shall be made for lube oil supply from the pump to the consumers, bypassing the tank.

14.4.5 Lubricating oil system of the main turbine installation shall have two oil coolers, one main and one standby.

Where two turbine installations are located in the same machinery space, one standby oil cooler may be installed on both installations.

Oil cooler cooling system shall meet the requirements of 15.1.7.

14.4.6 Lubricating oil system of the main turbine installations and their drives shall also meet the requirements of 14.1.6, 14.2.3 and 14.2.5.

14.4.7 Throttles shall be installed on circulation line branches to control the oil level supplied to each customer.

14.5 LUBRICATING OIL TANKS

14.5.1 Lube oil tanks shall be separated from the feed water and vegetable oil tanks by cofferdams, the structural members of which shall comply with the requirements of Part II “Hull”.

14.5.2 Drain and circulation tanks in ships with turbine installations shall in all cases be isolated from the bottom shell plating with a cofferdam, the structural members of which shall comply with the requirements of Part II “Hull”.

In other ships, installation of such cofferdams is recommended.

Where no cofferdams are available, non-return or shut-off valves operated from above the machinery space floor plates shall be fitted on drain pipes of engine crankcases.

In this case, the system shall have proper pipelines with valves for emergency pumping of oil from engine crankcases in the event of tank leakage.

Valves shall be operated from above the machinery space floor plates.

14.5.3 A reserve tank shall be provided, with a capacity sufficient to fill the system with oil until proper operating condition is reached.

It is recommended to install the tank beyond the double bottom.

In ships that navigate in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN,** a reserve tank is not necessary.

14.5.4 Suction pipes from tanks installed beyond the double bottom, fitted with shut-off valves installed onto the tanks.

Such valves on tanks with a capacity exceeding 500 l that are kept open in normal operating conditions, except for the tanks within gravity lubrication sys-

tems, shall be closed remotely from locations with continuous access outside of the space in which the tank is located.

14.5.5 Oil heating device shall meet the requirements of 13.3.

14.5.6 Lube oil tanks installed in category A machinery spaces and, where practicable, in other machinery spaces, shall meet the requirements of 10.4, 13.5.1, 13.6 of this Part and 4.3.3, 4.3.4, Part VII "Machinery Installations" with regard to tank arrangement above heated machinery surfaces.

14.6 ARRANGEMENTS FOR COLLECTION OF LEAKAGE OIL

14.6.1 Arrangements used to collect leakage lube oil shall meet the requirements of 13.5.

14.7 LUBRICATING OIL SUPPLY TO GAS TURBINES

14.7.1 Lubricating oil systems of gas turbines shall meet the requirements of 14.1 to 14.5 to the extent that these requirements apply to gas turbines.

15. COOLING WATER SYSTEM

15.1 PUMPS

15.1.1 Cooling water systems of the main engines shall meet the following requirements:

.1 seawater cooling system of one main engine shall be equipped with two pumps, one of these being a standby pump. The capacity of the standby pump shall not be less than that of the main pump. At least one of the pumps shall have an independent drive.

The same requirements apply to the freshwater cooling system of the main engine.

A common independently driven standby pump may be used for fresh and sea water, with a capacity at least equal to that of the main pumps; provision shall be made to prevent mixing of seawater and freshwater;

.2 the seawater cooling system for two or more main drives each served by a separate cooling pump shall include one independently driven standby pump to ensure operation of each engine at full power condition.

A standby pump is not necessary where a spare pump to be used as standby pump is available on board, provided it is easily mounted in ship's conditions.

The same requirements apply to the freshwater cooling system.

A common independently driven standby pump may be used for fresh and sea water cooling of any of the engines; provision shall be made to prevent mixing of seawater and freshwater;

.3 several engines may be cooled with the same independently driven pump. Pump capacity in this case shall allow simultaneous cooling of all engines at full load conditions. A standby pump shall be provided, with a capacity at least equal to that of the main pump for simultaneous cooling of all engines.

The cooling pipeline upstream of every engine shall include a valve for cooling water level control;

.4 in installations bearing an automation mark in their class notation separate standby freshwater and seawater cooling pumps shall be provided, with

the capacity at least equal to that of the main pump;

.5 in ships that navigate in restricted areas, special standby arrangements are not necessary, however, provisions for direct seawater cooling of the engine shall be made.

In ships that navigate in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, **R3-IN** and **C-R3-S, C-R3-RS**, **B-R3-S, B-R3-RS, D-R3-S**, **D-R3-RS**, equipped with two or more main engines, direct standby seawater cooling is not necessary.

15.1.2 Oil and air coolers of electric propulsion motors shall be provided with standby cooling arrangements equivalent to the main arrangements.

15.1.3 Where each auxiliary engine is fitted with an independent water cooling pump, standby pumps for these engines need not be provided.

If a common cooling system is provided for the auxiliary engines group, one standby pump for freshwater and seawater cooling will suffice.

Standby pumps for auxiliary engine cooling within a common cooling system for main and auxiliary engines need not be provided.

Diesel engines in permanent readiness (on hot standby), where applicable, shall be provided with continuous hot water circulation.

15.1.4 Ballast, bilge or general service pumps may be used as standby cooling pumps for fresh water only.

Fire pumps may be permitted subject to compliance with 3.2.3.2, Part VI "Fire Protection".

15.1.5 An independent piston cooling system shall include a standby pump with a capacity not less than that of the main pump.

15.1.6 An independent burner cooling system shall include a standby pump with a capacity not less than that of the main pump.

15.1.7 Oil coolers of the main turbine installations, as a rule, shall be serviced by circulating pumps of the main condensers.

Beside a separate autonomous circulating pump is provided to service oil coolers, an additional standby pump shall be provided, with a capacity not less than 0.66 of the circulating water flow per oil cooler under rated power conditions of the turbine installation.

Any general service pump may be used as a standby cooling pump.

15.1.8 A standby pump, with a capacity at least equal to that of the main pump, shall be provided within an independent system for sea water cooling and lubrication of sternbush bearings. Any general service seawater pump as specified in 15.1.4 may be used as a standby cooling pump.

15.2 PIPING LAYING

15.2.1 Cooling water shall be supplied from at least two interconnected sea connections, bottom and side, located in the machinery space.

The number of sea connections in cargo ships of less than 500 gross tonnage that navigate in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN** is subject to special consideration by the Register in each case.

15.2.2 In cooling systems for auxiliary engines and auxiliary turbine condensers independent sea connections are recommended. Where sea connections

are located in machinery spaces, the cooling system filling pipes shall be connected through shut-off valves to the shared suction main downstream of the sea connections specified in 15.2.1.

15.2.3 The requirements for sea chest heating in ships strengthened for ice navigation are set forth in 4.3.1.

15.3 COOLING WATER FILTERS

15.3.1 Filters shall be fitted on the cooling water filling mains of the main and auxiliary internal combustion engines.

These filters shall be equipped with a device to check for pressure prior to opening the filter. Provision shall be made for filter cleaning without interrupting the operation of the cooling pumps.

It is recommended to install such filters within the water cooling systems of turbine installations.

15.4 COOLING OF INTERNAL COMBUSTION ENGINES

15.4.1 Fresh water cooling systems for engines shall include an expansion tank with the water level exceeding the maximum engine water level. The expansion tank shall be connected to the filling pipes of the pumps and may be shared by water cooling systems of several engines.

The tank shall be equipped with a level gauge.

The design of seawater discharge pipeline within the engine cooling system shall be such as to provide filling with water of the uppermost coolable chambers of engines, water and oil coolers, and shall eliminate trapped zones.

15.4.2 Cooling water systems shall be equipped with thermometers and devices for cooling water temperature regulation.

The system shall be equipped with a limit cooling water temperature alarm (refer to 2.12, Part IX “Machinery”).

15.4.3 The cooling water system of the engine to be used in emergency shall meet the requirements of 2.2.5, Part IX “Machinery”.

15.4.4 Where fuel or oil is used in the cooling water systems of burners or pistons, such systems shall meet the requirements of Section 13 or Section 14, respectively.

15.5 COOLING OF GAS TURBINES

15.5.1 The system for cooling of gas turbine casings shall meet the requirements of 15.4.

15.5.2 Cooling water systems for turbine casings shall make use of fresh water.

Seawater cooling is allowed in emergency cases.

15.5.3 The air cooler cooling system shall be in compliance with the requirements of 19.2.1, 19.2.3 and 19.3.1.

Standby pumps are not mandatory where in case of water supply cut-off in the air cooler 30 per cent rated capacity of the gas turbine is available.

15.6 KEEL COOLING SYSTEMS

15.6.1 Keel systems for cooling of internal combustion engines are allowed for use in ships including icebreakers and ships with ice strengthening category of **Ice4** to **Ice6**. The use of keel systems in ships with these categories of ice strengthening that navigate in restricted areas is subject to special consideration by the Register in each case.

15.6.2 In ships with a single main engine provision shall be made for at least two seawater coolers, one of these being a standby cooler.

15.6.3 In ships with two or more main engines, one standby cooler shall be fitted to maintain operation of each engine. In ships that navigate in restricted areas with two or more main engines, no standby coolers are necessary.

15.6.4 Each cooler shall be fitted with an air exhaust device.

15.6.5 Shut-off valves shall be fitted on supply and discharge pipelines for the cooled medium upstream of the coolers.

15.6.6 Provision shall be made for draining or purging of the cooler.

16. COMPRESSED AIR SYSTEM

16.1 NUMBER OF AIRTANKS AND STARTING AIR CHARGE

16.1.1 The compressed air system of the main engines shall enable simultaneous start and reversal of the main engines; the starting devices shall meet the requirements of 2.9, Part IX "Machinery".

For requirements to the compressed air system of gas turbines refer to 8.1.5, Part IX "Machinery".

16.1.2 The compressed air used for starting the main engines and engine controls shall be stored in at least two airtanks or two airtank groups so installed as to enable separate use; each airtank or each airtank group shall contain the amount of compressed air at least equal to half of the amount required under 16.1.3 and 16.1.4 (refer also to 16.1.6).

In ships that navigate in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN**, where an electrical typhon is used, one airtank may be provided with a capacity in compliance with the requirements of 16.1.3 and 16.1.4.

16.1.3 The aggregate compressed air reserve to be used for starting and reversal of the main engines shall provide for at least 12 alternating charges for ahead and reverse running of each engine that is in running order but is idling, as well as for the action of engine controls.

In ships with ice category **Ice6** and icebreakers, the aggregate starting air reserve is subject to special consideration by the Register in each case.

16.1.4 The aggregate compressed air reserve for starting the main engines connected to a controllable pitch propeller or other machinery for starting the engines at no load shall allow at least 6 starts of each engine that is in running order but is idling, and where two or more engines are used — at least 3 starts for each engine. Operation of engine controls shall also be provided.

16.1.5 Auxiliary engines shall be started using compressed air from at least one airtank with a capacity such as to allow 6 starts of one engine of the highest rating in running order.

Where approved by the Register, such airtank is not necessary.

In this case, auxiliary engines shall be started using the air from one airtank or from one airtank group of the main engines.

16.1.6 The starting air charge from one airtank or one group of airtanks of the main engines specified in 16.1.2 may be used for typhon operation and for do-

mestic needs, provided that the airtank capacity is increased up to a capacity required for the typhon airtank, or provided that automatic boosting of the airtank is available or low pressure alarms in the airtanks are installed for pressure drop up to 0.49 MPa below of the working pressure.

Where a dedicated typhon airtank is provided, it shall have a capacity determined based on uninterrupted typhon operation during 2 min.; hourly compressor output shall be at least equal to that required for uninterrupted typhon operation during 8 min.

Where an airtank for typhon operation or for other purposes is provided, it shall have a capacity increased with regard to the rated capacity for the typhon. In this case, automatic airtank refilling or alarms to be actuated when the air supply in the airtank is only sufficient for typhon operation, shall be provided.

In ships bearing an automation mark in their class notation, airtanks shall be refilled in accordance with 4.5, Part XV "Automation".

16.1.7 Airtanks for auxiliary engines specified in 16.1.5 may be refilled with air from the main engine airtanks specified in 16.1.6; the reversing of air flow shall be possible.

16.1.8 The starting devices of emergency diesel generators shall meet the requirements of 9.5, Part XI "Electrical Equipment".

Where a compressed air system is used to start the emergency diesel generator among other means, airtanks may be filled from starting airtanks of the main and auxiliary engines through a non-return valve installed inside the emergency engine room, or from the electrical engine compressor fed from the emergency switchboard.

16.2 COMPRESSORS

16.2.1 The number of the main air compressors on board shall be not less than two. The main compressor aggregate capacity shall allow uninterrupted filling of the main engine airtanks during 1 h, starting with atmospheric pressure and up to the pressure required for the number of starts and reverses as specified in 16.1.3 and 16.1.4.

In ships with the main engines started at no load, one of the compressors may be overhung.

Separate main compressors shall be of equivalent capacity. Independently driven compressors shall have the capacity of at least 50 per cent of the aggregate capacity of the main compressors, but not less than the airflow per typhon in accordance with 16.1.6.

In ships with ice strengthening of category **Ice6** with reversible engines, and icebreakers, the number and capacity of the compressor is subject to special consideration by the Register in each case.

16.2.2 In cargo ships that navigate in restricted areas **R3-S**, **R3-RS**, **R3** and **R3-IN** of less than 500 gross tonnage with reversible main engines, one independently driven compressor, and in ships with nonreversible main engines, one overhung compressor may be provided. In the above ships, where equipped with combined starting systems, one overhung compressor is acceptable. The compressor capacity shall meet the requirements of 16.2.1.

16.2.3 In ships in which the main and auxiliary engines are started with

compressed air, in case of deenergizing provision shall be made for special devices to enable starting the main compressors within 1 hour maximum. For this purpose, a manually driven compressor or a diesel compressor with manual engine starting shall be used to refill an airtank with a capacity sufficient to enable three starts of each diesel generator or main compressor, provided it is driven by the internal combustion engine.

A separate airtank is not necessary where the diesel compressor or the manual compressor are capable of refilling the airtank of the least capacity as specified in 16.1.5 within the set period.

Where the emergency diesel generator is used to supply the motor of the compressor capable of refilling one of the airtanks mentioned above, no such device need be provided.

The above requirement does not apply to cargo ships of less than 500 gross tonnage that navigate in restricted areas **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, and **R3-IN**.

16.3 PIPING LAYING

16.3.1 Pipelines intended for airtank filling shall be laid to the airtanks from the starting air compressors.

Starting air pipelines downstream of the airtanks to the main and auxiliary engines shall be isolated from the pipelines used to refill the airtanks from starting air compressors.

16.3.2 Each of the starting airtanks specified in 16.1 shall be capable of being refilled from the main compressors as specified in 16.2. For air flow reversing, refer to 16.1.7.

16.3.3 Pipelines downstream of each compressor shall be fitted with non-return shut-off valves.

In air supply pipelines of each engine, a non-return valve shall be fitted upstream of the starting valve**.**

Where the engine design provides for arrangements preventing the build up of potentially explosive conditions, this valve is not necessary (refer to 2.9.1, Part IX “Machinery”).

16.3.4 The temperature of air or compressed gases supplied into the airtank shall not exceed 90 °C. Where applicable, appropriate coolers shall be fitted.

16.3.5 Pipelines shall be straight, where practicable, and shall have a slight inclination towards the main engine starting valve for the purposes of water draining.

16.3.6 Pipelines laid between compressors and airtanks shall be fitted with arrangements for water and oil discharge, where such arrangements are not fitted in the compressors.

16.3.7 If compressed air from safety valves fitted on the airtanks is discharged outside the machinery space, the cross-sectional area of the pipes shall be at least twice the cross-sectional area of the air ducts of the safety valves. Water draining arrangements shall be fitted on pipelines.

17. FEED WATER SYSTEM

17.1 PUMPS

17.1.1 Each main boiler and essential auxiliary boiler or a group of boilers shall be equipped with at least two feed water pumps with an independent mechanical drive.

For non-essential auxiliary boilers as well as waste heat boilers so designed that they may be left without water while heated by exhaust gases, one feed water pump will suffice.

For boilers with manual feeding control, each pump shall have a capacity at least equal to 1.5 of the rated boiler capacity, and in boilers with automatic feeding control, at least 1.15 of the rated boiler capacity.

Where more than two feed water pumps are fitted, their capacity shall be selected based on the condition that in case of failure of any pump the total pump capacity of the remaining pumps shall be at least equal to the above capacity of a single pump.

In direct-flow boilers, the capacity of each feed water pump shall be at least equal to the rated boiler capacity.

17.1.2 Steam engine driven feed water pumps shall have a separate main steam line to which steam from all serviced boilers shall be discharged.

17.1.3 Forced-circulation main and essential auxiliary boilers, as well as waste heat boilers connected to gas exhaust systems of two-stroke diesel engines with inlet waste gas temperature 270 °C and below, shall be serviced by at least two circulating pumps, one of which is a standby pump.

17.2 PIPING LAYING

17.2.1 In an open feed water system, feed pumps shall be capable of water intake from a hot well tank and reserve feed water tanks.

17.2.2 Feed water systems of each main boiler and essential auxiliary boiler shall be so designed as to enable feeding to a boiler or a group of boilers from each of the feeding pumps through two isolated feeding pipelines, main and reserve.

Nonessential auxiliary boilers shall be fed through a single feed water line.

This level of redundancy is sufficient for a steam raising plant which consists of two or more steam boilers of adequate steam-production capacity, each fitted with a separate feed water pump.

17.2.3 Structural measures shall be taken to prevent the contamination of the feed water system with oil and petroleum products.

17.2.4 Feed water system of the main boilers and essential auxiliary boilers shall have automatic devices for control of salinity of boiler feed water.

17.2.5 In forced-circulation waste heat boilers (refer to 17.1.3), circulation water flow rate shall be at least 5 times the rated boiler capacity for excess heat reduction in case of ignition of sediments. For this purpose a standby waste heat boiler circulation pump or another equivalent pump may be used.

17.2.6 Gas-tube waste heat boilers shall be fitted with arrangements for feed water treatment, heating and de-airing to ensure feed water compliance with the manufacturer’s requirements.

17.3 TANKS

17.3.1 Feed water tanks shall be separated from the liquid fuel, lube oil and vegetable oil tanks by cofferdams, the structural members of which shall comply with the requirements of Part II "Hull".

18. STEAM AND BLOW-DOWN PIPELINES

18.1 PIPING LAYING

18.1.1 Where two or more boilers are interconnected, the steam pipeline of each boiler shall be fitted with non-return valves upstream of the connection with the shared mains.

The non-return valves are not necessary where stopping valves of non-return shut-off type are installed on boilers.

18.1.2 Bottom and surface blow-down valves of two or more boilers may share a discharge pipeline, provided that non-return shut-off valves are fitted on the pipeline for each boiler upstream of the connection to the shared line.

18.1.3 Machinery utilizing steam lines shall be released from stresses due to thermal expansion in the pipeline, due to homing (pipe bend), or by way of compensators installed in suitable places.

18.1.4 Steam lines feeding steam to the machinery and appliances with pressure rating less than that of the boiler pressure rating shall be fitted with reducing valves and shall meet the requirements of 1.4.4.

18.1.5 Where pipelines for steaming of fuel and liquid cargo tanks are fitted, non-return shut-off valves shall be installed next to each tank.

18.1.6 Steam lines in machinery spaces and boiler rooms, where practicable, shall be laid in the upper parts of the spaces in locations readily accessible for inspection and maintenance.

Laying of steam lines under the flooring of machinery spaces and boiler rooms is not accepted, except for heating and boiler blow-off pipelines.

Steam lines shall not be laid in the vicinity of fuel oil tanks.

In addition, steam lines shall not be laid in flammable substances spaces and paint lockers.

Laying of steam lines with steam temperature above 220 °C in cargo pump rooms of oil tankers is not allowed.

18.1.7 When laying steam pipelines, the following minimum distances from pipe insulation shall be complied with:

to hull structures — 50 mm;

to cable ducts — 150 mm;

to liquid fuel tanks — 450 mm.

Requirements of 5.5 shall apply in this case.

18.1.8 Steam heating coils shall be installed not less than 50 mm apart from the hull structures.

Where hull structures are plated with combustible materials, areas next to the heating coils shall be protected with thermal insulation of non-combustible materials. Where such insulation is not available, heating coils shall be installed at a distance not less than 150 mm of the combustible plating.

18.1.9 Ship's whistle shall be supplied with steam via a separate pipeline from the main boiler. This does not apply to ships equipped with air or electrical

acoustic alarms other than the steam whistle.

18.2 STEAM PIPELINE BLOW-DOWN

18.2.1 Provision shall be made in the main steam lines for condensate discharge arrangements to prevent hydraulic impacts in the machinery.

18.2.2 Open ends of steam line blow-down pipes shall be located below the floor level of the machinery space and boiler room (refer also to 5.3.7).

18.3 THERMAL EXPANSION CALCULATION OF STEAM PIPELINES

18.3.1 Thermal expansion calculations made for steam pipelines shall be based on the conventional techniques for the structural mechanics of frame structures. The calculation may be made using ECM or modelling approach as approved by the Register.

18.3.2 The calculation of steam lines for thermal expansion shall include a summary table of stresses and safety factors for all steam line sections included in calculation.

The calculation of steam lines that operate at temperatures that allow no stress relaxation[5] for thermal expansion, as a rule, shall include installation stretching (including when cold).

Steam lines that operate in relaxed conditions shall be calculated when cold; the calculation shall include 100 per cent installation stretching equivalent to displacement (including the displacement of supports) but with an opposite sign. Where the steam line is subject to displacement when hot, it shall be calculated for displacement when hot, followed by 100 per cent installation stretching calculation (including the displacement of supports) when cold.

18.3.3 Steam line valves and formed components (bends, t-pieces etc.) may be assumed to be completely rigid and need not be included in the calculation of flexibility.

18.3.4 Design forces in the steam line shall be calculated based on the cross-sectional areas of pipes with account of a positive pipe wall rolling allowance. The same pipe dimensions shall be used to calculate the displacement stresses. Pressure stresses shall be calculated based on the pipe cross-sectional areas with account of a negative pipe wall rolling allowance.

18.3.5 For all types of butt welds of steam pipes welded root side, double-sided penetration butt welds by machine submerged arc welding, and welds made using a removable backup ring with surface conditioned, the reduction factor in a formula to calculate steam line stresses may be taken equal to one ($\varphi = 1$).

18.3.6 In general, three reaction components for a flat section and six — for a 3D section shall be calculated based on a force technique known in the structural mechanics of frame structures. In calculation of reaction components, a 3D section of the steam line shall be reduced to three flat sections. To reduce the error of 3D section reduction to three flat sections, the axes along which the steam line

[5] Temperatures at which the steam line operates in stress relaxation conditions:

350 °C and above — for carbon steel pipes;

420 °C and above — for alloy steel pipes.

section is viewed shall be arranged in parallel (or perpendicular) to the longest straight segments of this section, and its curved segments shall be projected onto the axial planes, where practicable, without curving or as straight segments.

18.3.7 Flexibility coefficient k of the curved segment shall be determined from the formulas:

$$k = \frac{10 + 12\lambda^2}{1 + 12\lambda^2} \quad \text{for } \lambda \geq 0.4 \qquad (18.3.7\text{-}1)$$

and

$$k = 1.65/\lambda \text{ for } 0.2 \leq \lambda \leq 0.4, \qquad (18.3.7\text{-}2)$$

with λ = geometric factor for a curved pipe equal to sR/r^2;

s = straight pipe wall thickness, in mm;

R = radius of curvature of a curved segment, in mm;

r = mean cross-sectional radius of a straight pipe, in mm.

18.3.8 In thermal expansion calculation of the steam pipeline, the following major stresses shall be taken into account:

reference stress in a straight pipe of a hot steam line at work pressure and of a cold steam line under pressureless conditions;

overall local stress over the internal surface of a curved pipe of a hot steam line at work pressure and of a cold steam line under pressureless conditions.

To calculate reference stress, curved pipes with $\lambda \geq 1.44$ may be assumed to be straight, and no overall local stress shall be calculated for them.

During hydraulic tests of steam pipeline assemblies on board the ship reference stresses in the cold steam pipeline shall also be calculated at test hydraulic pressure.

18.3.9 Reference stress σ_c in a straight pipe under internal pressure as well as under bending moment and torque shall be calculated from the formula

$$\sigma_c = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - \sigma_1\sigma_2 - \sigma_1\sigma_3 - \sigma_2\sigma_3 + 3\tau^2}, \qquad (18.3.9)$$

where σ_1 = overall longitudinal stress due to bending and internal pressure, in MPa;

σ_2 = circumferential stress due to internal pressure, in MPa;

σ_3 = radial stress due to internal pressure, in MPa;

τ = torsional stress, in MPa.

18.3.10 Overall local stress over the internal surface of a curved pipe shall be calculated for all bending types (flat, normal to the plain of the pipe curvature, and skew) as a total of bending stresses and circumferential stress due to internal pressure.

18.3.11 Safety factors with respect to the yield strength or stress-rupture strength for reference and overall local stresses shall be taken equal to:

1.2 — for flat steam line sections;

1.5 — for 3D steam line sections.

19. CONDENSING PLANTS

19.1 GENERAL INSTRUCTIONS

19.1.1 Every main turbine installation shall have an autonomous condensing plant to provide stable vacuum under any rated conditions.

Auxiliary turbines may share a common condensing plant. Exhaust steam from auxiliary turbines during nav-

igation may be discharged into the main condenser or into the main turbine stages.

19.2 PUMPS

19.2.1 The main condenser shall be fed by two circulation pumps one of which is a standby pump.

Standby pump capacity shall be equal to at least 30 per cent of the rated circulation water flow for all consumers.

Any pump of adequate capacity may be used as a standby pump (refer to 15.1.4).

In twin-shaft ships one standby circulation pump may be utilized by both turbine installations.

Where simultaneous operation of both pumps is required for the main condenser, the pumps shall be of a capacity at least half rated circulation water flow for all consumers; no standby circulation pump need be fitted.

19.2.2 If all turbine installations share a common auxiliary condenser, this condenser shall be fed by two circulation pumps one of which is a standby pump.

Any pump of adequate capacity may be used as a standby pump.

19.2.3 Gravity circulation of cooling water is allowed provided that a circulation pump is fitted with a capacity sufficient to allow running under fast astern conditions. The standby circulation pump shall meet the requirements of 19.2.1.

19.2.4 Condensing systems of steam turbines shall be serviced by two condensate pumps.

The capacity of each pump shall be not less than 25 per cent above the maximum amount of exhaust steam condensate fed into the condenser. In plants with two main condensers located in the same machinery space, a common standby condensate pump may be shared by both condensers.

19.3 PIPING LAYING

19.3.1 The arrangement of piping and piping connections shall meet the requirements of 15.2.

19.3.2 The condensate tank, discharge pipe and condensate pump shall be arranged so as to preclude flooding of the bottom rows of condenser tubes and to provide for adequate boost pressure and smooth feeding of condensate to the pump.

A manhole shall be fitted for condensate tank cleaning.

19.3.3 Ejector nozzles of condensing plants shall be protected against damage and contamination. For this purpose protective wire gauze shall be provided.

19.4 CONTROL AND MEASURING INSTRUMENTS

19.4.1 Condensing plants shall be equipped with control and measuring instruments and with alarms, including:

.1 condenser level gauge;

.2 vacuum gauges and vacuum pressure gauges on condensers and ejector coolers;

.3 pressure gauge on steam line upstream of ejector;

.4 thermometers on cooling water discharge pipes for condensers and ejector coolers;

.5 salinity meters with visual and audible condensate salinity alarms.

20. SYSTEMS CONTAINING ORGANIC COOLANTS

20.1 DEFINITIONS AND EXPLANATIONS

The following definitions have been adopted in this Section.

Organic coolant boiler is a heat exchanger for organic coolant heating up to the needed temperature due to the burning of fuel, engine exhaust gases or electrical power.

Organic coolant heater is a heat exchanger for organic coolant heating with steam, water or organic coolants of other circuits.

Working pressure in the organic coolant system is the maximum pressure which may occur during system operation in any of its parts.

Organic coolant system is a system in which organic coolant circulates in liquid.

Coolant temperature is the temperature measured at the centre of the cross-sectional area of the pipeline.

20.2 COOLANT REQUIREMENTS

20.2.1 Coolant may be used within the temperature range as specified by the manufacturer. The maximum coolant working temperature shall not be less than 50 °C below the bubble point under atmospheric pressure.

20.2.2 In organic coolant heaters, the heating medium temperature shall not be less than the bubble point of the heated coolant.

20.3 ORGANIC COOLANT CIRCULATION SYSTEM

20.3.1 Coolant circulation within the circuits of all boilers and essential heaters shall be provided by two circulation pumps.

In nonessential systems in which coolant heaters are used, a single pump may be fitted.

20.3.2 Provision shall be made for pressure gauges at coolant outlets of the pumps.

20.3.3 Coolant circulation pump motors shall have disconnection devices meeting the requirements of 5.7.1, Part XI “Electrical Equipment”.

20.3.4 Circulation pumps shall be operated locally and remotely.

20.3.5 In case heating of all consumers is cut off, provision shall be made for automatic organic coolant circulation within boilers or heaters during the time necessary to discharge excess heat.

Where the temperature of engine exhaust gases or heated coolant does not exceed the bubble point of the heated coolant under atmospheric pressure, this requirement may be omitted.

20.4 EXPANSION TANK

20.4.1 Expansion tanks shall be provided in systems containing organic coolants. The expansion tank shall be installed in the highest location within the system.

20.4.2 The expansion tank shall be fitted with a level gauge meeting the requirements of 10.4.

The level gauge shall have a low-level mark.

20.4.3 Expansion tanks in an open system shall be fitted with an air pipe and an overflow pipe discharging into a drain tank, where any, or into a reserve tank.

20.4.4 Low and high level alarms shall be fitted in the tank. Where liquid level drops below the low level mark, coolant heating shall be cut off automatically and circulation pumps shall be stopped.

20.4.5 In closed systems, expansion tanks shall be equipped with pressure gauges and safety valves. A safety valve discharge pipe shall be connected to a drain tank or a reserve tank. Provision shall be made for closed system operation under open system conditions.

20.4.6 Expansion tanks with thermal insulation shall be equipped with thermometers for coolant temperature control.

20.4.7 The expansion tank capacity within sight of the level gauge, measured from the low level mark until the overflow pipe level, shall be at least 30 per cent in excess of the rated coolant volume gain within the system in operation, with the total volume of coolant in the equipment and piping taken as the initial volume, provided the expansion tank is filled up to the low level mark.

20.4.8 The expansion tank shall be equipped with an emergency coolant discharge valve operated both locally and remotely from outside the space in which it is located.

20.5 RESERVE TANK AND DRAIN TANK

20.5.1 The system shall include a reserve tank and a drain tank. The reserve tank capacity shall not be less than 40 per cent of the overall system's capacity. The rated capacity may be reduced based on the purpose of the system and the ship's area of navigation.

20.5.2 The drain tank capacity shall allow coolant discharge from the major section of the system that is being cutoff.

The capacity of a drain tank for organic coolant from boilers (refer to 3.5, Part X "Boilers, Heat Exchangers and Pressure Vessels") shall allow coolant discharge from the entire system.

20.5.3 A single tank for coolant storage and discharge may be available. Such tank shall have a capacity to allow simultaneous storage and discharge of the coolant. The storage tank in this case shall be arranged so as to allow discharging the entire volume of coolant.

20.5.4 Organic coolant tanks shall be fitted with gauges.

Where ignition sources are present, coolant tank gauges shall meet the requirements of 10.4.2 and 10.4.4.

20.6 PIPELINES AND VALVES

20.6.1 The laying of organic coolant pipelines shall be in accordance with the requirements of 13.2 and Section 5.

20.6.2 The system shall be equipped with valves having bellow seals. The use of sealing valves shall be specially considered by the Register in each case.

20.6.3 System components that contact with the coolant shall not be made of copper or copper alloys.

20.6.4 Seals and gaskets shall be of organic coolant resistant materials.

20.6.5 Organic coolant pipelines shall not have threaded joints.

20.6.6 The steel pipe wall thickness shall be in compliance with 2.3.1. The rated pressure of at least 1.4 MPa shall be provided.

20.6.7 The organic coolant system layout shall provide for the system filling, expansion tank refilling, as well as coolant pumping.

20.6.8 Provision shall be made for coolant sampling in each independent circuit.

20.6.9 The system shall be so designed as to prevent deterioration of coolant quality due to local overheating or air exposure.

20.6.10 Provision shall be made for an efficient steam and gas recovery and discharge device. This device shall not allow coolant circulation and heating in the expansion tank to a temperature above 50 °C.

20.6.11 Coolant flow rate and temperature control shall be effected by a manual control device at the local control station.

20.6.12 A nameplate shall be provided in a conspicuous place in a close vicinity to the circulation pumps, indicating the following system data:

manufacturer;

year of manufacture;

maximum design coolant temperature;

system capacity;

maximum working pressure.

20.6.13 Organic coolant tanks in which water may accumulate shall be equipped with cocks for sediment discharge.

20.7 AIR PIPES

20.7.1 Organic coolant air pipes shall meet the requirements of 10.1 which also apply to fuel oil and lube oil tanks.

20.7.2 Organic coolant air pipes shall be laid to open decks.

20.8 ARRANGEMENTS FOR COLLECTION OF LEAKAGE ORGANIC COOLANT

20.8.1 Arrangements for collection of leakage organic coolant shall meet the requirements of 13.5.

20.8.2 Waste heat boilers and exhaust gas piping shall be equipped with devices to prevent organic coolant, as well as water for fire extinguishing or boiler washing on gas side, from entering the engine in case of leakage.

20.9 BOILERS CONTAINING ORGANIC COOLANTS

20.9.1 Boilers and heaters containing organic coolants shall meet the requirements of 3.5, Part X “Boilers, Heat Exchangers and Pressure Vessels”.

20.10 INSULATION

20.10.1 Insulation of pipelines and equipment of the system shall meet the requirements of 4.6, Part VII “Machinery Installations”.

20.11 LIQUID CARGO HEATING

20.11.1 Coolants used for the heating of liquid cargo or other liquid products shall be suitable for use with the products to be heated and, in case of contact due to leakage from heating coils or tubes.

Coolants which may react with the heated product are not allowed.

20.11.2 The use of organic coolant systems for the heating of liquid cargo with flash point below 60 °C is only allowed provided a self-contained intermediate system is available within the cargo space.

This self-contained intermediate system need not be provided in the following cases:

.1 the system is so designed that with circulation pump off heat coil overpressure is at least 0.03 MPa above the static pressure of the cargo;

.2 means for detection of combustible cargo gases are provided in the organic coolant expansion tank;

.3 valves of separate heating coils are fitted with stopping arrangements so that the coils are under continuous static pressure.

20.12 TESTING OF PIPING CONTAINING ORGANIC COOLANT

20.12.1 Piping and formed elements of organic coolant systems shall be tested in compliance with 21.2 similar to fuel oil piping under rated pressure above 0.35 MPa.

21. TESTS

21.1 HYDRAULIC TESTS OF VALVES

21.1.1 Valves installed on Classes I and II piping shall be subjected to hydraulic tests with test pressure under 1.3.1, Part IX “Machinery”.

21.1.2 Valves rated for 0.098 MPa and less, as well as for operation under vacuum, shall be tested with pressure of at least 0.196 MPa.

21.1.3 Valves, cocks and other arrangements to be installed on the hull shell plating below the waterline shall be tested with hydraulic pressure not less than 0.5 MPa.

21.1.4 Valve assemblies shall be subjected to hydraulic tests for tightness with pressure equivalent to the rated pressure.

21.2 HYDRAULIC TESTS OF PIPING

21.2.1 Classes I and II piping, as well as all steam, feed water, compressed air and fuel oil piping rated for above 0.35 MPa, irrespective of their class, shall be subjected to hydraulic tests after fabrication and final treatment prior to the application of insulation and coating, witnessed by the Surveyor to the Register, with test pressure as follows:

$$p_{test} = 1{,}5p \quad , \qquad (20.2.1\text{-}1)$$

where p = design pressure (refer to 2.3.1), MPa.

Test pressure, in MPa, during hydraulic tests of steel piping for design temperatures above 300 °C shall be determined from the following formula, provided it does not exceed 2p,

$$p_{test} = 1{,}5\frac{\sigma_{100}}{\sigma_t} p \qquad (20.2.1\text{-}2)$$

where σ_{100} = permissible stress at 100 °C;

σ_t = permissible stress at design temperature.

Where during hydraulic tests overstress occurs in certain piping components, test pressure determined from the Formula (21.2.1-2) may be reduced upon approval by the Register to 1.5*p*.

In any case, stresses that occur during hydraulic tests shall not exceed 0.9 times the yield stress of the material under test temperature.

21.2.2 Hydraulic tests of small-bore pipes (less than 15 mm) of any class may be omitted upon approval by the Register, with an account of the pipe designation.

Where hydraulic tests are carried out on board the ship for piping assembly strength with test pressure of 1.5*p,* preliminary strength tests for pipes listed in 21.2.1 may be omitted.

21.2.3 All piping, following assembly on board, shall be tested for tightness in operation witnessed by the Surveyor to the Register, except for:

.1 heating coils and liquid or gaseous fuel piping to be tested with pressure of 1.5*p*, but not less than 0.4 MPa;

.2 liquefied gas piping to be tested under 13.14.17.

21.2.4 Where hydraulic tests of the complete piping may not be carried out for technical reasons, proposals shall be submitted for approval to the Register for tests on separate piping sections, in particular assembly end joints.

21.2.5 Where hydraulic tests of piping assemblies are carried out on board the ship, tightness and stress tests may be combined.

21.2.6 Liquefied gas pipes laid from containers to reducing valves shall be tested in accordance with 13.14.17.

21.3 TESTS OF DEVICES PREVENTING PASSAGE OF FLAME INTO CARGO TANKS OF OIL TANKERS

21.3.1 Flame arresters, flame aborting strainers, high-speed gas exhaust devices and breathing valves, as well as safety devices for protection against precipitation, prior to mounting on board, shall be tested in accordance with IMO procedure stated in the Maritime Safety Committee Circular MSC/Circ.677.

21.4 TESTS OF AUTOMATIC AIR PIPE CLOSURES

21.4.1 The type and size of air pipe closure shall be inspected and subjected to checks and tests as follows:

.1 determination of hydraulic resistance of the closure based on the flow rate.

Pressure drop in air pipe closures is determined based on the volume flow rate, where flame aborting strainers and protective wire gauzes are fitted. The test medium shall be water.

.2 test for tightness during submersion and emersion.

Automatic closures shall undergo a series of watertightness tests including at least two submersion cycles provided:

the device is submersed below the water surface at a speed of about 4 m/min. and resumes its initial state. The number of leaks shall be recorded;

the device is submersed below the water surface at a speed of about 8 m/min. and remains completely submersed for not less than 5 min.

Water tightness tests shall be carried out with the device submersed both verti-

cally and at an angle of 40° in the least favourable position with regard to tight closing.

Where such position is not evident, tests at an angle of 40° shall be repeated, with the device submerged in three different positions: with the opening facing up, down, right or left.

The maximum allowable amount of leakage per one cycle is not more than 2 ml per 1 mm of the nominal diameter;

.3 discharge capacity check.

A vacuum pump or another suitable device shall be connected on tank side.

The air flow velocity shall be built up until the float is caught by the flow and obstructs the flow.

Flow velocity at which obstruction occurs shall be recorded.

The permissible flow velocity shall be assumed equal to 80% of the value at which the device is locked.

21.4.2 Non-metal ball floats shall be factory tested for impact resistance and compression in accordance with Table 21.4.2 and conditions as follows:

.1 impact resistance tests shall be carried out using a Charpy impact machine.

The float shall be subjected to 5 impacts 2.5 N/m each. The float shall show no permanent deformation, cracks nor surface damage.

The float shall then be subjected to 5 more impacts 25 N/m each. Separate confined area surface damage at the impact site are allowed, but no permanent deformation nor cracks shall occur;

.2 compression tests shall be carried out with the float fitted on a support ring with the diameter and a mounting seat fitting the valve seat. Load shall be applied through a concave hood with the internal radius similar to that of the closure to be tested.

The load shall be raised gradually to 350 kg within 1 min., and continuous full load shall be maintained during 1 h. The deflection shall be measured at an interval of 10 min. following the application of full load. Continuous increase of deflection is not acceptable. When the load is removed, permanent deformation is not acceptable;

.3 metal ball floats shall be tested in accordance with 21.4.2.1.

Table 21.4.2

Testing conditions	Test temperature, °C		
	−25	+20	+85
Dry state	+	+	+
Submersed in water	+	+	+
Submersed in fuel oil	–	+	–

Symbols:
"+" — to be tested;
"+" — not tested

Note. The specimen shall be submersed in water or fuel for at least 48 h.

21.5 PLASTIC PIPE TESTS

21.5.1 Plastic pipes shall be tested with regard to the requirements set forth in 6.8, Part XIII "Materials" and, where necessary, fire resistance and flame propagation tests shall be carried out in accordance with 3.3.1 and 3.3.2.1 of this Part. **21.5.2** The quality of joints shall be tested in accordance with the requirements of 3.5.2, and piping tests following

mounting on board — in accordance with the requirements of 3.8.