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RULES FOR CLASSIFICATION OF OFFSHORE FLOATING INSTALLATION

PART V UTILITY SYSTEMS

CCS OFFSHORE ENGINEERING TECHNOLOGY CENTER

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CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.1 Application

1.1.1.1 This PART is applicable to the utility systems of ship shaped floating installation; and the utility systems on other types of floating installation are also to comply with the applicable requirements of this PART.

1.1.1.2 The propulsion installation of a self-propelled floating installation is to be in compliance with the relevant provisions of CCS Rules for Classification of Sea-going Steel Ships.

1.1.1.3 The utility systems of column-stabilized units are to be in compliance with the relevant provisions of CCS Rules for Classification of Mobile Offshore Units.

1.1.2 Objective

The objective specified in this chapter is to provide safe and effective support for well fluid inputting, crude oil processing, storage and export, as well as accommodation to the floating installation.

1.1.3 Functional requirements

To achieve the objective specified in this chapter, the utility machinery installation are to have the following functions:

- (1) The types of equipment are to fit for ocean environment;
- (2) The power generation equipment is to satisfy the maximum load of unit with certain allowance;
- (3) The capacity of boilers and pressure vessels is to satisfy the demand of heat and pressure energy of unit;
- (4) The capacity of air compressors, pumps and fans is to satisfy the demand of fluid transfer by the systems that they serve;
- (5) The equipment is firmly and securely installed;
- (6) The equipment and their arrangements are safe and environment-friendly and easy for operation and maintenance.

1.1.4 Ambient conditions

1.1.4.1 All machinery equipments and systems related to the safety of the unit are to be capable of being operated under the upright and the static and dynamic conditions of inclination given in the following Table 1.1.4.1. Smaller angles of inclination may be permitted, considering the size and service conditions, etc. of the unit.

Angles of Inclination of a Unit

Table 1.1.4.1

System component or	Angle of inclination ¹ (°)			
	Transverse		Longitudinal	
	Static	Dynamic	Static	Dynamic
Equipment related to safety	15	22.5	5	7.5
Emergency safety equipments such as emergency power generator, fire pump, etc.	22.5	22.5	10	10

Notes: ¹ Transverse inclination and longitudinal inclination may occur simultaneously.

1.1.4.2 For the machinery equipments and systems relating to the safety of the unit, their design and arrangements are to comply with the provisions of ambient temperature of Table 1.1.4.2 to ensure their normal operation. For unit in restricted service, the ambient temperature may be selected according to the actual conditions of the service region.

Ambient Temperature**Table 1.1.4.2**

Ambient	Position	Temperature (°C)
Atmosphere	Indoor	0~45
	Weather deck	-25~45
	In specific space or on specific machinery equipment	Actual temperature of specific space or equipment
Seawater	All positions	32

1.1.4.3 For floating installation in unrestricted service, the rated power of diesel engine is to take the benchmark ambient conditions in Table 1.1.4.3.

The engine manufacturers are not expected to provide simulated ambient reference conditions at a test bed as required by the Rules, but are required to submit the modified values of the rating of the diesel engines under the ambient reference conditions.

Benchmark Ambient Conditions**Table 1.1.4.3**

Absolute atmosphere	0.1 MPa
Ambient temperature	45°C
Relative humidity	60%
Seawater temperature (charge air coolant inlet)	32°C

1.1.4.4 In the case of units for restricted service, the ambient conditions, on which the rating of diesel engines is based, are to be suitable for the service.

1.1.5 Overload power

The prime movers of electric generators are to be capable of running at an overload power corresponding to 110% of their rated power.

1.1.6 Dead ship starting

The machinery equipment is to be so designed that it can be brought into operation from the dead ship condition using only the facilities available onboard the unit without external aid within 30 minutes.

Dead ship condition is to be understood to mean a condition under which the main propulsion plant, boilers and auxiliaries are not in operation due to lack of power.

1.1.7 Human-machinery interface

1.1.7.1 The arrangements and design of machinery space are to provide a working environment beneficial for personal safety, health and efficiency, and minimize the hazard of incapability and mishandling.

1.1.7.2 Machinery equipment is to be functionally identified by marks, piping is to be identified by color and flow direction according to the recognized international, national or industrial standards, and cables are to be provided with permanent identification marks.

1.1.7.3 The design and arrangement of control panel are to comply with the recognized international standards on ergonomics.

1.1.7.4 The equipments or components (such as valves and instruments) which need to be operated, tested, repaired and inspected during the service are to be installed in the positions which are accessible for the above personnel activities.

1.1.7.5 Spares and tools are to be stored in such positions as to facilitate convenient use.

1.1.8 Failure protection

1.1.8.1 In the event of failure, components and systems are to maintain the conditions with the minimum hazard to machinery, human and environment or in a fail- safe state.

1.1.8.2 The probability of damage caused by component failure or failure to other components is to be reduced to an acceptable level.

1.1.8.3 The failure of the redundant components in system is not to lead to damage or failure of standby or parallel components of the system.

1.1.9 Anti-corrosion

The parts exposed to corrosive environment are to be made of corrosion resistant materials or provided with effective anti-corrosion means.

1.1.10 Materials

1.1.10.1 The materials used for fabrication of machinery installation and pipes are to comply with the relevant requirements of the CCS Rules for Materials and Welding.

The materials not specified in the CCS Rules for Materials and Welding may be accepted after being qualified through necessary surveys and tests and approved by relevant authorities.

1.1.10.2 Use of asbestos material is prohibited on the unit.

1.1.11 Automation

The unit with automation additional notation is to comply with the relevant requirements of PART VII of the Rules.

1.1.12 Communication

The communication in machinery spaces or between control room of engine and the navigation bridge is to comply with the relevant requirements of Chapter 7, PART VII of the Rules.

1.1.13 Detailed requirements of machinery equipment

1.1.13.1 The diesel engines, boilers and pressure vessels are to comply with the relevant requirements of PART III of CCS Rules for Classification of Sea-going Steel Ships.

1.1.13.2 The air compressors and pumps are to comply with the relevant requirements of Section 1, Chapter 3 of this PART.

1.1.14 Test

After the utility machinery installation are installed onboard the unit, mooring test and navigation test are to be performed according to the relevant requirements of the Rules and the agreed test program.

After completion of the tests, the shipyard is to provide test-related technical files and test reports.

1.1.15 Plans and information

1.1.15.1 The following plans and information are to be provided to CCS for checking:

- (1) Legend, symbols and notes of system plans and information;
- (2) Piping and instrument diagram (P&ID) of bilge system;
- (3) P&ID of open drain system;

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- (4) P&ID of ballast system;
 - (5) P&ID of tank vent system
 - (6) P&ID of overflow system;
 - (7) P&ID of sounding system;
 - (8) P&ID of fuel oil system;
 - (9) P&ID of helicopter fuel system;
 - (10) P&ID of lube oil system;
 - (11) P&ID of hydraulic system;
 - (12) P&ID of thermal oil system;
 - (13) P&ID of boiler feed water, blow-off and condensation system;
 - (14) P&ID of cooling water system;
 - (15) P&ID of compressed air system;
 - (16) P&ID of exhaust discharge system;
 - (17) Calculation of pipe wall thickness and diameter design;
 - (18) Plans of power ventilation system and arrangement of ventilation ducts;
 - (19) Instructions for utility machinery installation and systems;
 - (20) List of utility machinery equipment;
 - (21) Calculation of utility machinery equipment and piping systems;
 - (22) Test program of utility machinery equipment and systems;
 - (23) Operation manuals for utility machinery equipment and systems;
 - (24) Plans of arrangement of utility machinery spaces;
 - (25) Other plans and information deemed necessary by CCS.

1.1.15.2 The materials, sizes, types, design pressure and design temperature of pipes, valves and fittings, etc. are to be marked on the plans and information. Necessary calculation is to be included, if there is no additional calculation sheet.

Section 2 ARRANGEMENT AND INSTALLATION

1.2.1 Arrangement of equipment

1.2.1.1 Combustion equipment (e.g. internal combustion engines, boilers) is to be arranged outside all of hazardous areas.

1.2.1.2 The equipment installed in non-enclosed area is to be suitable for exposed environment.

1.2.1.3 The equipment, components and piping are to be so arranged that no leaked or overflow liquid will spray or drop onto the electric objectives.

1.2.1.4 Refer to the relevant provisions on firewater system in PART VIII for the requirements on the subdivision and arrangement of fire pumps.

1.2.1.5 The safety-related equipment like generators, boilers, pressure vessels, hydraulic units, air compressors, pumps, etc. is to be arranged outside the assumed damage zone; in addition, the emergency generators and centralized ballast control room are to be arranged above the final damage waterline.

1.2.2 Arrangements of fire prevention

1.2.2.1 Where the surface temperature may exceed 220°C, if the insulation is oil-absorbing or pervious to oil, such insulation is to be encased in steel or equivalent.

1.2.2.2 Measures are to be taken to prevent splashing flammable oil leaked from pumps, oil separators, filters and other detachable connectors to heat surfaces.

Oil pumps, oil filters, boiler burners and oil fuel devices shall be provided with oil collecting pan and led to the collecting container.

1.2.2.3 Oil tanks are not to be arranged above the boilers, funnels, exhaust pipes, mufflers and other heat sources, and if inevitable, measures are to be taken to prevent flammable oil from dropping onto the heat surfaces.

1.2.2.4 The clearance between boilers and oil fuel tank boundaries is to be not less than that specified in Table 1.2.2.4.

Clearance between Boilers and Oil Fuel Tank Boundaries (mm)

Table 1.2.2.4

		Top plating of double bottom fuel oil tank	Oil fuel tank boundary
Water-tube boiler	Outer wall	—	450
	Bottom	600	—
Fire-tube boiler	End plate	—	600
	Bottom	450	—

1.2.2.5 Oil fuel tanks are to be part of unit's structure and located outside category A machinery space as far as practical. If oil fuel tanks, other than double-bottom tanks, are necessarily to be located adjacent to or within the machinery spaces of category A, at least one of their vertical sides is to be contiguous to the machinery space boundaries, and their bottoms are not directly accessible to possible fire. The area of the tank boundary common with the machinery spaces is to be kept to a minimum.

Where such tanks are situated within the boundaries of machinery spaces of category A, they are not to contain oil fuel having a flash point of less than 60°C (closed cup test).

In general, the use of free-standing oil fuel tanks is to be avoided. When such tanks are employed, they are to be placed in an oil-tight spill tray of ample size having a suitable drain pipe leading to a suitably sized spill oil tank.

The above principle is also applicable to other flammable oil tanks.

1.2.2.6 The skylight of category A machinery space is to be made of steel and not to contain glass plate.

Appropriate measures are to be taken so that fume gas could be released from the protected space when fire occurs.

1.2.2.7 Hydraulic units with working pressure above 1.5 MPa are to be placed in separate spaces or other measures to be taken to prevent leaked hydraulic oil from spraying to ignition source.

1.2.3 Installation of equipment

1.2.3.1 All equipment is to be securely fixed to the foundation, which is to be welded to the decks or bulkheads of robust construction.

1.2.3.2 Pumps are to be installed vertically or horizontally. The motors of pumps are to be securely fixed to void excessive vibration and exposed above the floor gratings.

1.2.4 Accessibility of equipment

Accessibility, for the purposes of maintenance, operation and repair of various machinery and equipment, is to be provided in machinery spaces. Where climbing is required, ladders, handrails and guardrails are to be provided and if necessary, a platform with guardrails is to be fitted.

1.2.5 Repair of equipment

1.2.5.1 For facilities required to be overhauled during normal operation, space is to be left for the overhauling or drawing out their components.

1.2.5.2 The machinery spaces are to be provided with necessary lifting appliances to facilitate the removing and replacing of equipment.

1.2.5.3 Stuffing boxes are to be fitted on the watertight bulkhead of the engine room where shafts pass through. They are to be so arranged as to be convenient for tightening and renewing the packages from the engine room side. The fore sealing ends of the stern tubes as well as the plumber blocks are to be easily accessible for maintenance.

1.2.6 Separation of tanks

1.2.6.1 When lube oil tanks are adjacent to water tanks or fuel oil tanks, they are to be separated by cofferdams.

1.2.6.2 When freshwater tanks are adjacent to any oil tank, they are to be separated by cofferdams.

1.2.6.3 Service lube oil tanks, lube oil circulating tanks or hydraulic oil tanks are not to have one common bulkhead with any other liquid tank.

1.2.7 Personnel protection

1.2.7.1 In places where the moving parts of machinery and equipment may cause injuries to the operating personnel, protecting casings, handrails or other safety protection facilities are to be provided.

1.2.7.2 The edges of deck openings over 2 m depth are to be provided with reliable safety protection handrails.

1.2.7.3 Anti-slip measures are to be taken for all surfaces of working areas, passageways and ladders where personnel frequently pass through so as to ensure the safety.

1.2.7.4 Areas with stumbling, bumping or falling danger are to be conspicuously identified.

1.2.7.5 Passageways are to be provided with appropriate clearance; handrails and guardrails are to be provided on both sides of ladders and the inclination of the ladders to the floor plating should not be more than 60°.

1.2.7.6 To avoid burning by heat surfaces, such surfaces are to be insulated so that the surface temperature is not to exceed 60°C, and if it is impracticable, fences are to be provided to prevent personnel from contacting the heat surfaces.

The surfaces below 0°C should be properly insulated.

1.2.7.7 Precautionary measures to prevent electric shock, electrical fire and other electrical hazards are to be provided.

1.2.7.8 Measures are to be taken to reduce machinery noise in machinery spaces to the acceptable levels. If such noise could not be sufficiently reduced, the source of excessive noise is to be suitably insulated or isolated or a refuge from noise is to be provided if the space is required to be manned. Ear protectors are to be provided for personnel required to enter such spaces, if necessary.

1.2.8 Prevention of inadvertent operations

1.2.8.1 The utility machinery installation is to be so arranged to prevent units and personnel from leading to the danger state as a consequence of one single operation error.

1.2.8.2 The equipment and piping are to be arranged to prevent fluid from entering into dry compartments or oil fluid or chemicals from being discharged overboard as a consequence of inadvertent operation.

1.2.8.3 The systems and tanks are to be arranged that leakage or operation of valves will not lead to threat to machinery or personnel due to mixing of different fluids.

1.2.8.4 Similar manual buttons like emergency stoppage, emergency shutdown, etc. are to be protectively covered from mishandling.

1.2.8.5 The on/off positions of valves are to be conspicuous.

1.2.8.6 Placards or labels are to be provided for illustrating the correct procedures of safe operation, so as to avoid any mistakes in the operation or changeover of the machinery or systems.

1.2.9 Escape passageways of category A machinery space

The escape passageways of category A machinery space are to comply with the relevant requirements of Chapter 12, PART VIII of the Rules.

Chapter 2 GENERAL OF PIPING DESIGN

Section 1 GENERAL PROVISIONS

2.1.1 Objective

The objective specified in this chapter is to ensure the strength and integrity of piping.

2.1.2 Functional requirements

To achieve the objective of specified in this chapter, the piping is to have the following functions:

- (1) The piping is capable of carrying fluids under the pre-set design pressure, temperature and flow;
- (2) The materials of piping are to be suitable to the ambient environment, internal media, fire resistance performance, pressure and temperature, and the intended service;
- (3) The connection of piping is to ensure flow of fluids in the tightly-enclosed system and convenient for dismantling, inspection and maintenance;
- (4) The piping is to be provided with arrangements for separation and drainage of the medium and arrangements for flow control;
- (5) The piping is to be located at such places that it will not be easily damaged, cause fires or result in damage to the electrical equipment and instruments in the event of any leakage.

2.1.3 Definitions

2.1.3.1 Pipe: a pressure-tight cylinder used to convey a fluid or to transmit a fluid pressure.

2.1.3.2 Piping: assemblies of piping components used to convey, distribute, mix, separate, discharge, meter, control, or snub fluid flows. Piping also includes pipe-supporting elements.

2.1.3.3 Piping components: refer to pipes, fittings, flanges and fasteners, valves, expansion joints, strainers, flame arrestors, silencers, flow sight glasses, etc.

2.1.3.4 Fittings refer to elbows, tees, crosses, caps, bosses, o-lets, reduce nipples, threaded nipples, mechanical joints, plugs, instrument nozzles, quick hose connections, hoppers, small nozzles, etc.

The main functions of fittings are changing piping directions, changing piping diameters, piping branching, regional enhancement, piping terminal and piping connection.

2.1.3.5 Piping system: interconnected piping subject to the same set or sets of design conditions.

2.1.4 Class of pipes

2.1.4.1 The objectives of class of pipes are to select reasonable connection types of piping components (selection of butt welding, socket welding, slip-on welding, selection of flange type, selection of mechanical joint type and selection of expansion joint type), and determine suitable materials, welding, NDT and test requirements.

2.1.4.2 The pressure pipes of different purposes are divided into three classes according to their design pressure and design temperature, as shown in Figure 2.1.4.2 and Table 2.1.4.2.

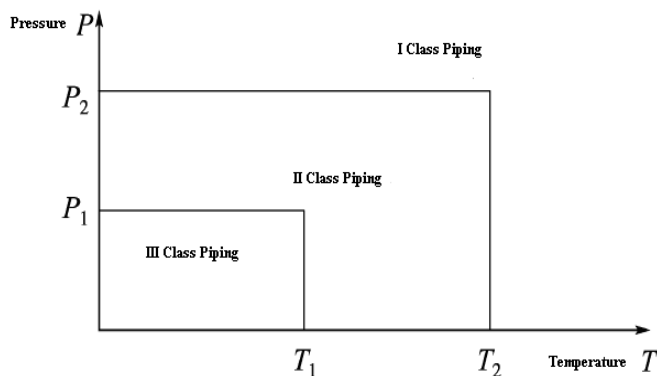


Figure 2.1.4.2 Class of Piping

Pipe Class

Table 2.1.4.2

Piping system	Class I		Class II		Class III	
	Design pressure (MPa)	Design temperature (°C)	Design pressure (MPa)	Design temperature (°C)	Design pressure (MPa)	Design temperature (°C)
Steam	> 1.6	or > 300	≤ 1.6	and ≤ 300	≤ 0.7	and ≤ 170
Thermal oil	> 1.6	or > 300	≤ 1.6	and ≤ 300	≤ 0.7	and ≤ 150
Oil fuel, lube oil	> 1.6	or > 150	≤ 1.6	and ≤ 150	≤ 0.7	and ≤ 60
Flammable hydraulic oil						
Other media	> 4.0	or > 300	≤ 4.0	and ≤ 300	≤ 1.6	and ≤ 200

Notes: ① For Class I pipes, only the parameter for design pressure or design temperature is to be met, for Classes II and III pipes, both parameters are to be met;

② Pipes carrying toxic or corrosive media, flammable media heated above flash point or media having a flash point below 60°C and liquefied gas, in general, belong to Class I. If special safeguards for preventing leakage and its consequences are provided, they may also belong to Class II, provided that no toxic media are carried;

③ Class III pipes may be used for open-ended non-pressure piping, e.g. drains, overflows, exhaust gas pipes, vents, boiler waste steam pipes, etc.;

④ Other media mean air, water, and non-flammable hydraulic oil;

⑤ Thermal oil means the circulating oil used in the thermal oil system as specified in Section 13, Chapter 3 of this PART.

2.1.4.3 The strength of pipes, valves and other components in piping is to be appropriate to the strength required by the connected pipes and is to be capable of working efficiently under the maximum working pressure.

2.1.5 Pressure protection

2.1.5.1 The pipes which may be subject to a pressure greater than the design value are to be fitted with relief valves at the output end of pumps. For the oil piping, the liquid overflowing from relief valves is to be led to the suction end of pumps or tanks. Heaters and air compressor coolers are also to be fitted with relief valves. The set pressure of relief valves is, in general, not to be greater than the design pressure of piping.

2.1.5.2 Where pressure-reducing valves are fitted in the pressure piping, a relief valve and a pressure gauge are to be fitted behind the pressure-reducing valve and a bypass pipe is to be provided.

2.1.6 Corrosion protection

2.1.6.1 Steel pipes in corrosive environment are to be protected against corrosion, and protective coatings are to be applied upon completion of all fabrication sequences (i.e. bending, forming and welding of the steel pipes).

2.1.6.2 Where pieces of different metals are connected in piping, means is to be provided against electrochemical corrosion.

2.1.7 Insulation

2.1.7.1 All pipes intended for steam, exhaust gas and for other high temperature services are to be well wrapped with insulation material. The surface temperature of insulation is, in general, not to exceed 60°C. The insulations wrapped in way of detachable joints and valves are to be capable of being easily renewed. Where the surface of insulation is oil-absorbing or pervious to oil, the insulation is to be protected against possible oil absorption.

2.1.7.2 Pipes passing through refrigerated spaces, excluding those intended to serve such spaces, are to be well insulated to prevent freezing so as to avoid increased corrosion due to surface condensation and frosting of pipes and insulated from the steel structure.

2.1.7.3 Where the pipes pass through compartments intended for temperatures of 0°C or below, they are in general to be insulated from the steel structure of these compartments.

2.1.8 Pipe products

The requirements on steel or copper pipe products are to comply with the relevant provisions in Chapter 4 and Chapter 9, PART I and Chapter 4, PART II of CCS Rules for Materials and Welding.

Section 2 DESIGN CONDITIONS

2.2.1 Design Pressure

2.2.1.1 In general, the design pressure of piping is not to be less than the expected pressure under the most rigorous condition composed of internal pressure (or external pressure) plus temperature during the service period. If safety relief device is provided for the piping, the design pressure is to be taken not less than the set pressure of such safety relief device.

2.2.1.2 The design pressure for oil fuel piping may be taken from Table 2.2.1.2.

Design Pressure for Oil Fuel Piping

Table 2.2.1.2

Working pressure \ Working temperature	$T \leq 60 \text{ } ^\circ\text{C}$	$T > 60 \text{ } ^\circ\text{C}$
	$P \leq 0.7 \text{ MPa}$	0.3 MPa or maximum working pressure, whichever is greater
$P > 0.7 \text{ MPa}$	Maximum working pressure	1.4 MPa or maximum working pressure, whichever is greater

2.2.1.3 For special cases, the design pressure is to be additionally considered.

2.2.2 Design temperature

2.2.2.1 The design temperature is to be taken not less than the expected temperature under the most rigorous conditions during service period, but in no case is it to be less than 50°C.

2.2.2.2 For special cases, the design temperature is to be additionally considered.

2.2.3 Calculation of wall thickness

2.2.3.1 Formula for calculation of minimum wall thickness δ

The minimum wall thickness δ of metal pipes subject to internal pressure is to be not less than that determined by the following formula:

$$\delta = \delta_0 + b + c \text{ mm}$$

Where: δ_0 – basic wall thickness, in mm, see 2.2.3.2 of this Section;

b – bending allowance, in mm, see 2.2.3.4 of this Section;

c – corrosion allowance, in mm, see 2.2.3.5 of this Section.

2.2.3.2 Formula of basic wall thickness calculation of metal pipes

(1) Where D/δ is not less than 6, the basic wall thickness δ_0 is to be calculated by the following formula:

$$\delta_0 = pD / (2[\sigma] + p) \text{ mm}$$

Where: p – design pressure, in MPa, see 2.2.1 of this Section;

D – external diameter of pipes, in mm;

$[\sigma]$ – permissible stress, in N/mm².

(2) Where D/δ is less than 6 and high pressure piping is applied, the wall thickness calculation is to be determined by the standard accepted by CCS.

2.2.3.3 Permissible Stress

(1) The permissible stress $[\sigma]$ of steel pipes is to be taken as the least of the following values:

$$[\sigma] = \sigma_b / 2.7 \quad \text{N/mm}^2$$

$$[\sigma] = \sigma_s^T / 1.6 \quad \text{N/mm}^2$$

$$[\sigma] = \sigma_D^T / 1.6 \quad \text{N/mm}^2$$

$$[\sigma] = \sigma_c^T \quad \text{N/mm}^2$$

Where: σ_b — specified minimum tensile strength of material at ambient temperature (20°C), in N/mm²;

σ_s^T — specified minimum yield stress or 0.2% proof stress ($\sigma_{P0.2}$) of material at design temperature, in N/mm²;

σ_D^T — average stress of material to produce rupture in 100000 h at design temperature, in N/mm²;

σ_c^T — average stress of material to produce 1% creep in 100000 h at design temperature, in N/mm²;

σ_b , σ_s^T , σ_D^T are to comply with the relevant requirements of CCS Rules for Materials and Welding. If it is regarded as necessary by CCS, σ_c^T could be taken depending on its reliability.

(2) The basic wall thickness of copper and copper alloy pipes is to be determined by Table 2.2.3.3.

Permissible Stress of Copper and Copper Alloy Pipes

Table 2.2.3.3

Pipe material	Condition of supply	Tensile strength (N/mm ²)	Permissible stress (N/mm ²)										
			Design temperature (°C)										
			50	75	100	125	150	175	200	225	250	275	300
Copper	Annealed	215	41	41	40	40	34	27.5	18.5	—	—	—	—
Aluminium	Annealed	325	78	78	78	78	78	51	24.5	—	—	—	—
Copper nickel													
CuNi5Fe1Mn	Annealed	275	68	68	67	65.5	64	62	59	56	52	48	44
CuNi10Fe1Mn													
Copper nickel	Annealed	365	81	79	77	75	73	71	69	67	65.5	64	62
CuNi30													

Notes: ① If the metal temperature is between the values listed in the Table, the permissible stress may be determined by linear interpolation;

② The permissible stresses of the materials not covered by the Table are subject to approval by CCS.

2.2.3.4 Bending Allowance

Bending allowance b is to be not less than that determined by the following formula:

$$b = 0.4 \frac{D}{R} \delta_0$$

Where: R – average radius of curvature of a pipe bend, in mm, in general, R is to be not less than $3D$;

D – external diameter of pipes, in mm;

δ_0 – basic wall thickness, in mm, see 2.2.3.2 of this Section.

2.2.3.5 Corrosion Allowance

(1) The values of corrosion allowance of carbon steel and low alloy steel pipe are shown in Table 2.2.3.5(1);

For pipes passing through tanks, an additional corrosion allowance is to be taken on account of external corrosion, depending on the nature of external medium. Where the pipes and their joints are efficiently protected against corrosion by means of coating, liner, etc., the corrosion allowance may be reduced by not more than 50%. Where highly corrosion-resistant special steel is employed, the corrosion allowance may be reduced, even to zero.

(2) The values of corrosion allowance of nonferrous metal pipes are shown in Table 2.2.3.5(2).

2.2.3.6 The minimum wall thickness δ in 2.2.3.1 of this Section has not taken into account the negative manufacturing tolerance, where there is any negative tolerance allowable in manufacture, the wall thickness δ_m of pipes is not to be less than that determined by the following formula:

$$\delta_m = \frac{\delta}{1-a} \text{ mm}$$

Where: a – ratio of negative manufacturing tolerance to nominal thickness.

Corrosion Allowance *C* for Steel Pipes, in mm

Table 2.2.3.5 (1)

Piping service	C	Piping service	C
Superheated steam system	0.3	Lubricating oil system	0.3
Saturated steam system	0.8	Fuel oil, thermal oil system	1.0
Steam heated system in oil storage tank	2.0	Oil storage system	2.0
Feed water for boiler in open circuit system	1.5	Refrigerating plant coolant system	0.3
Feed water for boiler in closed circuit system	0.5	Fresh water system	0.8
Blow-off (for boiler) system	1.5	Seawater system	3.0
Compressed air system	1.0	Brine system for refrigerated chamber	2.0
Hydraulic oil system	0.3		

Corrosion Allowance *C* for Nonferrous Metal Pipes, in mm

Table 2.2.3.5 (2)

Pipe Materials	C (mm)
Copper, brass and similar alloys, copper-tin alloys (except lead content)	0.8
Copper-nickel alloys (with Ni not less than 10%)	0.5

Note: Where the pipes used for non-corrosive media and highly corrosion-resistant special alloy pipes are employed, the corrosion allowance may be reduced, even to zero.

2.2.4 Determination of minimum wall thickness

2.2.4.1 For the carbon steel and low alloy steel pipes under internal pressure, where the minimum wall thickness calculated by the formula specified in 2.2.3.6 is less than that shown in Table 2.2.4.1 (1), Table 2.2.4.1 (2) or Table 2.2.4.1 (3), the minimum nominal thickness for the appropriate standard pipe size shown in the Tables is to be used.

External Diameter and Minimum Nominal Thickness δ for Steel Pipes, in mm

Table 2.2.4.1 (1)

External diameter <i>D</i>	Minimum Nominal Thickness δ			
	Pipes in general ^{③④⑥} ®	Air, overflow and sounding pipes for structural tanks of the unit ^{①②③④⑥⑦}	Bilge, ballast and general seawater pipes, steam heating coil inside liquid tanks ^{①③④⑤⑥⑦}	Bilge, air, overflow and sounding pipes through ballast and fuel tanks, ballast lines through fuel tanks and fuel lines through ballast tanks ^{①②③④⑤⑥⑦}
10.2~12	1.6			
13.5~19.3	1.8			
20	2.0			
21.3~25	2.0		3.2	
26.9~33.7	2.0		3.2	

External diameter <i>D</i>	Minimum Nominal Thickness δ			
	Pipes in general ^{③④⑥} ®	Air, overflow and sounding pipes for structural tanks of the unit ^{①②③④⑥⑦}	Bilge, ballast and general seawater pipes, steam heating coil inside liquid tanks ^{①③④⑤⑥⑦}	Bilge, air, overflow and sounding pipes through ballast and fuel tanks, ballast lines through fuel tanks and fuel lines through ballast tanks ^{①②③④⑤⑥⑦}
38~44.5	2.0	4.5	3.6	6.3
48.3	2.3	4.5	3.6	6.3
51~63.5	2.3	4.5	4.0	6.3
70	2.6	4.5	4.0	6.3
76.1~82.5	2.6	4.5	4.5	6.3
88.9~108	2.9	4.5	4.5	7.1
114.3~127	3.2	4.5	4.5	8.0
133~139.7	3.6	4.5	4.5	8.0
152.4~168.3	4.0	4.5	4.5	8.8
177.8	4.5	5.0	5.0	8.8
193.7	4.5	5.4	5.4	8.8
219.1	4.5	5.9	5.9	8.8
244.5~273	5.0	6.3	6.3	8.8
298.5~368	5.6	6.3	6.3	8.8
406.4~457	6.3	6.3	6.3	8.8

- Notes: ① For pipes and their connectors efficiently protected against corrosion like coating or lining, the minimum wall thickness may be reduced by an amount up to not more than 1 mm;
- ② For sounding pipes, except those for tanks with oil having a flash point less than 60°C, the minimum wall thickness is intended to apply to the part outside the tank;
- ③ For threaded pipes, where allowed, the minimum wall thickness is to be measured at the bottom of the thread;
- ④ The external diameters and thicknesses have been selected from ISO Recommendations R 336 for welded and seamless steel pipes. For pipes covered by other standards, slightly less thickness may be accepted;
- ⑤ The minimum wall thickness for bilge lines and ballast lines through deep tanks will be subject to special consideration by CCS. The minimum wall thickness for ballast lines through oil storage tanks is not to be less than that specified in Table 3.1.9.6 of Chapter 3;
- ⑥ For the minimum wall thickness of pipes having an external diameter more than 457 mm, reference is made to national or international standards, but the minimum thickness is to be in any case not less than that specified in Table 2.2.4.1 (1) for pipes having an external diameter of 406.4 ~ 457 mm;
- ⑦ In general, the minimum thickness listed in this Table is the nominal wall thickness and no allowance needs be made for negative tolerance and reduction in thickness due to bending;
- ⑧ The minimum wall thickness of exhaust gas pipes will be subject to special consideration.

External Diameter D and Minimum Nominal Thickness δ for Stainless Steel Pipes **Table 2.2.4.1 (2)**

External diameter of pipes (D)	Minimum nominal thickness (δ)
≤ 10	1.0
11 ~ 18	1.5
19 ~ 83	2.0
84 ~ 169	2.5
170 ~ 246	3.0
247 ~ 340	3.5
341 ~ 426	4.0
427 ~ 511	4.5
512 ~ 597	5.0

**External Diameter D and Minimum Nominal Thickness δ (in mm)
for Austenite Stainless Steel Pipes**

Table 2.2.4.1 (3)

External Diameter (D)	Minimum Nominal Thickness (δ)
10.2 ~ 17.2	1.0
21.3 ~ 48.3	1.6
60.3 ~ 88.9	2.0
114.3 ~ 168.3	2.3

219.1	2.6
273.0	2.9
323.9 ~ 406.4	3.6
>406.4	4.0
Note: Selection of external diameter and wall thickness as per national or international standards is acceptable.	

2.2.4.2 For the copper and copper alloy pipes under internal pressure, where the minimum wall thickness calculated by the formula specified in 2.2.3.6 is less than that shown in Table 2.2.4.1 (4), the minimum nominal thickness for the appropriate standard pipe size shown in the Table is to be used.

2.2.4.3 For threaded pipes, the thickness is to be measured at the root of the thread.

2.2.4.4 The minimum wall thickness of deck water discharge pipes and scupper pipes is to comply with the relevant requirements in Section 3, Chapter 3 of this PART.

2.2.4.5 The minimum wall thickness of air pipes above the weather deck is to comply with the relevant requirements of 3.5.7, Section 5, Chapter 3 of this PART.

2.2.4.6 The wall thickness of CO₂ fire-fighting steel pipes is to comply with the requirements of Table 6.9.4.1 (5) of Section 9, Chapter 6 of PART VIII.

**External Diameter and Minimum Nominal Thickness δ for
Copper and Copper Alloy Pipes, in mm**

Table 2.2.4.1 (4)

External diameter D	Minimum Nominal Thickness	
	Copper	Copper alloy
8~10	1.0	0.8
12~20	1.2	1.0
25~44.5	1.5	1.2
50~76.1	2.0	1.5
88.9~108	2.5	2.0
133~159	3.0	2.5
193.7~267	3.5	3.0
273~470	4.0	3.5
508	4.5	4.0

Notes: ① The external diameters and the thickness have been selected from ISO Standards;

② For pipes covered by other standards, slightly less thickness may be accepted.

2.2.5 Selection of Pipe Diameter

2.2.5.1 In selection of pipe diameter, consideration is to be given that the flow velocity of media is to be appropriate. Low speed is not capable of flushing the impurity inside the pipes. High speed is easily to lead to erosion.

2.2.5.2 The speed of water media inside copper pipes should not be higher than 1 m/s.

2.2.5.3 In the pipes made of the following materials, the speed of water media is generally not to be less than 1 m/s and the maximum speed is not to exceed the values listed in Table 2.2.5.3.

Speed of Water Media in Pipes of Different Materials, in m/s**Table 2.2.5.3**

Pipe Material	Speed
Galvanized steel tube	3
Aluminum-brass alloy	3
90/10 copper-nickel-iron alloy	3.5

2.2.5.4 The minimum internal diameters of bilge, sounding, air and overflow pipes are to the values listed in Table 2.2.5.4

Minimum Internal Diameter of Bilge, Sounding, Air and Overflow Pipes, in mm**Table 2.2.5.4**

Description	Internal Diameter
Bilge pipes	50
Sounding pipes	32
Air and overflow pipes	50

2.2.5.5 For the selection of internal diameter of bilge pipes, refer to the relevant requirements of 3.2.9, Section 2, Chapter 3 of this PART.

Section 3 MATERIALS

2.3.1 General requirements

The materials applied in all pipes, fittings and valves are to be suitable to media and intended service of piping.

2.3.2 Carbon and low alloy steel pipes, fittings and valves

2.3.2.1 Classes I and II pipes are to be seamless steel pipes or welded pipes fabricated in accordance with a welding procedure approved by CCS.

2.3.2.2 Forged steel pipes with longitudinal butt welds are not to be used as fuel oil pipes, oil heating coil pipes or in pressure vessels under a pressure above 0.4 MPa.

2.3.2.3 In general, carbon and carbon-manganese steel pipes, valves and fittings are not to be used for medium temperatures above 400°C. Nevertheless, they may be used for higher temperatures if their metallurgical behavior and time-dependent strength (UTS after 100000 h) are in compliance with national or international codes or standards and if such values are ensured by the steel manufacturer.

2.3.3 Copper and copper alloy pipes, fittings and valves

2.3.3.1 Copper and copper alloy pipes used in Classes I and II piping are to be seamless.

2.3.3.2 Copper and copper alloys used in Class III piping are to be manufactured and tested in accordance with the technical standards approved by CCS.

2.3.3.3 Copper and copper alloy pipes, fittings and valves are not to be used for media having a temperature above the limits in Table 2.3.3.3.

Service Temperature**Table 2.3.3.3**

Copper and aluminum brass	200°C
Copper-nickel alloy	380°C

Special bronze suitable for high temperature services	260°C
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2.3.4 Grey cast iron pipes, valves and fittings

2.3.4.1 Grey cast iron pipes, valves and fittings are in general not to be used in Class I and Class II piping systems. Grey cast iron valves and fittings may be used in Class II steam piping, but the design pressure or temperature does not exceed 1.3 MPa or 220°C respectively.

2.3.4.2 Grey cast iron pipes, fittings and valves may, in general, be accepted in Class III piping, in oil storage piping and ballast line within oil storage tanks of oil storage units, but grey cast iron is not to be used for the following:

- (1) Clean ballast lines through oil storage tanks to forward ballast tanks;
- (2) Pipes for oil piping on weather deck of units intended to store crude oil having a flash point less than or equal to 60°C;
- (3) Piping intended for conveying media having temperatures above 220°C;
- (4) Piping subjected to pressure shock, excessive stress and vibration;
- (5) Unit-side valves and fittings and sea valves;
- (6) Valves fitted on the collision bulkhead;
- (7) Boiler blow-off piping;
- (8) Pipes for steam, fire extinguishing, bilge and ballast systems;
- (9) Valves under static head fitted on the outside of fuel tank walls.

Ordinary cast iron may be accepted for pressures up to 1.6 MPa for oil pipe lines on weather decks of oil storage units, except for manifolds and their valves and fittings connected to oil handling hoses.

2.3.5 Nodular graphite cast iron pipes, fittings and valves

2.3.5.1 Ferritic nodular graphite iron castings for pipes, valves and fittings in Class II and Class III piping systems are to be made in a grade having a specified minimum elongation not less than 12% on a gauge length of $5.65\sqrt{A}$, where A is the cross-sectional area of the test piece.

2.3.5.2 Ferritic nodular graphite cast iron pipes, fittings and valves are not to be used in piping systems for conveying media having temperatures exceeding 350°C.

2.3.5.3 Where ferritic nodular graphite iron castings are used for ship-side pipes and valves, the properties of this material are to comply with the relevant requirements of CCS Rules for Materials and Welding.

2.3.5.4 Where the elongation is less than the minimum required in 2.3.5.1 of this Section, the material is to be subject to the same limitations as grey cast iron.

2.3.6 Plastic pipes

2.3.6.1 The application and location of plastic pipes on the unit are to comply with the requirements of Table 1.4.1.3 of Appendix 1 of this Chapter, and satisfy the fire protection requirements in the Table.

2.3.6.2 Plastic pipes used on units are to be selected according to their chemical composition, mechanical properties and temperature limits.

2.3.6.3 Plastic pipes are in general not to be used for media with a temperature above 60°C or below 0°C.

2.3.6.4 The design, construction, usage and test of the plastic pipes used on the unit are to comply with the relevant requirements of Appendix 1 of this Chapter.

2.3.7 Flexible hoses

2.3.7.1 Flexible hoses refer to the metallic or non-metallic short hoses of end fittings prepared for installation.

2.3.7.2 Flexible hoses may be used for permanent connection of fixed piping with machinery components, and also for temporary connection of portable equipment with piping.

2.3.7.3 The design, fabrication, usage and test of the flexible hoses on the unit are to comply with the relevant requirements of Appendix 2 of this Chapter.

Section 4 CONNECTION OF PIPING COMPONENTS

2.4.1 General requirements

2.4.1.1 Piping components are to be connected by the following means:

- (1) Welding;
- (2) Flange connection;
- (3) Threaded joint connection;
- (4) Mechanical joint (coupler) connection;
- (5) Other special connections approved by CCS.

2.4.1.2 Besides compliance with the requirements of this Section, the welding preparation and welding of pipes are to comply with the requirements of Section 9, Chapter 3 of CCS Rules for Materials and Welding.

2.4.2 Welding

2.4.2.1 Butt weld connection

- (1) Butt welds includes the butt welds between pipes and pipes, neck butt flanges (A_1 in Figure 2.4.3.2), loose flanges (A_2 in Figure 2.4.3.2) or fittings, etc;
- (2) The butt weld flanges and fittings are generally selected in accordance with the international, national or industrial standards;
- (3) The internal diameters of connected butts are to be matched each other. Pipe expander, machining, etc. could be applied but the pipe wall thickness is to be ensured not less than the design value. For connection of pipes with different wall thicknesses, the thicker pipes are to be tapered till the consistency at the butt connection;
- (4) The butt welds are to be full penetration weld type with special requirement of root quality, or the full penetration weld type with no special requirement of root quality.

2.4.2.2 Socket weld connection (see Figure 2.4.2.2 (a))

- (1) The socket weld fittings are to be of forged steel with materials compatible with the relevant piping;
- (2) The wall thickness of socket weld fittings is to comply with the requirements of 2.2.4 of this Chapter but not to be less than 1.25 times of the wall thickness of connection pipes;
- (3) The radial clearance between the internal diameter of socket weld fittings and the external diameter of connection pipes is not to exceed 0.8 mm. A gap of about 1.5 mm between the ends of pipes connected and the bottom of the socket is to be provided;
- (4) The throat dimension of the fillet weld of connection pipes with socket fittings is not to be less than the nominal wall thickness of pipes.

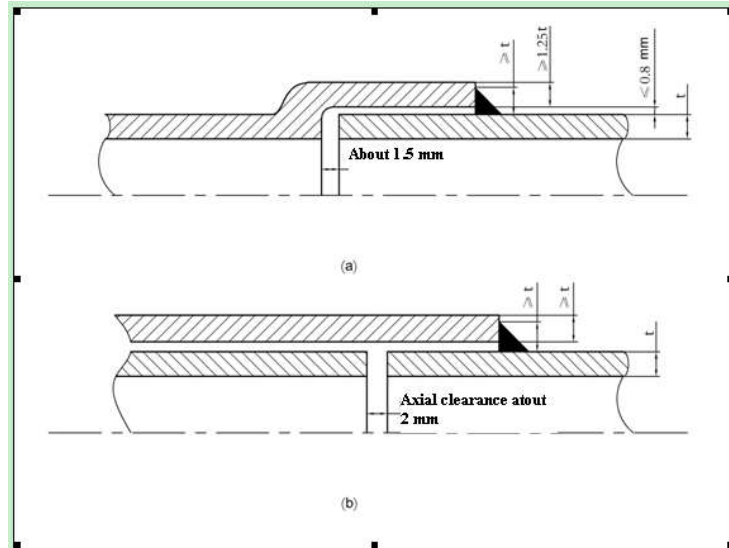


Figure 2.4.2.2 Socket Weld Connection and Sleeve Weld Connection

2.4.2.3 Slip-on (or sleeve) weld connection (see Figure 2.4.2.2 (b))

- (1) The material of sleeve is to be compatible with the relevant piping;
- (2) The wall thickness of sleeve is to comply with the requirements in 2.2.4 of the Chapter but not to be less than the wall thickness of connection pipes;
- (3) The radial clearance between the internal diameter of sleeve weld fittings and the external diameter of connection pipes is not to exceed the following values:
 - ① 1 mm, when the nominal diameter of connection pipe ≤ 50 mm;
 - ② 2 mm, when the nominal diameter of connection pipe > 50 mm but ≤ 200 mm;
 - ③ 3 mm, when the nominal diameter of connection pipe > 200 mm.
- (4) The ends of connection pipes are to be within the middle of the sleeve fittings with a radial clearance of about 2 mm;
- (5) The minimum length of sleeves is to comply with the following formula:

$$L_s = 0.14D + 36 \text{ mm}$$

Where: L_s – length of sleeve, in mm

D – external diameter of connection pipe, in mm

- (6) The throat dimension of the fillet weld of connection pipes with sleeves is not to be less than the nominal wall thickness of pipes.
- (7) Except compliance with Table 2.4.2.4, the weld joints of sleeves are not to be applied to the followings:
 - ① Bilge piping of deep tanks;
 - ② Offloading piping outside of oil storage tanks;
 - ③ Air and sounding pipes through oil storage tanks.

2.4.2.4 The application of various welds is shown in Table 2.4.2.4.

Application of Various Welds

Table 2.4.2.4

Type of connection		Suitable for classes	Suitable for external diameter
Butt welded joints	Welded butt joints with special provisions for a high quality of root side	I, II, III	No restriction
	Welded butt joints without special provisions for a high quality of root side	II, III	
Socket welded joints		III	No restriction
Slip-on welded joints		I, II, exclusive of piping conveying toxic media or causing fatigue or serious corrosion in anticipated services	$D \leq 88.9$ mm

2.4.3 Flange connection

2.4.3.1 General requirements

(1) The dimensions of flanges and their bolts are to be chosen in accordance with the national standards. For special application, the dimensions of flanges and their bolts are to be subject to special consideration.

The dimensions and shapes of gaskets are to be selected in accordance with the national or acceptable standards, and suitable to the media carried under the design pressure and design temperature.

The flange connections are to comply with the international, national or industrial standards and suitable to the piping systems, transferred fluid, design pressure and temperature conditions, external and periodic load as well as the locations.

(2) Flanges are categorized by the means of connection with pipes as weld flanges, threaded flanges (Figure 2.4.3.2 D) and loose (or lap joint) flanges (Figure 2.4.3.2 A₂, F);

(3) The approved flange connectors are shown in Figure 2.4.3.2.

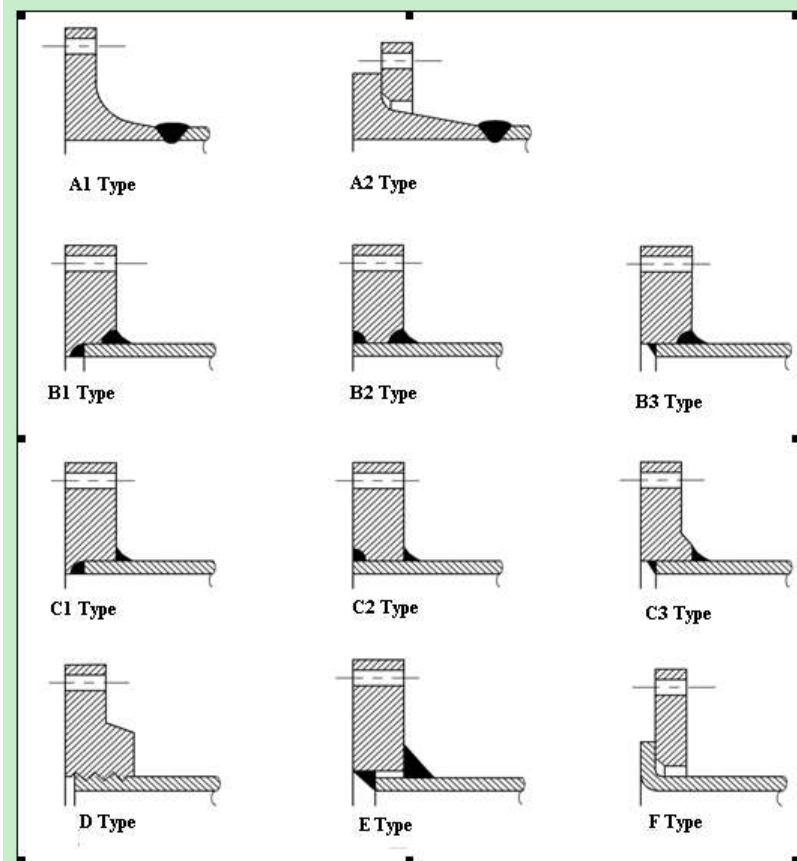


Figure 2.4.3.2 Flange Connectors of Approved Types

2.4.3.2 Welded Flanges

- (1) The butt-welded flanges are generally of full penetration weld type. When backing rings are employed in A₁ and A₂ flanges, such backing rings are to be closely fit to the pipe bore and immediately moved after welding. The ring materials are to be consistent with the pipe materials or made of low-carbon steel with sulfur content less than 0.05%;
- (2) Socket and slip-on welded flanges are not allowed to tightly fit to the pipes. The clearance between the inner surface of flange and the external diameter of pipes at any point is not allowed to exceed 3 mm, and the total radial clearance at any point not to exceed 5 mm;
- (3) In Figure 2.4.3.2, the throat dimension of weld leg of fillet weld seam and flange groove penetration is generally 1.5 times of wall thickness but not to be less than 5 mm;
- (4) Manual arc welding, inert gas protection welding and acetylene welding could be applied, but acetylene welding is generally not suitable to welding of pipes with diameter over 100 mm or wall thickness over 9.5 mm;
- (5) B and C-type flanges include hub and non-hub.

2.4.3.3 Threaded Flanges

- (1) The threads of threaded flanges (shown in Figure 2.4.3.2D) and pipes are to reduce since the end and finally vanish. The diameter of threaded pipe part is to be slightly less than that of the part with no threads. After connection and tightening of pipes and flanges, pipes are to be sleeve expanded to the flanges;
- (2) The length of threads is not to be less than 3 times of thread pitch and the diameter at the root of threads is to gradually enlarge till the diameter of thread top;
- (3) Such connections may be applied in the steam piping system with design pressure less than 3.0 MPa and design temperature less than 370°C, and also in the water feed piping system with design pressure less than 5.0 MPa.

2.4.3.4 The application and limits of various flanges are shown in Table 2.4.3.4.

Application and Limits of Various Flanges

Table 2.4.3.4

Class of piping	Toxic or corrosive media ^④ , Flammable media ^④ , LG	Lube oil, fuel oils	Steam ^⑥ and thermal oil	Other media ^{①②③}
I	A, B ^⑥	A, B	A, B ^⑥	A, B
II	A, B, C	A, B, C, E ^⑦	A, B, C, D ^⑤ , E ^⑦	
III		A, B, C, E	A, B, C, D, E	A, B, C, D, E, F ^②

Notes: ① Including water, air, other gases, hydraulic oil;

② Type F for water pipes and open ended lines only;

③ Only type A when design temperature exceeds 400°C;

④ Only type A when design pressure exceeds 1 MPa;

⑤ Types D and E are not to be used when design temperature exceeds 250°C;

⑥ Type B for pipes with external diameter < 150 mm only;

⑦ Type E for oil piping with design temperature < 150°C and design pressure < 1.6 MPa only.

2.4.4 Threaded connections

2.4.4.1 Threaded connections are only suitable to the pipes with external diameter not more than 51 mm. The threaded fittings are to comply with the international, national or industrial standards.

2.4.4.2 Threaded sleeve connection

The threaded sleeve joints in compliance with the international, national or industrial standards may be used together with carbon steel pipes, exclusive of piping conveying toxic or flammable media or causing fatigue or serious corrosion in anticipated services. The threaded joints in CO₂ systems are allowed only for protected spaces and CO₂ cylinder storage rooms. Other limits of threaded sleeve connection are shown in Table 2.4.4.2.

Conditions of Using Threaded Sleeve Connections

Table 2.4.4.2

Type of thread	External diameter of pipe (mm)		
	Class I	Class II	Class III
Tapered thread	< 33.7	< 60.3	< 60.3
Parallel thread	-	-	< 60.3

2.4.4.3 In special cases, greater external diameters may be accepted if satisfying the requirements of recognized international or national standards.

2.4.5 Olet connection

2.4.5.1 Olet is the enhancement fitting for connection of branch pipes. The typical types are shown in Figure 2.4.5.1.

2.4.5.2 Olet fittings are to be selected in accordance with the international, national or industrial standards.

2.4.5.3 Olet body is to be made of quality forged pieces and its materials are to be the same as those of pipes.

2.4.5.4 Olets are to be welded to main pipes.

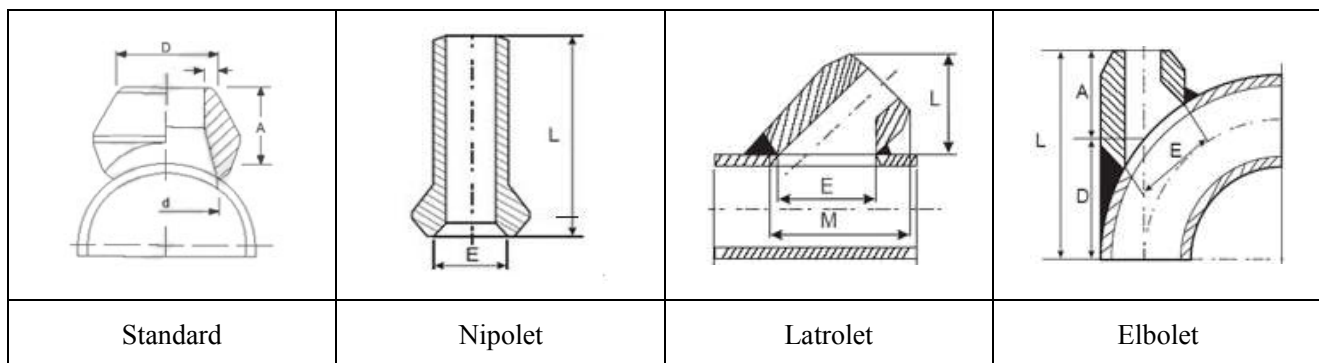


Figure 2.4.5.1 Typical Olets

2.4.5.5 The connections between olet and branch, other fitting (e.g. nipple, plug, etc.), instrument or valve may be butt welded, slip-on welded, threaded, etc.

- (1) Where the nominal diameter of branch pipe is of 50 mm or above, butt weld is generally applied;
- (2) Where the nominal diameter of branch pipe is less than 50 mm, slip-on weld is generally applied;
- (3) Where the branch pipes are connected to instruments, thread connection is generally applied.

2.4.5.6 Besides olet connection, branch pipes may be connected to pipes by other welding means, provided that the pipes are reinforced at the branch pipes by compensation plate, collar or other approved means.

2.4.6 Mechanical joint connection

The approved mechanical joints are to comply with the relevant requirements of 2.5.3 of PART III of CCS Rules for Classification of Sea-going Steel Ships.

2.4.7 Expansion joints

2.4.7.1 The piping to stand expansion, compression or other stress is to take necessary compensation measures like bending or expansion joints, etc. The expansion compensation devices and flange gaskets of oil piping and fire water piping are to be made of inflammable materials.

2.4.7.2 The expansion joints employed in piping are to be approved types. The pipes adjacent to expansion joints are to be properly aligned and fixed. Where necessary, the expansion joints of corrugated pipes are to be protected to prevent mechanical damage.

2.4.7.3 General slide-type expansion joints are employed for piping that is accessible at all time during normal service or moving navigation. The piping located at the spaces not conveniently accessible like deep tank are not be provided with slide expansion joints. But the piping in the tanks carrying the same liquid may be provided with slide expansion joints.

The slide-type expansion joints are not to be applied in the following piping:

- (1) Class I piping;
- (2) Oil piping (e.g. fuel oil, lube oil, hydraulic oil, thermal oil) of class II piping;
- (3) Steering gear hydraulic piping;
- (4) Starting air and air control piping;
- (5) Boiler water supply piping;
- (6) Fixed gas extinguishing piping;
- (7) Bilge water piping located in deep tanks and double-bottom tanks;
- (8) Oil piping (e.g. fuel oil, lube oil, hydraulic oil, thermal oil) of class III piping in the category A machinery space, accommodation space and the tunnels with no mechanical ventilation;
- (9) Piping through other tanks;

(10) Exhaust piping.

Section 5 VALVES

2.5.1 General requirements

2.5.1.1 Valves are to be designed or manufactured as per the approved national and industrial standards.

2.5.1.2 Valves are to be made of steel, cast iron, copper alloy or other approved materials and suitable to their intended services.

2.5.1.3 Valves, valve disks, valve seats and other components easily to wear are to be made of anti-corrosive materials and suitable to their intended services.

2.5.1.4 Valves are to be of such construction that the closing of which is obtained by clockwise rotation and the opening by counter-clockwise rotation.

2.5.1.5 The classes of pressure and temperature of the selected valves in piping are not to be less than those of piping. The diameters of valve and piping are to be matched each other.

2.5.1.6 The types of valves are to be suitable to their intended services.

2.5.2 Marking

2.5.2.1 The valves of essential services are to be fitted with visible nameplates indicating their services.

2.5.2.2 The hand wheels of valves of essential services are to be provided with direction indicators showing the opening and closing directions.

2.5.2.3 The valves of essential services are to be fitted with state indicators showing the opening and closing states.

2.5.3 Sealing

2.5.3.1 All valves are to be so constructed as to prevent the possibility of valve covers or glands being slackened back or loosened when the valves are operated.

2.5.3.2 Valves intended for immersion in liquid are to be suitable for both internal and external media. Spindle sealing is to withstand the maximum working pressure of internal and external media.

2.5.3.3 The sealing materials of valves are to be suitable to the media contacted.

2.5.4 Fire resistance

2.5.4.1 Where valves are required to be remotely closed in the event of fire, the valves and their control gear are to be made of steel materials or have acceptable design of fire resistance.

2.5.4.2 If valve isolation or sealing components are not fire-resistant, the valves are not to be employed in spaces where failure caused by fire could result in fire spread, flooding or the loss of essential functions of system.

2.5.5 Hydraulic test

2.5.5.1 Valves are to undergo hydraulic test before assembling and such test pressure is to be 1.5 times of design pressure.

2.5.5.2 Valves, cocks and distance pieces intended to be fitted on the unit's side below the load waterline are to be tested by hydraulic pressure not less than 0.5 MPa.

2.5.5.3 Flow test of relief valve

For the displacement pumps with relief valve, their set pressure and flow of relief valve corresponding to the maximum nominal flow of pump are to be tested.

2.5.6 Installation

2.5.6.1 Connection between valves or cocks and watertight tanks are to be secured by means of studs screwed into the pads welded on the plating, but not penetrating through the plating. Valves and cocks may also be fixed to the distance pieces welded to the plating of watertight tanks.

2.5.6.2 If valves are welded with other components, the weld necks of valves are to have sufficient length to ensure no deformation of valves due to welding and post-weld heat treatment.

2.5.6.3 The relief valves on piping are to be vertically installed at the conspicuous places.

Section 6 PIPING ARRANGEMENT AND INSTALLATION**2.6.1 General requirements**

2.6.1.1 Piping is to be arranged in order with a certain distance from the floor to facilitate maintenance and inspection. Cold and heat pipes are to be installed separately.

2.6.1.2 The easily damaged pipes are to be protected by reliable and detachable shields.

2.6.1.3 To ensure the integrity of piping, the detachable joints in piping are to be reduced to a minimum required by repair and maintenance.

2.6.1.4 The arrangement of flanges, fittings and valves in piping is to be convenient for inspection, maintenance and operation.

2.6.1.5 The design and arrangement of piping are to prevent liquid piping, especially the inlet piping of centrifugal pumps, from arising gas pocket and prevent gas piping from arising liquid pocket.

2.6.1.6 The pipes through watertight or gastight structures are to be provided with through fittings or pads. Where the pipes are fixed on watertight bulkheads by bolts, the bolts openings are not to penetrate bulkheads.

Pipes through fire-division decks or bulkheads, the arrangement is not to damage the integrity of fire-divisions.

2.6.1.7 As far as possible fresh-water pipes are to be avoided to pass through oil tanks and oil pipes are also to be avoided to pass through freshwater tanks. If not avoidable, such pipes are to pass through within watertight tunnels or sleeves. Where other pipes pass through fuel oil tanks, the wall thickness is to be increased and such pipes are not to be equipped with detachable joints.

2.6.1.8 Liquid and steam piping are to be avoided being above or adjacent to switchboards and if not avoidable, such piping is to be provided with reliable protection measures.

2.6.2 Damage protection**2.6.2.1 Requirements of damage stability**

Piping is to be avoided to provide within the assumed damage zones and if not avoidable, analysis is to be carried out. If the piping within the damage zone is broken, it will not lead to further flooding of compartments other than the damaged zone via the broken piping, such piping may be provided within the assumed damage zone.

2.6.2.2 Requirements of essential functions

Besides the requirements of damage stability, the piping serving generators and propulsion plant, ballast piping, bilge piping, bilge suctions and bilge wells are not to be arranged within the assumed damage zones so as to ensure that the essential functions of the units are not impacted by the damage.

2.6.3 Fire protection

2.6.3.1 Oil piping are not to be directly arranged above or adjacent to the heat surfaces (e.g. boilers, steam pipes, exhaust manifolds, mufflers), electrical equipment and other ignition sources and if not avoidable, measures are to be taken (e.g. no detachable joints) to prevent oil from spraying or dropping onto the heat surfaces.

2.6.3.2 The number of detachable joints in oil piping is to be kept at a minimum required by dismantling inspection.

2.6.3.3 The gaskets in oil piping and those of manholes and hand holes on oil tanks are to be made of oil-resistant and heat-resistant materials.

2.6.3.4 Oil trays are to be provided in the places where leakage may be possibly caused and discharge will be required during the operation and the leakages are to be collected to a safety place.

2.6.3.5 Oil piping is to be avoided to pass through accommodation spaces and control stations.

2.6.3.6 The oil piping is to be so arranged as to facilitate observation and adequately illuminated.

2.6.3.7 As far as practicable, components of the oil fuel system containing heated oil under pressure exceeding 0.18 MPa are not to be placed in a concealed position so that defects and leakage can be readily observed. The spaces in which such components are placed are to be adequately illuminated.

2.6.3.8 The external high pressure fuel delivery line between high pressure fuel-pumps and oil injectors are to be protected with jacketed pipes, which is capable of containing the leaked fuel due to failure of high pressure piping. Such jacketed pipes and their internal high pressure oil pipes are to constitute a fixed assembly. The jacketed piping system is to include a means for collection of leakages and arrangement is to be provided for an alarm to be given of a fuel line failure.

2.6.4 Piping installation

2.6.4.1 Pipes to be installed on equipment are to be freely aligned to prevent additional stress on the equipment.

2.6.4.2 Piping is to be adequately supported and secured. Piping is not to be supported each other and consideration is to be given to convenient maintenance, dismantling and heat expansion.

2.6.4.3 Piping flexibility is to be considered and where necessary, flexibility analysis is required to prevent possible deformation, leakage, damage and excessive additional stress thereof, etc. Piping is to be so installed to prevent vibration propagation as far as possible.

2.6.4.4 All piping systems are to be identified by designated colors.

Section 7 TEST

2.7.1 Test before installation onboard

2.7.1.1 All Classes I and II pipes and their associated fittings and, all steam pipes, feed pipes, compressed air pipes and fuel oil pipes having a design pressure greater than 0.3 MPa together with their fittings are to be hydraulically tested after completion of manufacture and before insulating or coating.

2.7.1.2 The hydraulic test pressure P_s for pipes and fittings of all materials is not to be less than that determined by the following formula:

$$P_s = 1.5p \quad \text{MPa}$$

where: p – design pressure, in MPa, see 2.2.1 of this Chapter.

2.7.1.3 For carbon and low alloy steel pipes and fittings for use in systems where the design temperature exceeds 300°C, test pressure P_s is to be determined by the following formulas.

(1) For carbon and carbon-manganese steel pipes, the test pressure P_s is to be:

$$P_s = 2p \quad \text{MPa}$$

(2) For alloy steel pipes, the test pressure P_s is not to be less than that determined by the following formula, but need not exceed $2p$:

$$P_s = 1.5 \frac{[\sigma]_{100}}{[\sigma]_t} p \quad \text{MPa}$$

Where: P – as defined in 2.7.1.2 of this Section;

$[\sigma]_{100}$ – permissible stress for 100°C, in N/mm²;

$[\sigma]_t$ – permissible stress for design temperature, in N/mm².

The test pressure may be reduced to $1.5p$ where it is necessary to avoid excessive stress in way of bends and branches. In no case is the membrane stress to exceed 90% of the yield stress at the testing temperature.

2.7.1.4 Where the hydraulic test of piping is carried out onboard, it may be carried out concurrently with the tightness test required after assembly onboard.

2.7.1.5 For pipes with an internal diameter less than 15 mm, the hydraulic test may be exempted subject to agreement by CCS.

2.7.1.6 Where, for technical reasons, it is not possible to carry out complete hydraulic testing for all sections of piping, before assembly onboard, the closing lengths of piping are to be tested, particularly in respect to closing seams.

2.7.2 Testing after assembly onboard

2.7.2.1 After assembly onboard and before commencing the test, all piping is to be flushed to remove oil residues and impurities. Oil fuel piping, lube oil piping and hydraulic piping are to be oil flushed after hydraulic test.

2.7.2.2 All piping systems are to be checked for leakage under working conditions.

2.7.2.3 For fuel oil pipes, tank heating pipes, bilge pipes passing through double-deck or deep tanks, and hydraulic pipes, hydraulic tests for welded parts on floating installation shall be carried out in accordance with Table 2.7.2.3, and for flanged pipes, tightness tests of 1.1 times design pressure shall be carried out.

Hydraulic Testing after Assembly Onboard

Table 2.7.2.3

Piping system	Test pressure
Oil fuel, lubricating oil, and other flammable oil and gas piping	1.5 times design pressure, but not less than 0.4 MPa
Heating coils in tanks	
Steam piping, feed piping, compressed air piping	
Hydraulic piping	1.5 times design pressure, but not greater than design pressure plus 7 MPa

2.7.2.4 Where Classes I and II pipes are butt welded together during assembly onboard, they are to be tested by hydraulic pressure in accordance with the requirements of 2.7.1.1 to 2.7.1.4 of this Section after welding. During installation and before the hydraulic test is carried out, the pipe lengths may be insulated, except in way of the joints.

The hydraulic test required in 2.7.2.3 of this Section may be exempted provided that non-destructive tests by ultrasonic or radiographic methods are carried out on the entire circumference of all butt welds with satisfactory results.

APPENDIX 1 PRODUCTION AND APPLICATION OF PLASTIC PIPES ON UNITS^①

1.1 Terms and definitions

- (1) Plastic(s) means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as polyvinyl chloride (PVC) and fiber reinforced plastics (FRP);
- (2) (Plastic) pipes/piping systems means those made of plastics and include the pipes, fittings, system joints, method of joining and any internal or external liners, coverings and coatings required to comply with the performance criteria.
- (3) (Plastic pipe) joints means joining pipes by adhesive bonding, laminating, welding, etc.
- (4) (Plastic) fittings means bends, elbows, fabricated branch pieces etc. of plastic materials.
- (5) (Plastic pipe) nominal pressure means the maximum permissible working pressure which is to be determined in accordance with the requirements in 1.3.1 of this Appendix.
- (6) (Plastic pipe) design pressure means the maximum working pressure which is expected under operation conditions or the highest set pressure of any safety valve or pressure relief device in the system (if fitted).
- (7) (Plastic pipe) fire endurance means the capability of piping to maintain its strength and integrity (i.e. capable of performing its intended function) for some predetermined period of time while exposed to fire.

1.2 Application

- (1) This Appendix is applicable to plastic pipes/piping systems on units.
- (2) This Appendix is not applicable to flexible pipes and hoses and mechanical couplings used in metallic piping systems.
- (3) Piping systems made of thermoplastic materials (such as polyethylene (PE), polypropylene (PP), polybutylene (PB)) and intended for non-essential services are to meet the requirements of recognized standards and 1.5 and 1.6 of this Appendix.

1.3 General requirements

The technical specification of piping is to be in accordance with a recognized national or international standard acceptable to CCS. In addition, the following requirements apply:

1.3.1 Strength

1.3.1.1 The strength of the pipes is to be determined by a hydrostatic test failure pressure of a pipe specimen under the standard conditions: atmospheric pressure equal to 0.1 MPa, relative humidity 30%, environmental and carried fluid temperature 298 K (25 °C).

1.3.1.2 The strength of fittings and joints is not to be less than that of the pipes.

1.3.1.3 The nominal pressure is to be determined from the following conditions:

(1) Internal Pressure

For an internal pressure $P_{n \text{ int}}$, the following value is to be taken, whichever is smaller:

$$P_{n \text{ int}} \leq P_{sth}/4 \text{ or } P_{n \text{ int}} \leq P_{lth}/2.5$$

Where: P_{sth} — short-term hydrostatic test failure pressure, in MPa;

P_{lth} — long-term hydrostatic test failure pressure (100,000 h), in MPa.

(2) External Pressure

For an external pressure:

$$P_{n \text{ ext}} \leq P_{col}/3$$

^① The Production and Application of Maritime Plastic Pipes is addressed by IACS according to the provisions of IMO resolution A.753 (18).

Where: P_{col} — pipe collapse pressure, in MPa.

1.3.1.4 In no case is the collapse pressure to be less than 0.3 MPa.

1.3.1.5 The maximum working external pressure is a sum of the vacuum inside the pipe and a head of liquid acting on the outside of the pipe.

1.3.1.6 The maximum permissible working pressure is to be determined with due regard for the maximum permissible working temperatures recommended by the manufacturer.

1.3.2 Axial Strength

1.3.2.1 The sum of the longitudinal stresses due to pressure, weight and other loads is not to exceed the allowable stress in the longitudinal direction.

1.3.2.2 In the case of fiber reinforced plastic pipes, the sum of the longitudinal stresses is not to exceed half of the nominal circumferential stress derived from the nominal internal pressure condition (see 1.3.1 of this Appendix)

1.3.3 Impact Resistance

1.3.3.1 Plastic pipes and joints are to have a minimum resistance to impact in accordance with recognized national or international standards.

1.3.3.2 After testing, the specimen is to be tested to a hydraulic pressure equal to 2.5 times the design pressure for at least 1 h.

1.3.4 Temperature

1.3.4.1 The permissible working temperature depending on the working pressure is to be in accordance with manufacturer's recommendations, but in each case it is to be at least 20°C lower than the minimum heat distortion temperature of the pipe material (determined according to ISO 75 method A, or equivalent).

1.3.4.2 The minimum heat distortion temperature is not to be less than 80°C.

1.4 Requirements for pipes/piping systems depending on service and/or locations

1.4.1 Fire Endurance

1.4.1.1 Pipes and their associated fittings whose integrity is essential to the safety of units are to meet the minimum fire endurance requirements of Appendix 1 or 2, as applicable, of IMO resolution A.753 (18).

1.4.1.2 Depending on the capability of a piping system to maintain its strength and integrity, there exist three different levels of fire endurance for piping systems.

(1) Level I: Piping having passed the fire endurance test specified in Appendix 1 of IMO resolution A.753 (18) for a minimum duration of one hour without loss of integrity in the dry condition is considered to meet level I fire endurance standard (L1);

(2) Level II: Piping having passed the fire endurance test specified in Appendix 1 of IMO resolution A.753 (18) for a minimum duration of 30 min in the dry condition is considered to meet level II fire endurance standard (L2);

(3) Level III: Piping having passed the fire endurance test specified in Appendix 2 of IMO resolution A.753 (18) for a minimum duration of 30 min in the wet condition is considered to meet level III fire endurance standard (L3).

1.4.1.3 Permitted use of piping depending on fire endurance, location and piping system is given in Table 1.4.1.3.

1.4.2 Flame Spread

1.4.2.1 All pipes, except those fitted on open decks and within tanks, cofferdams, pipe tunnels and ducts are to have low surface flame spread characteristics not exceeding average values listed in IMO resolution A.653 (16).

1.4.2.2 Surface flame spread characteristics are to be determined using the procedure given in IMO resolution A.653 (16) with regard to the modifications due to the curvilinear pipe surfaces as listed in Appendix 3 of IMO resolution A.753 (18).

1.4.3 Fire Protection Coatings

Where a fire protective coating of pipes and fittings is necessary for achieving the fire endurance level required, it is to meet the following requirements:

- (1) The pipes are generally to be delivered from the manufacturer with the protective coating on;
- (2) The fire protection properties of the coating are not to be diminished when exposed to salt water, oil or bilge slops. It is to be demonstrated that the coating is resistant to products likely to come into contact with the piping;
- (3) In considering fire protection coatings, such characteristics as thermal expansion, resistance against vibrations, and elasticity are to be taken into account;
- (4) The fire protection coatings are to have sufficient resistance to impact to retain their integrity.

1.4.4 Electrical conductivity

Where electrical conductivity is to be ensured, the resistance of the pipes and fittings is not to exceed $1 \times 10^5 \Omega/m$.

Fire-resistance Requirements

Table 1.4.1.3

Piping systems	Locations								
	A	B	C	D	E	F	G	H	I
	OIL with flash point $\leq 60^\circ\text{C}$								
1 Crude oil lines	NA	NA	L1	O	NA	NA	O	NA	L1 ^②
2 Crude oil washing lines	NA	NA	L1	O	NA	NA	O	NA	L1 ^②
3 Vent lines	NA	NA	NA	O	NA	NA	O	NA	×
INERT GAS									
4 Water seal effluent line	NA	NA	O ^①	O ^①	O ^①	O ^①	O ^①	NA	O
5 Scrubber effluent line	O ^①	O ^①	NA	NA	NA	O ^①	O ^①	NA	O
6 Main line	O	O	L1	NA	NA	NA	O	NA	L1 ^②
7 Distribution line	NA	NA	L1	O	NA	NA	O	NA	L1 ^②
OIL with flash point $> 60^\circ\text{C}$									
8 Base oil lines	×	×	L1	NA ^③	O	NA	O	NA	L1
9 Fuel oil lines	×	×	L1	NA ^③	O	O	O	L1	L1
10 Lubricating lines	×	×	L1	NA	NA	NA	O	L1	L1
11 Hydraulic oil lines	×	×	L1	O	O	O	O	L1	L1
SEAWATER ^①									
12 Bilge main & branches	L1	L1	L1	NA	O	O	O	NA	L1
13 Fire main & water spray	L1	L1	L1	NA	NA	O	O	×	L1

Piping systems	Locations								
	A	B	C	D	E	F	G	H	I
	Essential	Essential	Essential	Essential	Essential	Essential	Essential	Essential	Essential
14 Foam system	L1	L1	L1	NA	NA	NA	O	L1	L1
15 Automatic sprinkler system	L1	L1	L3	NA	NA	O	O	L3	L3
16 Ballast system	L3	L3	L3	NA	O	O	O	L2	L2
17 Cooling water, essential services	L3	L3	NA	NA	NA	O	O	NA	L2
18 Tank cleaning services fixed machines	NA	NA	L3	O	NA	O	O	NA	L3 [®]
19 Non-essential systems	O	O	O	NA	O	O	O	O	O
FRESH WATER									
20 Cooling water essential services	L3	L3	NA	NA	O	O	O	L3	L3
21 Condensate backwater	L3	L3	L3	NA	NA	NA	O	O	O
22 Non-essential systems	O	O	O	NA	O	O	O	O	O
SANITRAY/ DRAINAGE/ DISCHARGE									
23 Deck drainage (inside)	L1 ^④	L1 ^④	NA	NA	O	O	O	O	O
24 Sanitary drainage (inside)	O	O	NA	NA	O	O	O	O	O
25 Scupper and discharge (overboard)	O ^{①⑦}	O ^{①⑦}	O ^{①⑦}	O	O	O	O	O ^{①⑦}	O
Sounding/air									
26 Water tank/dry space	O	O	O	NA	O	O	O	O	O
27 Oil tank (flash point > 60°C)	×	×	×	× [®]	O	NA	O	×	×
Other piping systems									
28 Air piping for control	L1 ^⑤	L1 ^⑤	L1 ^⑤	NA	O	O	O	L1 ^⑤	L1 ^⑤
29 Service air pipe	O	O	O	NA	O	O	O	O	O

Piping systems	Locations								
	A	B	C	D	E	F	G	H	I
	(no-essential service)								
30 Salt water pipe	O	O	NA	NA	NA	NA	O	O	O
31 Auxiliary low pressure steam pipe (≤ 0.7 MPa)	L2	L2	O [®]	O	O	O	O	O [®]	O [®]

Notes: L1—Fire endurance test (Annex 1 of IMO resolution A.753 (18)) in dry conditions, 60 min;

L2—Fire endurance test (Annex 1 of IMO resolution A.753 (18)) in dry conditions, 30 min;

L3—Fire endurance test (Annex 2 of IMO resolution A.753 (18)) in wet conditions, 30 min;

O — No fire endurance test required;

NA— Not applicable;

× — Metallic materials having a melting point greater than 925°C.

① Where non-metallic piping is used, remotely controlled valves to be provided at ship’s side (valve is to be controlled from outside space);

② Remote closing valves to be provided at the crude oil tanks;

③ Where crude oil tanks contain flammable liquids with f.p. > 60°C, “O” may replace “NA” or “×”;

④ For drains serving only the space concerned, “O” may replace “L1”;

⑤ When controlling functions are not required in statutory requirements or guidelines, “O” may replace “L1”;

⑥ For pipe between machinery space and deck water seal, “O” may replace “L1”;

⑦ Scuppers serving open decks in positions 1 and 2, as defined in regulation 13 of the International Convention on Load Lines, 1966, are to be “×” throughout unless fitted at the upper end with the means of closing capable of being operated from a position above the freeboard deck in order to prevent down-flooding;

⑧ For essential services, such as fuel oil tank heating and unit’s whistle, “×” is to replace “O”.

Location Definition:

A — Machinery spaces of category A

Machinery spaces of category A as defined in SOLAS^① Reg. II-2/3.19;

B — Other machinery spaces and pump rooms

Spaces, other than category A machinery spaces and cargo pump rooms, containing propulsion machinery, boilers, steam and internal combustion engines, generators and major electrical machinery, pumps, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces, and trunks to such spaces;

C — Crude (cargo) oil pump rooms

Spaces containing crude oil pumps and entrances and trunks to such spaces;

D— Crude (cargo) oil tanks

Spaces containing crude oil and trunks to such spaces;

E — Oil fuel tanks

All spaces used for oil fuel and trunks to such spaces;

F — Ballast water tanks

① SOLAS 1974, as amended by the 1978 SOLAS Protocol and the 1981 and 1983 amendments thereto (consolidated text).

All spaces used for ballast water and trunks to such spaces;

G — Cofferdams, voids, etc.

Cofferdams and voids are those empty spaces between bulkheads separating two adjacent compartments;

H — Accommodation and service spaces

Accommodation spaces and service spaces as defined in Reg. II-2/3.1 and 3.45 of SOLAS 错误!未定义书签。

I - Open decks

Open deck spaces as defined in Reg. II-2/3.50 of SOLAS 错误!未定义书签。

1.5 Approval and quality control of materials during manufacturing

(1) Prototypes of pipes and fittings are to be tested to determine short-term and long-term design strength, fire endurance and low surface flame spread characteristics, electrical resistance (for electrically conductive pipes), impact resistance in accordance with the unified requirements of International Association of Classification Societies (IACS UR);

(2) For prototype testing, representative samples of pipes and fittings are to be selected to the satisfaction of CCS;

(3) The manufacturer is to have quality system that meets ISO 9000 series standards or equivalent. The quality system is to consist of elements necessary to ensure that pipes and fittings are produced with consistent and uniform mechanical and physical properties;

(4) Each pipe and fitting is to be tested by the manufacturer at a hydrostatic pressure not less than 1.5 times the nominal pressure. For the rigid plastic pipes and fittings which are fabricated as per the national or international standards accepted by CCS other than those pasted by hand, test may be carried out in accordance with the relevant requirements of hydraulic test of national or international standards, but the manufacturer is to establish an effective quality system;

(5) Pipes and fittings are to be permanently marked with identification. Identification is to include pressure ratings, the design standards that the pipe or fitting is manufactured in accordance with, and the material of which the pipe or fitting is made;

(6) If the manufacturer does not have an approved quality system which is in line with or equivalent to ISO 9000 series, pipes and fittings shall be tested in accordance with IACS UR, and each batch of pipes shall be inspected and a product certificate shall be obtained.

1.6 Installation

1.6.1 Supports

1.6.1.1 Selection and spacing of pipe supports in systems on units are to be determined as a function of allowable stresses and maximum deflection criteria. Support spacing is not to be greater than the pipe manufacturer's recommended spacing. The selection and spacing of pipe supports are to take into account pipe dimensions, mechanical and physical properties of the pipe material, mass of pipe and contained fluid, external pressure, operating temperature, thermal expansion effects, loads due to external forces, thrust forces, water hammer, vibrations, maximum accelerations to which the system may be subjected. Combination of loads is also to be considered.

1.6.1.2 Each support is to evenly distribute the load of the pipe and its contained media over the full width of the support. Measures are to be taken to minimize wear of the pipes where they contact the supports.

1.6.1.3 Heavy components in the piping system such as valves and expansion joints are to be independently supported.

1.6.2 Expansion

1.6.2.1 Suitable provision is to be made in each pipeline to allow for relative movement between pipes made of plastic and the steel structure, having due regard to:

(1) the difference in the coefficients of thermal expansion;

(2) deformations of the unit's hull and its structure.

1.6.2.2 When calculating the thermal expansions, account is to be taken of the system working temperature and the temperature at which assembly is performed.

1.6.3 External Loads

1.6.3.1 When installing the piping, allowance is to be made for temporary point loads, where applicable. Such allowances are to include at least the force exerted by a load (person) of 100 kg at mid-span on any pipe of more than 100 mm nominal outside diameter.

1.6.3.2 Besides for providing adequate robustness for all piping (including open-ended piping) a minimum wall thickness, complying with 1.3.1 of this Appendix, may be increased upon the demand of CCS taking into account the conditions encountered during service onboard units.

1.6.3.3 Pipes are to be protected from mechanical damage where necessary.

1.6.4 Strength of Connections

1.6.4.1 The strength of connections is not to be less than that of the piping system in which they are installed.

1.6.4.2 Pipes may be assembled using adhesive-bonded, welded, flanged or other joints.

1.6.4.3 Adhesives, when used for joint assembly, are to be suitable for providing a permanent seal between the pipes and fittings throughout the temperature and pressure range of the intended application.

1.6.4.4 Tightening of joints is to be performed in accordance with manufacturer's instructions.

1.6.5 Installation of conductive Pipes

1.6.5.1 In piping systems for fluids with a conductivity less than 1,000 pS/m, such as refined products and distillates, use is to be made of conductive pipes.

1.6.5.2 Regardless of the fluid being conveyed, plastic piping is to be electrically conductive if the piping passes through a hazardous area. The resistance to earth from any point in the piping system is not to exceed $1 \times 10^6 \Omega$. It is preferred that pipes and fittings be homogeneously conductive. Pipes and fittings having conductive layers are to be protected against a possibility of spark damage to the pipe wall. Satisfactory earthing is to be provided.

1.6.5.3 After completion of the installation, the resistance to earth is to be verified. Earthing wires are to be accessible for inspection.

1.6.6 Application of Fire Protection Coatings

1.6.6.1 Fire protection coatings are to be applied on the joints, where necessary for meeting the required fire endurance as for 1.4.3 of this Appendix, after performing hydrostatic pressure tests of the piping system.

1.6.6.2 The fire protection coatings are to be applied in accordance with manufacturer's recommendations, using a procedure approved in each particular case.

1.6.7 Penetration of Divisions

1.6.7.1 Where plastic pipes pass through A or B class divisions, arrangements are to be made to ensure that the fire endurance is not impaired. These arrangements are to be tested in accordance with Recommendations for fire test procedures for A, B and C bulkheads (resolution A.754 (18), as amended).

1.6.7.2 When plastic pipes pass through watertight bulkheads or decks, the watertight integrity of the bulkhead or deck is to be maintained.

1.6.7.3 If the bulkhead or deck is also a fire division and destruction by fire of plastic pipes may cause the inflow of liquid from tanks, a metallic shut-off valve operable from above the freeboard deck is to be fitted at the bulkhead or deck.

1.6.8 Control during Installation

1.6.8.1 Installation is to be in accordance with the manufacturer's guidelines.

1.6.8.2 Prior to commencing the work, joining techniques are to be approved by CCS.

1.6.8.3 The tests and examinations specified in IACS UR are to be completed before piping installation commences on units.

1.6.8.4 The personnel performing this work are to be properly qualified and certified to the satisfaction of CCS.

1.6.8.5 The procedure of making bonds is to include:

- (1) materials used;
- (2) tools and fixtures;
- (3) joint preparation requirements;
- (4) cure temperature;
- (5) dimensional requirements and tolerances;
- (6) tests acceptance criteria upon completion of the assembly.

1.6.8.6 Any change in the bonding procedure which will affect the physical and mechanical properties of the joint is to require the procedure to be re-qualified.

1.6.9 Bonding Procedure Quality Testing

1.6.9.1 A test assembly is to be fabricated in accordance with the procedure to be qualified and it is to consist of at least one pipe-to-pipe joint and one pipe-to-fitting joint.

1.6.9.2 Where the test assembly has been cured, it is to be tested to a hydraulic pressure equal to 2.5 times the design pressure for at least 1 h. No leakage or separation of joints is allowed. The test is to be conducted so that the joint is loaded in both longitudinal and circumferential directions.

1.6.9.3 Selection of the pipes used for test assembly, is to be in accordance with the following:

- (1) When the largest size to be joined is 200 mm nominal outside diameter, or smaller, the test assembly is to be the largest piping size to be joined;
- (2) Where the largest size to be joined is greater than 200 mm nominal outside diameter, the size of the test assembly is to be either 200 mm or 25% of the largest piping size to be joined, whichever is greater.

1.6.9.4 When conducting performance qualifications, each bonder and each bonding operator are to make up test assemblies, the size and number of which are to be as required above.

1.6.10 Testing after Installation onboard

1.6.10.1 Piping systems for essential services are to be tested to a pressure equal to 1.5 times the design pressure or 0.4 MPa, whichever is greater.

1.6.10.2 Piping systems for non-essential services are to be checked for leakage under operational conditions.

1.6.10.3 For piping required to be electrically conductive, earthing is to be checked and random resistance testing is to be conducted.

1.7 Test specification for plastic pipes

1.7.1 General Requirements

This Section contains requirements for the type approval of plastic pipes. It is applicable to rigid pipes, pipe joints and fittings.

1.7.2 Documentation

The following information for the plastic pipes, fittings and joints is to be submitted for consideration and approval:

- (1) General information:

-
- ① Pipe and fitting dimensions;
 - ② Maximum internal and external working pressure;
 - ③ Working temperature range;
 - ④ Intended services and installation locations;
 - ⑤ The level of fire endurance;
 - ⑥ Electrical conductivity;
 - ⑦ Intended fluids;
 - ⑧ Limits on flow rates;
 - ⑨ Serviceable life;
 - ⑩ Installation instructions;
 - ⑪ Details of marking.
- (2) Drawings and supporting documentation:
- ① Certificates and reports for relevant tests previously carried out;
 - ② Details of relevant standards;
 - ③ All relevant design drawings, catalogues, data sheets, calculations and functional descriptions;
 - ④ Fully detailed sectional assembly drawings showing pipe, fittings and pipe connections.
- (3) Materials:
- ① The resin type;
 - ② Catalyst and accelerator types, and concentration employed in the case of reinforced polyester resin pipes or hardeners where epoxy resins are employed, and mix proportion;
 - ③ A statement of all reinforcements employed where the reference number does not identify the mass per unit area or the tex number of a roving used in a filament winding process, these are to be detailed;
 - ④ Full information regarding the type of gel-coat or thermoplastic liner employed during construction, as appropriate;
 - ⑤ Cure/post-cure conditions. The cure and post-cure temperatures and times, resin/ reinforcement ratio;
 - ⑥ Winding angle and orientation.

1.7.3 Testing

1.7.3.1 Testing is to demonstrate compliance of the pipes, fittings and joints for which type approval is sought with the requirement of this Appendix.

1.7.3.2 Pipes, joints and fittings are to be tested for compliance with the requirements of standards^① acceptable to CCS 错误!未定义书签。

① As IACS Rec.86 listed

APPENDIX 2 FLEXIBLE HOSES

1.1 Definition

Flexible hose assembly^① means short length of metallic or non-metallic hose normally with prefabricated end fittings ready for installation.

1.2 Application

(1) This Appendix applies to flexible hoses of metallic or non-metallic material intended for a permanent connection between a fixed piping system and items of machinery. This Appendix may also be applied to temporary connected flexible hoses or hoses of portable equipment;

(2) Flexible hose assemblies satisfying the requirements of this Appendix may be accepted for use in oil fuel, lubricating, hydraulic and thermal oil systems, fresh water and sea water cooling systems, compressed air systems, bilge and ballast systems and Class III steam piping systems. Flexible hoses in high pressure fuel oil injection systems are not to be accepted;

(3) This Appendix is not applicable to hoses intended to be used in fixed fire extinguishing systems.

(4) The high pressure hoses used in drilling plants are to comply with the relevant requirements of CCS Guidelines for Certification of Drilling Plants or the standards accepted by CCS.

1.3 Design and fabrication

(1) Flexible hoses made of rubber materials and intended for use in bilge, ballast, compressed air, oil fuel, lubricating, hydraulic and thermal oil systems are to incorporate a single, double or more, closely woven integral wire braid or other suitable material reinforcement.

Flexible hoses of plastics materials for the same purposes, such as Teflon or Nylon, which are unable to be reinforced by incorporating closely woven integral wire braid, are to have suitable material reinforcement as far as practicable.

Where rubber or plastics materials hoses are to be used in oil supply lines to burners, the hoses are to have external wire braid protection in addition to the reinforcement mentioned above. Flexible hoses for use in steam systems are to be of metallic construction.

(2) Flexible hoses are to be equipped with approved end fittings in accordance with manufacturer's specification, and the end fittings are to comply with the requirements of this Appendix and approved by CCS. The end connections without a flange are to comply with the requirements of 2.4.6 of this Chapter as applicable and each type of hose/fitting combination is to be subject to prototype testing to the same standard as that required by the hose with particular reference to pressure and impulse tests.

^① Flexible hoses are to be designed and manufactured according to recognized national or international standards;

(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.

(4) Flexible hose assemblies intended for installation in piping systems where pressure pulses and/or high levels of vibration are expected to occur in service, are to be designed for the maximum expected impulse peak pressure and forces due to vibration. The tests required by 1.5 of this Appendix are to take into consideration the maximum anticipated in-service pressures, vibration frequencies and forces due to installation.

(5) Following flexible hose assemblies constructed of non-metallic materials are to be of fire-resistant type^①:

① used for flammable media;

② used for sea water systems where failure may result in flooding.

(6) Flexible hose assemblies are to be selected for the intended location and application taking into consideration ambient conditions, compatibility with fluids under working pressure and temperature conditions.

1.4 Installation

(1) In general, flexible hoses are to be limited to a length necessary to provide for relative movement between fixed and flexibly mounted items of machinery/equipment or systems.

(2) Flexible hose assemblies are not to be installed where they may be subjected to torsion deformation (twisting) under normal operating conditions.

(3) The number of flexible hoses, in piping systems mentioned in 1.2.2 of this Appendix is to be kept to minimum and to be limited for the purpose stated in 1.2.1.

(4) The flexible hoses used in piping systems conveying flammable fluids are to be kept away from heated surfaces, and where it is inevitable, the risk of ignition due to failure of the hose assembly and subsequent release of fluids is to be mitigated as far as practicable by the use of screens or other similar protection.

(5) Flexible hoses are to be installed in clearly visible and readily accessible locations.

(6) The use and installation of flexible hose assemblies are to be in accordance with the manufacturer's instructions and use limitations with particular attention to the following:

① orientation;

② end connection support (where necessary);

③ avoidance of hose contact that could cause rubbing and abrasion;

④ minimum bend radius.

^① Fire resistance is to be verified by the testing according to ISO 15540 and ISO 15541.

1.5 Tests

- (1) Acceptance of flexible hose assemblies is subject to satisfactory prototype testing. Prototype test programs for flexible hose assemblies and are to be in accordance with the applicable standards and submitted for approval.
- (2) The tests are, as applicable, to be carried out on different nominal diameters of hose type complete with end fittings for pressure, burst, impulse resistance and fire resistance in accordance with the requirements of the relevant standard^①.
- (3) All flexible hose assemblies are to be satisfactorily prototype burst tested to an applicable standard^② to demonstrate they are capable of withstanding a pressure not less than four times its design pressure without indication of failure or leakage. No pressure-holding period is required once the test pressure is increased to four times of the maximum working pressure.

1.6 Marking

Flexible hoses are to be permanently marked with the following details:

- (1) hose manufacturer's name or trademark;
- (2) date of manufacture (month/year);
- (3) designation type reference;
- (4) nominal diameter;
- (5) pressure rating;
- (6) temperature rating.

Where a flexible hose assembly is made up of items from different manufacturers, the components are to be clearly identified and traceable to evidence of prototype testing.

^① The following standards are to be used as applicable:

- (1) ISO 6802 – Rubber and plastics hoses and hose assemblies – Hydraulic pressure impulse test without flexing;
- (2) ISO 6803 – Rubber and plastics hoses and hose assemblies – Hydraulic pressure impulse test with flexing;
- (3) ISO 15540 – Ships and marine technology – Fire resistance of hose assemblies – Test methods;
- (4) ISO 15541 – Ships and marine technology – Fire resistance of hose assemblies – Requirements for test bench;
- (5) ISO 10380 – Pipework – Corrugated metal hoses and hose assemblies.

^② The international standards, e.g. EN or SAE for burst testing of non-metallic hoses, require the pressure to be increased until burst without any holding period at 4 x MWP.

CHAPTER 3 PUMPING SYSTEM

Section 1 GENERAL PROVISIONS

3.1.1 General requirements

3.1.1.1 The objective specified in this Section is to provide the general requirements of pumping system defined in this Chapter.

3.1.1.2 The pumping systems contained in this Chapter are generally categorized by media or purposes, including pumps, compressors (some individual systems with no pumps), piping or piping systems as well as other function equipment (e.g. vessels).

3.1.1.3 This Chapter gives provisions on systems other than fire protection system on board the unit. Refer to the provisions of PART VIII of the Rules for the requirements of fire protection systems.

3.1.1.4 The design, fabrication and survey of piping in all systems are to satisfy the requirements in Chapter 2 of this PART.

3.1.2 Air Compressors

3.1.2.1 The suctions of air compressors are to be provided in non-hazardous areas and provided with air filters to ensure no inlet of flammable gas.

3.1.2.2 The air compressors are to be provided with the facilities to separate oil and water in gas.

3.1.2.3 The air compressors are to be provided with the following safety protection arrangements:

- (1) Relief valves (each level of compressors, after cooler and oil water separation)
- (2) Low pressure alarm and shutoff of lube oil;
- (3) High and low pressure alarms of exhaust ends;
- (4) High temperature alarm of exhaust ends.

3.1.3 Pumps

3.1.3.1 Pumps are to be designed and manufactured according to accepted standards.

3.1.3.2 Hydraulic tests

All components of pumps subject to pressure are to be subject to hydraulic tests in workshop prior to assembly. The hydraulic test pressure is to be 1.5 times the design pressure, but need not exceed the design pressure plus 7 MPa.

3.1.3.3 Capacity tests

Pump capacities are to be checked with the pump operating at design conditions (rated speed and pressure head). For centrifugal pumps, the pump performance curve (head-flow rate curve) is to be verified by the Surveyor.

Capacity tests may be exempted if previous satisfactory tests have been carried out on similar pumps.

3.1.3.4 Relief valve capacity test

For positive displacement pumps with an integrated relief valve, the valve's setting and full flow capacity corresponding to the pump maximum rating is to be verified.

The flow test for relief valve capacity may be exempted if previous satisfactory tests have been carried out on similar pumps.

3.1.3.5 The outlet side of positive displacement pumps is to be provided with overflow valves. If the fluid pumped is flammable or toxic, the outlets of overflow valves are to be directed to the inlets of pumps.

3.1.3.6 The outlet side of centrifugal pumps is to be provided with check valves.

3.1.4 Separation of systems

3.1.4.1 The systems containing hazardous media are to be separated from those containing non-hazardous media.

3.1.4.2 Lube oil system is to be separated from hydraulic oil system.

3.1.4.3 Fuel oil system is to be separated from ballast system.

3.1.5 Isolation of equipment and instruments

3.1.5.1 To facilitate inspection and repair, the equipment in piping (e.g. pumps, compressors) is to be provided with isolating valves at inlets and outlets of pipes, which are to be as close as possible to the equipment. Failure or isolation of any redundancy equipment or redundancy component in the system is not to affect the normal operation of system.

3.1.5.2 Measures to isolate instruments and sensors are to be provided so that the system integrity is not damaged during replacement or repair.

3.1.6 Drainage and venting arrangements

3.1.6.1 All systems are to be provided with drainage valves or cocks on pumps, filters and other equipment and piping as required.

3.1.6.2 Vent valves are to be provided on equipment, components and piping based on the operation and maintenance needs of the system.

3.1.7 Electrostatic control

The equipment and piping located within the hazardous areas are to be reliably earthed as far as possible and their electric resistance to unit structures is not to exceed 1 M Ω .

3.1.8 Operation of valves

3.1.8.1 All valves are to be easily accessible and convenient for operation.

3.1.8.2 For the valves installed below the floor which are not easily accessible, the valve stems are to be extended to the easily accessible and operable places or provided with operable tools. Hatches and covers may be made in the floor as required. The hand wheel of sea inlet valve is to be situated not less than 450 mm above the floor.

3.1.8.3 All remote control valves are to be provided with the local manual operation devices (including extension rod manual operation devices) irrelevant with remote control facilities. Where manual operation devices are employed for opening and closing, the function of remote control system could not be affected. Local manual control of valves immersed in fluid or not easily accessible may be replaced by an extension rod or a permanent manual pump.

3.1.8.4 Each valve control position is to be provided with indicators showing whether the valve is open or shut. The indicators are to indicate on the basis of valve stem movement or its arrangement has the equivalent reliability.

3.1.8.5 The power supply failure of all remote control valves is not to render failure of the entire system.

3.1.8.6 The operation of valves provided to ensure watertight integrity at the watertight boundaries is to comply with the relevant provisions of Section 1, Chapter 4, PART III of the Rules.

3.1.9 Sea valves

3.1.9.1 Besides the requirements of this paragraph, the sea valves are to comply with the requirements of 3.1.8 of this Section.

3.1.9.2 All unit-side openings below the maximum loadline are to be provided with valves that comply with the following requirements:

- (1) All seawater inlets are to be provided with positively closing valves. The valves are to be capable of being remotely controlled from the attended control room above the damage waterline, and also being controlled by mechanical or equivalent manual pumps at proper locations above the damage waterline;
- (2) All seawater outlets are to be provided with positively closing valves and automatic check valves. Besides local control, the valves of bilge, ballast and seawater systems are to be capable of being remotely controlled from the attended control room above the damage waterline. The discharge valves installed on the side plating of side watertight compartments are to be capable of being locally controlled outside the watertight compartments by extension rods or permanent manual pumps;
- (3) The seawater inlet and outlet valves under remote control of ballast systems are to be designed as automatic shutoff in the event of failure of power supply;
- (4) The seawater inlet and outlet valves of seawater system that serves the power generators are to be designed to have the feature of automatic position keeping upon loss of power supply to the driving valve (i.e. keeping the original valve position before failure of power supply);
- (5) The sea inlet remote control valve designed as fail to set is to provide an independent secondary shutoff measure, which may be an independent remote control or mechanical control or equivalent manual pump control above the damage waterline.
- (6) Remote control fail-safe valves and fail to set valves are not to share a common sea inlet;
- (7) If the unit-side valves are provided within the attended spaces and easily accessible, the bilge water alarm arrangements may replace the remote control of valves.

3.1.9.3 The unit-side outlets above the maximum loadline and below final damage waterline are to be provided with positively closing valves and automatic check valves.

3.1.9.4 Where the water discharge pipe in spaces located above the bulkhead deck discharges through the openings on the unit-side plating, the relevant provisions of the currently valid Loadline Convention are to be complied with.

3.1.9.5 The sea valves on unit-side plating are not to use wafer type valves.

3.1.9.6 The sea valves are to be directly fixed on side plating or sea chest wall plating, and to comply with one of the following requirements:

- (1) Valves are to be secured by means of studs screwed into the pads welded on the side plating or wall plating of sea chests, but not penetrating the side or wall plating.
- (2) Valves may be installed on the distance pieces welded on the side plating or sea chest walls. The wall thickness of distance pieces is to comply with the requirements in Table 3.1.9.6. The distance pieces are to be adequately strengthened to ensure rigidity.

Wall Thickness of Distance Pieces

Table 3.1.9.6

Nominal diameter	mm	Thickness	mm
50		6.3	
100		8.6	
125		9.5	
150		11.0	
200 and over		12.5	

3.1.9.7 All inlet and outlet valves directly fixed on unit side plating are to be fitted with spigots passing through the plating. But the spigots on the valves or cocks may be exempted if these fittings are attached to pads or distance pieces which themselves from spigots in way of the side plating. Blow-off valves or cocks are also to be fitted with a protection rings through which the spigot is to pass, the ring being on the outside of the side plating.

3.1.9.8 It is to be avoided to locate the overboard discharges in way of the areas where the lifeboats are lowered. Where this is not practicable, effective means is to be provided to prevent any discharge of water into the lifeboats.

3.1.9.9 Unit side valves and fittings as well as sea chests, if made of steel, are to be suitably protected against corrosion.

3.1.10 Sea chest

3.1.10.1 Gratings are to be fitted at all openings in the sea chests. The direction of grating bars is to be in line with the length of the unit. The net area through the gratings is not to be less than twice that of the sea valve inlets in the chests, and provision is to be made for clearing the gratings by use of low pressure steam or compressed air.

3.1.10.2 Sea chests are to be so arranged as to avoid the formation of air pocket. For this purpose, one of the following measures is to be taken:

- (1) Air hole is to be provided at the side plate at the top of sea chest;
- (2) An air pipe is installed at the top of sea chest with stop valve at the root and its opening ends at the open space above the load line.

3.1.10.3 The transverse through pipe connecting two sea chests is to be provided with one isolating valve, which has the same requirements of local and remote control as the sea inlet valve.

3.1.10.4 If common sea inlet or discharge chests are provided, the design is to ensure no cross effect when different pumps are working concurrently.

3.1.10.5 Seawater for different purposes is to be taken in from at least two sea chests, the arrangement and location of which are to consider coordinated distribution on the left/right sides and at high/low positions so as to prevent blockage by ice and intake of sands.

Section 2 BILGE SYSTEM

3.2.1 Objectives

The objectives specified in this Section are:

- (1) To extract and drain possible water in each watertight compartment to ensure the unit's buoyancy and stability within an acceptable range;
- (2) To protect equipment in dry watertight compartments from immersing in water and further causing malfunctions.

3.2.2 Functional requirements

To achieve the objectives specified in this Section, the bilge system is to have the following functions:

- (1) The capacity of bilge pump is determined by drainage of the largest watertight compartment (the drainage may include unit damage flooding, failure flooding of watertight compartments adjacent to sea, piping failure flooding, fire hydrant release, water spray, failure flooding of watertight and weather-tight arrangements and, normal drainage and leakage from equipment and piping);
- (2) The bilge pumps are capable of self-priming;
- (3) The system is capable of being operated under the ambient conditions specified in 1.1.4, Chapter 1 of this PART;

- (4) Flooding in any watertight space is not to cause flooding in other spaces through bilge piping;
- (5) The arrangements of suction piping and suctions of engine rooms and pump rooms are of redundancy;
- (6) The bilge water system of hazardous area and that of non-hazardous area are mutually independent;
- (7) The slop system and bilge water system are mutually independent.

3.2.3 Installation requirements

3.2.3.1 The units are to be provided with effective bilge water system to drain water in any watertight compartment to overboard, but the tanks dedicated to carry freshwater, ballast water, oil fuel or other liquid tanks and the spaces with another effective drainage facility are to be excluded.

3.2.3.2 The bilge water system of hazardous area is to be fully independent from the bilge water system of non-hazardous area.

3.2.4 Number of bilge pumps

3.2.4.1 The unit is to be provided with at least two power bilge pumps in compliance with the displacement requirements of this Section.

3.2.4.2 For ballast pumps and general service pumps with independent power supply could be used as independent power bilge pumps, provided that such pumps have adequate capacity and are self-priming pumps or are fitted with self-priming devices and properly connected with bilge piping system.

3.2.4.3 A bilge water ejector properly connected with bilge piping system, in combination with a seawater pump of proper pressure, may be accepted as a substitute for an independent power bilge pump.

3.2.5 Type of bilge pumps

All power bilge pumps are to be of self-priming type.

3.2.6 Capacity of bilge pumps

3.2.6.1 The capacity Q of each bilge pump is not to be less than the value calculated by the following formula:

$$Q = 5.66d_1^2 \times 10^{-3} \text{ m}^3/\text{h}$$

where: d_1 – internal diameter of bilge main (upward rounding), in mm.

3.2.6.2 For spaces using fire-fighting water and water spraying, the capacity of bilge pump is to be not less than 125% of that released by fire-fighting and water spraying.

3.2.7 Dimensions of bilge pipes

3.2.7.1 The internal diameter of bilge water main is not to be less than 1.414 times of the maximum internal diameter of bilge water branches.

3.2.7.2 The internal diameter d_2 of bilge branch pipes of each compartment is not to be less than the value calculated by the following formula:

$$d_2 = 25 + 2.15\sqrt{A} \text{ mm}$$

Where: A – wetted surface in m^2 of the compartment, excluding stiffening members when the compartment is half filled with water. Where the compartment is of irregular profile, the value A is to be specially considered.

The internal diameter of any branch suction is not to be less than 50 mm.

3.2.7.3 The internal diameter of bilge pipes directly to bilge pumps is not to be less than the internal diameter of bilge main.

3.2.8 Connection of bilge pumps and bilge pipes

3.2.8.1 The connection of bilge pumps and bilge pipes is to be so arranged as to ensure at least one pump can continue its service when other bilge pumps are dismantled for inspection and repair.

3.2.8.2 All bilge suction pipes till the connection at suction valve chest of the bilge pumps are not to be connected with any other purpose piping.

3.2.8.3 For bilge pumps inside machinery spaces classified as non-hazardous areas, when the bilge water in the fore or aft compartments of the unit is being pumped, the piping of these pumps is not to pass through the crude oil tanks and may, where necessary, pass through the ballast tanks and void compartments in the cargo oil area.

3.2.9 Control of bilge pumps and relevant valves

All distribution valve chests and manual operating valves connected with bilge water pumping arrangements are generally to be fitted in easily accessible locations. If these valves are installed in the usually unattended spaces below the loadline without bilge water high-level alarm, they are to be capable of being operated from outside the compartments where the valves are located.

3.2.10 Non-return arrangement

For the purpose of preventing the possibility of one watertight compartment being placed in communication with another, or of machinery spaces or other dry compartments being placed in communication with the seawater or with tanks, screw-down non-return valves (or equivalent) are to be provided in the following fittings:

- (1) bilge water distribution valve chests;
- (2) connections of bilge suction hose fitted onto the bilge pump or the main bilge line;
- (3) direct bilge suction;
- (4) emergency suction;
- (5) bilge pump connections to main bilge line.

The remote control valve of bilge suction pipe is to be non-return valve or one check valve parallel to one non-return valve.

3.2.11 General arrangements of suction

3.2.11.1 The water in any compartment or watertight area is to be drained through at least one suction. For effective drainage, except one suction provided in short and narrow compartment, other compartments are generally to be added with suction.

3.2.11.2 The suction is to be located to make water easily flow to the suction.

3.2.12 Water discharge of machinery spaces

3.2.12.1 The bilge water discharge installation in machinery spaces are to be so arranged as to discharge water through at least two bilge water suction, with one suction being a branch suction and the other being a suction leading directly to the bilge pump, when the upright or listing angle of the floating installation is not greater than 5°.

3.2.12.3 One direct suction and one branch suction may be provided at locations as close as possible to the center line where the bottom rises to two ends at an angle of no less than 5°.

3.2.12.4 An additional branch suction is to be provided where the bottom rises to two ends at an angle of less than 5°.

3.2.12.5 Emergency suction is to be provided inside machinery spaces and connected to the pump with maximum capacity in the engine room via check valve. Emergency suction valves are to be provided with eligible permanent nameplates. Mud boxes and strainers are not to be fitted on the emergency suction lines.

3.2.13 Water discharge of cargo (crude) oil pump rooms

3.2.13.1 Cargo oil pump rooms are to be provided with special bilge pumps or ejectors for water discharge. Where cargo oil pumps or stripping pumps are used for water discharge, shut-off and check valves are to be fitted on the suction end of the bilge water piping and shut-off valve fitted between the pump suction line and bilge water valve chest.

3.2.13.2 The bilge water suction line of cargo pump room must not enter into other machinery spaces.

3.2.13.3 The discharge of bilge water in pump rooms is to comply with the relevant provisions on prevention of oil pollution. It is recommended that bilge water in pump rooms be discharged into slop tank.

3.2.13.4 Cargo oil pump tanks are to be provided with bilge water level monitoring arrangement and appropriate synchronous alarm device.

3.2.14 Water discharge of cofferdams in cargo oil area

Pumping equipment of bilge water in cofferdams are to be installed within cargo oil areas. Cargo oil pumps or stripping pumps may be used for water discharge, in which case the provisions of 3.2.13.1 are to be complied with. Bilge water ejectors may also be used for water discharge from cofferdams.

3.2.15 Water discharge of bow and stern compartments

Where bow/stern compartments are dry compartments, bilge water branch pipes and suction or effective manual pumps are to be provided for water discharge. The suction inlet of manual pumps is to be at a height no greater than 7 m from the pump.

3.2.16 Requirements on water discharge of spaces above the forepeak/afterpeak tanks and machinery spaces

3.2.16.1 Watertight compartments above the chain locker and forepeak tank are to be provided with manual pumps, or suction or other equipment connected to the power bilge tank for water discharge.

3.2.16.2 Small enclosed compartments and steering gear rooms above the afterpeak tank are to be provided with manual pumps or suction connected to the power bilge pump for water discharge. The water in these compartments may be drained into machinery spaces through drainage pipe having a diameter no less than 38 mm and self-closing cock is to be fitted at easily visible locations.

3.2.17 Bilge suction pipes through double-bottom and deep tanks

3.2.17.1 Bilge suction pipes are not to be led through double-bottom tanks if it is possible to avoid doing so. Bilge pipes which have to pass through double-bottom tanks are to have a wall thickness in accordance with Table 2.2.4.1 (1) of this PART, with no slide expansion joints.

3.2.17.2 Bilge suction pipes are not to be led through deep tanks if it is possible to avoid doing so. Bilge pipes which have to pass through deep tanks are preferably to be led through pipe tunnels. Where it is impracticable, the pipes are to have a wall thickness in accordance with Table 2.2.4.1 (1) of this PART, with welded joints or other reliable joints. The number of joints is to be kept to a minimum. The thickness of pipes made from material other than steel is to be specially considered.

3.2.17.3 Non-slide expansion joint are to be fitted to these pipes within the deep tanks. The pipes are to be tested, after installation, to a pressure not less than that required for the tanks through which they pass.

3.2.17.4 The open ends of the bilge suction pipes which pass through deep tanks are to be fitted with non-return valves of the approved type to minimize the risk of flooding.

3.2.18 Bilge fittings

3.2.18.1 In machinery space, the bilge suction are to be fitted in bilge wells. The bilge wells are to be made of steel and have a capacity not less than 0.3 m³.

3.2.18.2 Each branch bilge suction and each direct bilge suction in machinery spaces are to be led from easily accessible mud boxes fitted with straight tail pipes to the wells or bilges. Strum boxes are not to be fitted to the lower ends of these tail pipes.

The opening ends of tail pipes are to have adequate distance from the bottom plates of wells or bilges to ensure

unrestricted flow of water.

3.2.18.3 The open ends of bilge suctions in compartments other than machinery spaces are to be enclosed in strum boxes having perforations of not more than 10 mm diameter, whose combined area is not less than twice of that required for the suction pipe. The strum boxes are to be so constructed that they can be easily removed and replaced for cleaning.

3.2.18.4 Bilge valves, cocks and mud boxes are as far as possible to be fitted at, or above, the floor in machinery spaces. Where they are situated just below the floor, readily removable traps or covers are to be fitted together with nameplates indicating the presence of these fittings.

3.2.19 Void spaces

The void spaces adjacent to seawater or liquid tanks and the void spaces with through pipes carrying fluid are to have fixed bilge system or mobile facilities for drainage. If mobile pumps are used, there are to be two sets of mobile pumps and their arrangement is to be easily accessible. If the above-mentioned void spaces are not provided with bilge drainage system complying with the requirements above, the unit stability analysis and calculation are to be carried out.

3.2.20 Tunnels

The tunnel is generally to be provided with one bilge branch suction at the tail. If the fore end may have water accumulation or its length is over 35 m, the fore end is to be provided with suction additionally.

3.2.21 High-level alarm

3.2.21.1 Normally unattended engine rooms and pump rooms below the waterline are to be provided with high water level alarm devices.

3.2.21.2 Where the compartments adjacent to liquid tanks, seawater boundary or compartments through which liquid piping passes through are not provided with suctions to drain the water into other compartments having drainage capacity, water level monitoring devices are to be fitted in these compartments.

3.2.22 Pollution prevention

The installation of bilge system is to comply with the relevant regulations in MARPOL Annex I.

Section 3 OPEN DRAIN SYSTEM

3.3.1 Application

3.3.1.1 The open drain system in this Section includes:

- (1) Open drain of weather deck area;
- (2) Open drain of bilge water of enclosed spaces;
- (3) Open drain of oil trays around storage tanks, vessels or other equipment;
- (4) Open drain of sanitary water (sewage water) of enclosed accommodation space.

3.3.1.2 The open drain of crude oil processing system is to comply with the relevant provisions of this Section and CCS Rules for Classification of Offshore Oil and Gas Process System.

3.3.2 Objectives

The objectives specified in this Section are:

- (1) To prevent weather deck from accumulating water;
- (2) To prevent enclosed spaces from accumulating water;
- (3) To collect leaked oil that may cause fire;

- (4) To collect leaked fluids that may cause pollution;
- (5) To drain sewage water in a harmless way.

3.3.3 Functional requirements

To achieve the objectives specified in this Section, the open drain system is to have the following functions:

- (1) Draining the unpolluted fluid and oil-free rain water overboard easily;
- (2) Collecting oily rain water;
- (3) Collecting slop liquid drained during normal service or repair and leading the same to the safe containment places;
- (4) Providing oil trays at the places with possibility of oil leakage and overflow, and collecting the leakage and overflow and leading the same to the safe containment places;
- (5) Draining toxic fluid to dedicated collection vessels;
- (6) Collecting sanitary water and discharging overboard after treatment to compliance with discharge standards;
- (7) Preventing gas communication among spaces through sanitary drain system;
- (8) Preventing flammable gas escape from hazardous areas to non-hazardous areas or from highly hazardous areas to less hazardous areas through open drain system.

3.3.4 Separation of system

3.3.4.1 The open drain system of hazardous area is to be separated from open drain system of non-hazardous area. Piping is to be separately arranged but one common open drain tank (sump) may be applied, but all inlet pipes toward this tank (sump) are to be provided with water seals in way of the tank. The ends of inlet pipes are to be extended below the minimum liquid level of the drain tank.

3.3.4.2 The open drain system collecting sulfide is to be independently arranged.

3.3.4.3 The sanitary drain system is to be independently arranged.

3.3.4.4 The slop oil through blow-down valves of storage tanks, vessels or equipment may be directly discharged to slop tanks.

3.3.4.5 The leakage collection system of helicopter refueling plant is to be independently arranged.

3.3.5 Drain outlets

The drain outlets are to be located at the lowest points of oil trays, floors and decks to prevent accumulation of leaked fluid, wash water or rain in oil trays or on floors. The drain outlets are to be provided with gratings or pore plates.

3.3.6 Piping

3.3.6.1 The bends and other flow restrictions in piping are to be minimized.

3.3.6.2 The installation gradient toward the drain direction of drain piping is generally not to be less than 10 mm/m.

3.3.7 Water seals

3.3.7.1 To prevent communication between hazardous area and non-hazardous area, the height of water seals is not to be less than 300 mm; the height of other water seals is not to be less than 150 mm; the sanitary drain system is to have water seals of proper height.

3.3.7.2 Non-return valves are not to be used to replace water seals.

3.3.8 Open drain of weather deck area

3.3.8.1 The water on weather decks of superstructures and deck houses may be directly drained overboard or to the main deck.

3.3.8.2 Water drainage of modules on the main deck

(1) The water drained from various skids in hazardous areas and that drained from various skids in non-hazardous areas are to be respectively directed into the open drain tanks via their respective headers.

(2) The water outside the skids on deck may be directly drained to the main deck.

3.3.8.3 The oil-free rain water on the main deck may also be directly drained overboard through the discharge outlets. The discharge outlets are to be provided with valves or rubber plugs for closing or plugging the discharge pipe outlets in the event of oil overflow on the deck.

3.3.8.4 The oily water on the main deck is to be collected and drained to the open drain tank.

3.3.8.5 The water on the helicopter deck may be collected by the fire stopping gutters surrounding the deck and directly drained overboard.

3.3.9 Open drain tanks

(1) The capacity of open drain tank is to be capable of accommodating at least 10 min rainfall with the rate of 25 mm/h;

(2) The open drain tanks are to be provided with high/low level indicators and alarms;

(3) The vent pipe outlets of open drain tanks are to be led to a safe location;

(4) The oily water may be discharged overboard only after being treated to compliance with the discharge standards of MARPOL Annex I.

3.3.10 Open drain within enclosed spaces of accommodation area

3.3.10.1 All sanitary water and sewage water in the accommodation area are to be collected and may be discharged into the sea only after being treated to compliance with the requirements of MARPOL Annex IV, but the bathroom water may be directly bypassed to sea.

3.3.10.2 Each scupper in the accommodation area should be provided with water seals to prevent the odor from spreading to the said area.

Section 4 BALLAST SYSTEM

3.4.1 Objectives

The objectives of ballast system provided are:

(1) To adjust the unit's trim, listing, draught and gravity center to maintain good stability and maneuverability and to suit the environmental conditions;

(2) To satisfy the needs of oil loading and offloading and damage conditions of the unit.

3.4.2 Functional requirements

To achieve the objectives specified in this Section, the ballast system is to have the following functions:

(1) The ballast system has the capacity in line with the oil loading and offloading rate;

(2) The ballast system possesses redundancy feature;

(3) The ballast system possesses failure protection feature;

(4) The ballast system is capable of operating under the assumed flooding conditions;

(5) The ballast system is capable of being remotely and locally controlled;

(6) The ballast system has good corrosion resistance.

3.4.3 General provisions

3.4.3.1 The capacity and location of the ballast tank is to be so designed as to ensure that as the crude oil storage tank is being fully offloaded or partially loaded, the draught and trim of the floating installation can meet the stability requirements, the maximum trimming requirements for the operation of production equipment and the minimum fore draught requirements in order to protect the floating installation's bottom from suffering impact.

3.4.3.2 The ballast system is to be designed taking into account the following particulars of the floating installation:

(1) The frequency of oil offloading and ballasting operations on a floating installation is much higher than that on an oil tanker engaged in trade, and the pumps are susceptible to quicker wear;

(2) Pitch and trimming of the floating installation must be taken into account considering that offshore oil offloading and ballasting operations are different from those operations at the terminal;

(3) Where the failure of pumps will seriously affect the production, the reliability and redundancy of pumps are to be highlighted during design;

(4) In view of the fact that floating installation cannot be docked in a long term and that onsite maintenance and repair are difficult, corrosion resistant materials of high grades are to be selected, and the sea chest is to be designed taking into account easy blockage of the sea chest to facilitate repair of the valves fitted on the inner side of the hull;

(5) The vents of the ballast tank are to be designed to ensure they are free of the risks of being blocked.

3.4.3.3 The ballast water system is to be so arranged as to ensure that an individual failure or malfunction in the system cannot result in the loss of control over the ballast water in the tank of the entire system. The pumps, piping and control systems in the ballast system are not to be arranged within the specified damage zones.

3.4.3.4 Where the ballast tank exceeds 35 m in length, suction are to be provided both at the front end and at the rear end, as far as possible.

3.4.3.5 The ballast piping system is to be arranged to prevent the water overboard or water in the ballast tank from entering other compartments.

3.4.3.6 The ballast piping system for ballast tanks and double-bottom tanks located within the cargo oil area is to be mutually independent of system for ballast tanks located outside the cargo oil area.

3.4.3.7 Where the afterpeak tank (when the accommodation area is on the fore part) or the forepeak tank (when the accommodation area is on the aft part) located outside the cargo oil area is connected with the ballast system within the cargo oil area, such afterpeak or forepeak tank is to be considered as a hazardous area. All openings of such tank are to be led to an open deck and kept away from ignition sources. The concentration of flammable gas inside the tank is also to be capable of being measured on the open deck.

3.4.3.8 The ballast tank is to be:

(1) provided with level telemetry devices in addition to manual measuring means;

(2) provided with gas sampling tube;

(3) provided with heating apparatus and temperature telemetry devices as needed.

3.4.3.9 The ballast water sea valves and sea chests are to comply with the relevant requirements in Section 1 of this Chapter.

3.4.4 Ballast pump of ballast system in cargo oil areas

3.4.4.1 At least two ballast pumps with independent drives are to be provided and the failure of either pump is not to affect the operation of the other pump. Consideration is to be given to arranging the ballast pumps in different compartments, such that the unaffected pump in the other compartment will be operable in case one compartment sustains any flooding, fire or other damage.

3.4.4.2 The output of each ballast pump is to be consistent with the rate at which the crude oil is loaded to the shuttle tankers, and be capable of meeting the requirements of 3.4.3.1 of this Section during oil offloading operation.

3.4.4.3 Ballast pumps are to be self-priming, except where it has been proven to be unnecessary for the intended service. Centrifugal pumps with water self-filling system may be considered as self-priming pumps.

3.4.4.4 Ballast pumps are to be arranged at appropriate locations within the cargo oil areas or inside the cargo oil pump rooms.

3.4.4.5 When a ballast pump is arranged inside the cargo oil pump room, its seawater inlet is to be completely separated from that of the cargo oil pump.

3.4.4.6 Ballast pumps should be fitted with vibration measuring arrangements for continuous monitoring of pump conditions.

3.4.5 Ballast water piping

3.4.5.1 Ballast piping is to be made of steel or equivalent materials. Piping passing through crude oil tanks is to be of heavy-duty steel pipe with welded or heavy-duty flange joints. The pipes within crude oil tanks are to have a wall thickness not less than the required values listed in Table 3.4.5.1 and the number of joints is to be kept to a minimum. Wall thickness of the pipes may be reduced where the pipe material is more corrosion resistant than carbon steel.

Wall Thickness of Pipes in Crude Oil Tanks

Table 3.4.5.1

External diameter of pipe mm	Pipe wall thickness mm
50	6.3
100	8.6
125	9.5
150	11.0
200 and over	12.5

3.4.5.2 The ballast pipes in crude oil tanks are to be fitted with expansion joints of bend type or bellow type where necessary. Expansion joints of slide type are not to be used.

3.4.5.3 The ballast piping may be connected via a removable spool to the crude oil piping inside the pump room for emergency discharge purpose, provided that a check valve and a shut-off valve are to be fitted on the connecting pipe of ballast piping and a shut-off valve fitted on the connecting pipe of crude oil piping.

3.4.5.4 The ballast piping is to be so arranged as to allow transfer between the ballast tanks.

3.4.5.5 Installation of elbows that may help generate air pockets on the suction line is to be avoided.

3.4.6 Valves

3.4.6.1 All valves are to be clearly marked with signs showing their functions.

3.4.6.2 The opening/closing position of the valves is to be clearly indicated at the valve control location and the indication of positions is to depend on movement of the valve stem.

3.4.6.3 Valves are to be capable of being closed by mechanical or power means. The power operation system may consist of an accumulator system supplied by at least two power units or one electrical power supply system for operating the valves. Consideration is to be given to the reliable operation of the valves under immersed conditions. Measures are to be taken to prevent and mitigate the risks of compartment flooding.

3.4.6.4 The closing speed of power operated valves is to be limited, where necessary, to prevent excessive pressure surge.

3.4.7 Control of pumps and valves

3.4.7.1 All pumps and power operated valves are to be provided with independent local control system in addition to the remote control from the central control station. Local control may also be manual control. Local control of each pump and its related tank valve are to be provided at the same location. This local control position is to be easily accessible. Where practicable, the access route is not to be arranged in the specified damage zones. The schematic diagram of the typical part of the ballast system is to be posted at each location.

3.4.7.2 The control system and indication system are to be mutually independent in terms of function or have adequate redundancy. Failure of one system is not to affect the operation of the other system.

3.4.7.3 Fail-close valves are to remain in the closing position, when the power is restored, until the operator reactivates the system control.

3.4.7.4 The remote control panel is to be provided with indicating arrangements showing the running conditions of the remotely controlled ballast pumps.

3.4.7.5 The ballast control room is to be attended at all times by qualified personnel and ballasting operations cannot be executed by unqualified personnel. The operation manual is to be readily available.

Section 5 TANK VENT SYSTEM

3.5.1 Objectives

The objectives specified in this Section are:

- (1) To prevent atmospheric liquid storage tank from damage caused by over-pressure or negative pressure;
- (2) To prevent flame from entering into air pipe of oil tanks;
- (3) To prevent seawater and rain from entering into air pipes;
- (4) To prevent fire and explosion caused by the overflow fluid from air pipes.

3.5.2 Functional requirements

To achieve the objectives specified in this Section, the air pipes are to have the following functions:

- (1) The design of air pipes is to satisfy the vent demand of served tanks;
- (2) The oil overflowed from air pipes goes to the exposed location with no fire sources;
- (3) The flammable gas out of air pipes goes to a safe location;
- (4) The liquid overflowed from air pipes does not go to the spaces required to be watertight;
- (5) Flooding of service spaces through air pipes is not incurred under the normal static, dynamic inclination and assumed damage conditions;
- (6) Outside fire is not capable of igniting the stored oil via air pipes.

3.5.3 Installation

3.5.3.1 All atmospheric liquid storage tanks, cofferdam void spaces and tunnels are to be provided with air pipes.

3.5.3.2 The oil tanks storing oils having a flash point no higher than 60°C under atmospheric conditions are to be provided with venting arrangements (breathing valves).

3.5.3.3 For the venting of crude oil storage tanks, refer to the relevant provisions in Section 2, Chapter 4 of this PART.

3.5.4 Arrangement

3.5.4.1 Air pipes are to be led out from the highest point of the tanks.

3.5.4.2 The outlets of air pipes from the tanks are to be far from the filling inlets.

3.5.4.3 For the tanks having top plates not less than 7 m either in length or in width and the tanks of unusual or irregular profile, the number and positions of the air pipes may be decided on a case-by-case basis and subject to approval by CCS.

3.5.4.4 Tanks with cathodic protection are to have air pipes fitted forward and aft.

3.5.4.5 The location and arrangement of air pipes of fuel oil service, settling and lube oil tanks are to be such that, in the event of a broken vent pipe, the ingress of rainwater or seawater is to be avoided.

3.5.4.6 The arrangement of the air pipes is to be such that the tanks situated in other watertight compartments of the unit cannot be flooded by seawater through the air header in the event of any tank being damaged and flooded.

3.5.5 Termination

3.5.5.1 The air pipes of oil storage tanks and the adjacent cofferdam void spaces above these tanks are to be terminated at the exposed safe locations (where hazards will not be induced due to oil spillage or oil gas) above the damage waterline.

3.5.5.2 The air pipes of tanks outside machinery spaces with no overflow pipes and filled by pumps are to terminate at the exposed locations above the damage waterline.

3.5.5.3 Air pipes from fuel oil draining tanks (which cannot be pumped up) with a volume less than 0.5 m³ may terminate in the machinery space, provided that the open ends are so situated that the spilled oil cannot come into contact with electrical equipment or heated surfaces.

3.5.5.4 The air pipes terminating at the weather deck are to be provided with measures to prevent entry of rain and seawater.

3.5.5.5 The openings of air pipes are to be provided with permanently attached and satisfactory means of closing.

3.5.5.6 Where the closing appliances are not of an automatic type, provision is to be made for relieving vacuum when the tanks are being pumped out.

3.5.5.7 Air pipes which will be inaccessible when the deck cargo is carried are to be provided with automatic closing appliances.

3.5.6 Flow area

3.5.6.1 In the case of all tanks which can be pumped up, the total cross-sectional area of the air pipes to each tank is not to be less than 1.25 times of the effective area of the respective filling pipes. In any case, the internal diameter of air pipes is not to be less than 50 mm.

3.5.6.2 Where overflow pipes are fitted, the cross-sectional area of the air pipes is to be at least 1.2 times of that of the filling pipes. When an air pipe serves several tanks all having overflow pipes as specified in Section 6 of this Chapter, the cross-sectional area of the air pipe is to be at least 20% of the combined area of the two largest filling pipes for the separate tanks.

3.5.6.3 Air pipes for pipe tunnels are to have an internal diameter not less than 75 mm.

3.5.6.4 For the units navigating in ice region, the cross-sectional area of air pipes is to be properly enlarged.

3.5.7 Wall thickness

3.5.7.1 Where tanks form a part of the structure of the unit, the wall thickness of air pipes is to comply with Table 2.2.4.1 (1) of this PART.

3.5.7.2 The minimum wall thickness of air pipes on weather decks is not to be less the value specified in Table 3.5.7.2:

Air Pipes on Weather Decks

Table 3.5.7.2

External Diameter of Pipes	Wall Thickness
Pipes of 80 mm external diameter or smaller	6.0 mm
Pipes of 160 mm external diameter or greater	8.5 mm
Intermediate values	may be determined by linear interpolation

3.5.8 Height above decks

The height of air pipes extending from the open deck to the point where water may have access is not to be less than 760 mm on the freeboard deck and not less than 450 mm on the deck above freeboard deck. The pipe is to be solid.

3.5.9 Flameproof wire gauze

3.5.9.1 For oil tanks and other tanks possibly generating flammable gas, the outlets of air pipes are to be provided with corrosion-resistant and easily replaceable flameproof wire gauze.

3.5.9.2 The wire gauze diaphragm is to have a clear area not less than the cross-sectional area required for the air pipe.

3.5.9.3 For the requirements on flame arrestor at the vent outlet of crude oil tanks, see the relevant provisions in Section 3 of Chapter 3.

3.5.10 Bug screen

3.5.10.1 The freshwater tanks and other tanks with high requirement of cleanness for stored fluid are to be provided with bug screen.

3.5.10.2 The bug screen is to have a clear area not less than the flow area required for the air pipe.

3.5.11 Nameplates

Air pipes are to be provided with nameplates.

3.5.12 Materials

Air pipes are to be made of steel or other approved materials.

3.5.13 Dedication

Air pipes are dedicated to venting and not to be used as sounding pipes.

3.5.14 Watertight and weathertight requirements

Refer to the relevant provisions of Chapter 4 PART III of the Rules for the watertight and weathertight requirements of air pipes.

Section 6 OVERFLOW SYSTEM

3.6.1 Objectives

The objectives specified in this Section are:

- (1) To prevent hazards resulting from the fluid overflowing from air pipes after the tanks are fully filled;
- (2) To prevent water entry via overflow pipes assuming the unit is damaged.

3.6.2 Functional requirements

To achieve the objectives specified in this Section, the overflow piping is to have the following functions:

- (1) The design of overflow pipes is to satisfy the demand of overflow of the served tanks;
- (2) The fluid from overflow pipes is not to cause contamination;
- (3) In the event of assumed damage of unit, other watertight compartments of the unit could not be flooded through the overflow pipes.

3.6.3 Installation

All tanks which can be pumped up are to be fitted with high level alarms and overflow pipes, where the pressure head corresponding to the height of the air pipe is greater than the pressure that the tanks can withstand, or where the cross-sectional area of the air pipe is less than that required in 3.5.6 of this Chapter.

3.6.4 Flow area

The flow area of overflow pipe is not to be less than 1.25 times that of the filling pipe.

3.6.5 Arrangement

3.6.5.1 In the case of oil and toxic fluid tanks, the overflow pipes are to be led to the respective collection tanks of adequate capacity.

3.6.5.2 Overflow fluid with no recycling value and not causing contamination may be directly discharged into sea.

3.6.5.3 Shut-off valves or cocks are not to be fitted to the overflow pipes.

3.6.5.4 A well illuminated sight glass is to be provided in the overflow pipe at an easily visible position on the vertical section of the pipe. Alternatively, as an equivalent means, an alarm device may be provided to give warning either when the tanks are overflowing or when the oil reaches a predetermined level in the tanks.

3.6.5.5 The arrangement of the overflow pipes is to be such that tanks situated in other watertight compartments of the unit cannot be flooded by the seawater through the overflow main in the event of any tank being damaged and flooded.

3.6.6 Equivalent measures

To achieve the objectives specified in this Section, the tanks may be provided with high level alarm and devices to stop the filling to replace the overflow pipes with the consent of CCS.

Section 7 SOUNDING SYSTEM

3.7.1 Objectives

The objectives specified in this Section are:

- (1) To detect the storage volume of liquid and bulk tanks;
- (2) To detect the level of bilge wells not easily accessible;
- (3) To detect any fluid ingress into the watertight void spaces.

3.7.2 Functional requirements

To achieve the objectives specified in this Section, the sounding system is to have the following functions:

- (1) All liquid and bulk tanks are to be provided with liquid (bulk) level indicators or sounding pipes;
- (2) The oil tanks that carry flammable oil with flash point not higher than 60°C are to be provided with closed sounding devices of approved types; the approved-type closed sounding devices may replace the level indicators and sounding pipes;

(3) The tanks provided with a remote level indicating system, a manual sounding system is to be provided.

3.7.3 Installation

3.7.3.1 Sounding pipes are to be provided for all tanks, cofferdam void spaces and pipe tunnels as well as the bilges or bilge wells which are not at all times readily accessible. The piping arrangements are to facilitate manual sounding.

3.7.3.2 Level indicators may be used to replace sounding pipes but such indicators are to be of flat glass type and the use of cylindrical gauge glasses is prohibited. The valves used for level indicators are to be of self-closing type.

3.7.3.3 Remote control sounding devices may be applied to replace the sounding pipes of tanks. After installation on the unit, the sounding devices are to be qualified through test.

3.7.4 Arrangement

3.7.4.1 All sounding pipes are generally to be led to positions above the bulkhead deck which are readily accessible.

3.7.4.2 The sounding pipes are to be fitted as close as possible to the suction.

3.7.4.3 In order to prevent ingress of seawater into the tanks via the sounding pipe, all sounding pipes susceptible to possible water ingress are to be provided with permanently attached effective means of closing.

3.7.4.4 The bottom plating under open-ended sounding pipes is to be protected by striking plates of adequate thickness and size.

3.7.5 Sizes of sounding pipes

The internal diameter of sounding pipes is not to be less than 32 mm. For sounding pipes of heavy fuel oil tanks and those in excess of 20 m in length, the minimum internal diameter is not to be less than 50 mm. The internal diameter of all sounding pipes, which pass through spaces in which the temperatures contemplated are 0°C or below, are to be not less than 65 mm.

3.7.6 Level sounding of crude storage tanks

For sounding and monitoring of liquid level in crude storage tanks, refer to the relevant provisions in Section 1, Chapter 4 of PART FOUR.

Section 8 DIESEL SYSTEM

3.8.1 Objectives

The objectives specified in this Section are:

- (1) To provide suitable fuel oil for combustion equipment;
- (2) To provide suitable oil for chemical systems;
- (3) To provide suitable oil for well workover, flushing and displacement operations;
- (4) To take measures to prevent fuel supply to fires.

3.8.2 Functional requirements

To achieve the objectives specified in this Section, the diesel oil system is to have the following functions:

- (1) The system is capable of continuously supplying oil to combustion equipment;
- (2) The system is provided with low-pressure alarm;
- (3) The system is capable of purifying diesel oil;

- (4) The system is capable of preventing oil leakage;
- (5) The system is capable of collecting leaked oil;
- (6) The high pressure spraying piping is provided with anti-leakage spray protection.

3.8.3 Quality of diesel fuel

3.8.3.1 Diesel fuel users mainly include main turbo generator, main diesel generator of reciprocating type, reciprocating emergency diesel generator, reciprocating diesel fire pumps, diesel cranes and boilers.

3.8.3.2 The sulfur, sodium, potassium, lead, alkaline fluoride and chloride contained in diesel oil are corrosive to equipment, and the mercurides contained in diesel oil are corrosive to equipment made of materials containing lead, copper, aluminum and silver; calcium, magnesium and other oxides will form hard scaling on equipment; solid particles or water soluble metal compounds will aggravate the wear of critical elements. The content of these harmful components is to be limited.

3.8.3.3 Diesel fuel is to meet the user's requirements on quality. As different users having different requirements on the quality of diesel fuel, the designer of diesel fuel system is to communicate with the users' suppliers to obtain each user's specific requirements on the quality of diesel fuels.

In general, the requirements on quality of diesel fuel for turbo generators are as follows:

- (1) Fuel supply temperature is to be within the range of 0~60°C;
- (2) Viscosity of diesel at fuel supply temperature is to be within the range of 2.0~7.5 cSt;
- (3) Volumetric water content is to be less than 0.05%;
- (4) Vanadium content is to be less than 1 mg/L;
- (5) Sodium/potassium content is to be less than 1 mg/L;
- (6) Calcium content is to be less than 1 mg/L;
- (7) Zero lead content;
- (8) Sulfur content must be less than 0.5% (mass fraction);
- (9) Dust content must be less than 0.01% (mass fraction);
- (10) Pour point temperature of diesel is to be at least 5.6°C lower than fuel supply temperature.

In general, the requirements on the quality of diesel fuel for reciprocating generators are as follows:

- (1) API gravity is to be at least 30;
- (2) Cetane number is to be greater than 40;
- (3) Sulfur content is to be 0.5% at maximum;
- (4) Viscosity at 37.8°C is to be within the range of 1.5 ~ 7cSt;
- (5) Moisture content is to be less than 0.1%;
- (6) Pour point temperature must be 5.6°C lower than the ambient temperature;
- (7) Dust content must be 0.02% at maximum;
- (8) Distillation curve is to be of: an evaporate rate greater than 10% at 232°C; an evaporate rate of 50% at 246 ~ 288°C; a maximum evaporation rate of 90% at 357°C; and a final boiling point of 385°C.

3.8.3.4 In order to prevent air pollution, the quality of diesel fuel is also to comply with the requirements on sulfur content and nitrides emission as specified in Annex VI of MARPOL.

3.8.4 Flash point of diesel oil

3.8.4.1 The flash point (closed-cup test) of diesel fuels for combustion equipment and other users is, in general, to be not less than 60°C; for the prime movers of emergency generating sets, the flash point of diesel used is not to be less than 43°C.

3.8.4.2 For units of restricted services, where special precautions are taken so that the ambient temperature of the space in which diesel fuels are stored or used will be controlled at a value 10°C below the flash point of the diesel, the use of diesel fuels having a flash point of less than 60°C but not less than 43°C may be permitted.

3.8.4.3 Use of natural gas or crude oil as fuel is to comply with the requirements of Section 9 of this Chapter.

3.8.5 Diesel fuel pumps

3.8.5.1 Where a diesel fuel feed pump for diesel engine is fitted, one main feed pump of sufficient capacity and independent power drive and one standby pump are to be provided. Where two or more engines are fitted with each having its own supply pump, only one immediately available standby pump or supply pumps on mutual standby may be accepted, provided that the capacity of each pump is sufficient to satisfy the concurrent demand of two engines.

3.8.5.2 Diesel fuel transfer pumps, diesel fuel delivery pumps, diesel fuel booster pumps and oil sprayer cooling pumps, etc. are to be provided with main pumps and standby pumps.

3.8.5.3 In addition to the local controls, the power supply to all independently driven diesel fuel transfer pumps, diesel fuel delivery pumps, diesel fuel feed pumps of combustion equipment, diesel fuel booster pumps, oil separators and other pumps in the diesel fuel systems is to be capable of being stopped upon emergency from a readily accessible position outside the spaces in which the pumps are situated.

3.8.6 Diesel fuel tanks

3.8.6.1 The structure and arrangement of diesel fuel tanks are to comply with the relevant requirements of 1.2.2, Chapter 1 of this PART.

3.8.6.2 The volume of diesel storage tanks is to be designed taking into account the total daily consumption by all users on board the unit and the maximum diesel delivery interval of the supply ships, with an additional allowance of at least 20%.

3.8.6.3 Daily service fuel tanks

(1) The daily service tanks only refer to the fuel tanks carrying quality diesel fuel ready for immediate service, i.e. the grade and quality of the diesel fuel in the tanks comply with the specifications required by the equipment manufacturer.

(2) In general, one daily service diesel fuel tank is to be provided for each diesel user, and one daily service tank may be shared provided that such tank can satisfy the demands of quality and daily consumption.

(3) Two daily service diesel fuel tanks or equivalent arrangements are to be provided for each kind of diesel indispensable to the power generation and essential systems. The daily service diesel fuel tanks are to be arranged such that one tank can continue to supply diesel fuel while the other is under cleaning or repair. Each daily service tank is to have a capacity sufficient to work continuously for 8 h under normal operating loads.

3.8.6.4 Settling tanks

Settling tanks are to be provided with means for draining water. If settling tanks are not provided, the diesel storage tanks or daily service tanks are to be fitted with means of water drainage.

3.8.6.5 Drain valves or cocks fitted on all diesel fuel tanks are to be of self-closing type and led to the slop tanks. The sampling valves or cocks on the tanks are also to be of self-closing type.

3.8.6.6 The fire prevention and separation arrangements of oil tanks are to comply with the relevant requirements of 1.2.2 and 1.2.6 of this PART.

3.8.7 Valves on diesel fuel tanks

3.8.7.1 Diesel fuel pipe, which, if damaged, will cause the diesel to escape from a tank (including but not limited to storage tank, settling tank or service tank) situated above the double bottom, is to be provided with a cock or valve directly fitted on the tank. Besides local control, this cock or valve is to be capable of being remotely closed at the easily accessible location outside the space where such cock or valve is situated. Oil inlet pipe may be provided with an automatic non-return valve to replace stop valve. The oil tanks with capacity less than 500 L may be exempted from this requirement.

3.8.7.2 The remote stop valves are to be capable of being closed by manual mechanical drive or power driven (e.g. hydraulic, pneumatic or electric). If power drive is applied, the power supply is to be reliable and provided outside the space where the valve is situated. The valves and the closing devices within the space are to be made of fire resistant material.

3.8.7.3 The installation of valves on oil tanks is to comply with the requirements of 2.5.6 of this PART.

3.8.7.4 The remote shut-off controls and locations of diesel fuel valves for emergency generators and diesel fuel fire pumps are to be separated from the remote shutoff controls of other valves.

3.8.7.5 If the required stop valves are located within shaft tunnels, pipe tunnels or similar spaces, their closing may also be controlled by additional valves fitted on the pipes outside the shaft tunnels, pipe tunnels or similar spaces. If such additional valves are installed in machinery spaces, they are to be capable of being closed from a location outside the machinery spaces.

3.8.7.6 Other flammable oil tanks are also to comply with the requirements of this subsection.

3.8.8 Diesel fuel piping

3.8.8.1 Diesel fuel piping is to be separated from other piping.

3.8.8.2 Diesel fuel pipes, fittings and their valves are to be made of steel or other equivalent materials. Nodular graphite cast iron may be used for valves fitted on the diesel fuel tanks and subject to static head. In addition, ordinary cast iron valves may be used in diesel fuel piping system with design pressure of less than 0.7 MPa and design temperature of less than 60°C.

3.8.8.3 The filling piping on the floating installation is to comply with the following requirements:

(1) Fuel filling is to be effected by means of permanently installed lines. The filling pipes are to be extended into the tank to a position as close as possible to the bottom.

(2) Filling piping is to be fitted with flow meters and over-pressure protection devices. Any relief valve fitted for over-pressure protection is to discharge to an overflow tank or other safe position.

(3) The filling piping is to be designed such that the diesel in the storage tanks on the floating installation can be transferred to the supply ship.

(4) Filling hose is to have good flexibility and good resistance to pressure and oil.

(5) Where filling stations are fitted on board the unit, they are to be isolated from other spaces and are to be efficiently drained and ventilated. Filling stations are to be so arranged that filling can be performed safely from both sides of the unit.

3.8.8.4 Every oil fuel suction pipe from a double-bottom tank is to be fitted with a valve or cock.

3.8.8.5 The short joining lengths of pipes to the burners from the control valves at the boiler may have threaded cone unions of robust construction.

3.8.8.6 Flexible hoses may be used for the burner pipes, provided that sufficient spare lengths, complete with couplings, are to be carried on board. The flexible hoses are to comply with the relevant requirements in Chapter 2 of this PART.

3.8.8.7 The fire prevention requirements of the piping are to comply with the requirements of 2.6.3 of this PART.

3.8.9 Oil supply of generators

The two or more engine installation using the same oil supply are to be provided with the arrangements to separate oil supply and overflow piping of each engine. Such separation arrangements are not to affect operation of other engines and may be operated from the locations that will not be inaccessible due to fire of any engine. The shutoff arrangements are to be capable of being manually closed reliably.

3.8.10 Oil supply of boilers

3.8.10.1 The boiler is to be provided with at least two sets of diesel fuel supply arrangements, with each set generally including one pressure pump.

3.8.10.2 The burner arrangements are to be such that a burner could not be withdrawn unless the diesel fuel supply to that burner is shut out, and oil could not be supplied until the burner is correctly connected with the oil supply pipe.

3.8.10.3 A quick-closing master valve is to be fitted on each boiler diesel supply line and suitably located so that the valve can be readily operated in an emergency or remotely controlled from an appropriate location.

3.8.10.4 Reliable measures are to be provided (e.g. two stop valves in series) to prevent diesel fuel from leaking into the boiler after diesel fuel supply is shut off.

3.8.10.5 Provision is to be made, by suitable non-return arrangements, to prevent diesel oil from flowing to the burners from spill systems when the diesel supply to these burners has been shut off.

3.8.10.6 Boiler furnace alternately using diesel fuel and exhaust gases is to comply with the requirements of 3.18.3.3 of this Chapter.

3.8.10.7 The combustion control and safety system of periodically unattended boilers are to comply with the relevant requirements in PART VI.

3.8.11 Purification of diesel oil

3.8.11.1 The floating installation is to be provided with diesel fuel purification system as required to remove the water and harmful impurity in the diesel fuel.

During operation of the centrifugal oil separator, a proper amount of freshwater may be added to facilitate removal of harmful elements in the diesel oil such as sodium, potassium, calcium, etc.

3.8.11.2 At least two sets of diesel oil purification systems are to be provided with each having a capacity sufficient to accommodate the maximum continuous load of the engines; failure of either system is not to affect the normal operation of the other system.

For the light diesel fuel, only one purification system may be installed as required.

3.8.11.3 If the diesel fuel purification system needs to be heated, each system is to be equipped with heaters where each set of heaters is to satisfy the demands of purification system.

3.8.12 Filter

3.8.12.1 The fuel oil supply piping of each user is to be installed with diesel fuel filters and their arrangements are to ensure continuous supply of filtered diesel fuel when filters are being cleaned. For this purpose, duplex filters are generally to be installed.

3.8.12.2 The arrangement of duplex filters is to minimize the possibility of filter opening due to maloperation under pressure. The filters/filter chambers are to be provided with appropriate measures for ventilation when they are put into operation and relief of pressure before opening. Hence, the discharge valves and pipes to safe locations are to be provided.

3.8.12.3 The suction line in front of diesel transfer pumps should be fitted with small filters (e.g. "Y" type filter) and the discharge line of diesel transfer pumps fitted with coalescence filter.

3.8.12.4 Pressure differential monitoring devices are to be installed before and after the filters.

3.8.13 Heating of diesel oil

3.8.13.1 Whether heating and heat tracing of diesel oil is required is to be determined based on the ambient temperature and the users' demands. Where heating is selected, the maximum temperature of the heated diesel oils is to be at least 10°C lower than their flash points.

3.8.13.2 Where steam or hot water is used for heating, the condensate water or return water after heating is to be directed to a special condensate inspection tank which is adequately illuminated. The condensate inspection tank is to be arranged such that any signs of oil in the condensate or return water can be easily observed.

3.8.13.3 Where electric heaters are used, means are to be provided to ensure that all heating elements are always immersed in oil when they are energized.

3.8.14 Changeover of diesel fuel

The combustion system of diesel engines burning heavy diesel is to be fitted with the arrangement for immediate changeover to light diesel.

3.8.15 Application of diesel oil with flash point lower than 60°C but not lower than 43°C

3.8.15.1 The oil storage tanks other than double-bottom tanks are not to be located within category A machinery spaces.

3.8.15.2 The suction side of pumps is to be provided with temperature measurement devices.

3.8.15.3 Stop valves are to be provided at the inlet and outlet sides of fuel strainers.

3.8.15.4 Pipe joints are to be either welded or spherical type union joints.

3.8.16 Installation of oil leakage collection and oil trays

The installation of oil leakage collection and oil trays in the system is to comply with the requirements of 1.2.2 and 2.6.3 of this PART respectively.

3.8.17 Galley ranges

3.8.17.1 The diesel fuel tank is to be located outside the galley and is to be fitted with safe means of filling and venting.

3.8.17.2 The fuel supply to the burners is to be capable of being controlled from a readily accessible position in the event of a fire occurring in the galley.

3.8.17.3 The galley is to be well ventilated.

Section 9 Natural Gas and Crude Oil Fuel Systems

3.9.1 Objective

The objective specified in this Section is to provide suitable natural gas or crude oil fuel to combustion equipment and reduce the probability of explosion.

3.9.2 Functional requirements

To achieve the objective specified in this Section, the natural gas and crude oil fuel systems are to have the following functions:

- (1) The system is capable of continuously providing the combustion equipment with suitable fuel;
- (2) The system is capable of cutting off fuel supply in the event of leakage, fire or ventilation failure;
- (3) The fuel piping is independent from other piping and provided with reliable leakage prevention measures;
- (4) The storage and carriage equipment of natural gas and crude oil are installed within hazardous areas;
- (5) Natural gas or crude oil is suitable as fuel for combustion equipment and is capable of being burned completely and ensuring stable operation of the equipment.

3.9.3 Natural gas system

3.9.3.1 Arrangements of fuel gas supply

- (1) Natural gas taken directly from production process is to be properly dried to meet the requirements of fuel gas, and the extracted oil and water are to be led to the closed discharge system;
- (2) Each combustion equipment is to be fitted with independent fuel gas supply line and each line is to be fitted with a master control valve, which is to be fitted in the hazardous area; the master control valve is to be automatically closed in the following conditions in addition to the remote control in attended control room:

- ① Loss of pressure or detection of flammable gas in the annular space of double-wall fuel pipes;
- ② Failure of ventilation or detection of flammable gas in the ventilation ducts where the fuel pipes are located;
- ③ Detection of flammable gas or fire in the spaces where combustion equipment is located.

(3) The line between master control valves and combustion equipment is to be fitted with a double block and one bleed device, which is composed of three automatic control valves, two of which are connected in series with gas supply line enabling the gas supply to be shut off. Another valve is to be fitted on the vent pipe in between the two series valves with the vent outlet led to a safe location.

The location and arrangement of two block valves are to be such that the pipe sections within the space where the combustion equipment is located could be vented.

The valves are to be arranged such that under the conditions described in 3.9.3.1 (2) and in the event of failure of air supply to boiler combustion, flameout in boilers and abnormal pressure of fuel supply, the two valves in series will be automatically closed and the vent valve automatically opened in the meanwhile. Alternatively, the function of one of the two valves in series may be incorporated with the valve on the vent line into one valve body (three-way valve), which is so arranged that when one of the above conditions occurs, fuel supply can be shut off and the vent opened. All these valves are to be provided with manual reset.

The double block and one bleed device is to be remotely controlled in the control room. Alarm is to be given in the control room for action of these valves.

(4) The fuel pipe sections between the master control valves and combustion equipment are to be provided with measures for flammable gas freeing and inerting.

3.9.3.2 The sections of fuel pipes prior to the space where combustion equipment is situated are to be located in open areas and special safety measures are to be taken for the sections through enclosed non-hazardous areas.

Fuel pipes are to be made of seamless heavy steel tubes with full penetrating butt weld. All weld seams are to be fully radiographed and heavy flanges are to be adopted for flange connection. Such pipes are to be noticeably marked according to proper color standards.

3.9.3.3 The space where the combustion equipment is located is to comply with the following requirements unless the measures in 3.9.3.4 are taken:

- (1) The combustion equipment is to be fitted on the weather deck with ambient protection enclosure. The body part of boiler may be directly arranged on weather decks and only the front parts are to be shielded;
- (2) The enclosure is to be designed to prevent entry of seawater and rain and to meet the Class A-0 fire division standard;
- (3) The enclosure of internal combustion engine is to be separate from that of power generator. The space within the enclosure is only for installation of the internal combustion engine and its necessary equipment;
- (4) For boilers, only the burner control unit may be fitted inside the enclosure;
- (5) The ventilation air changes inside the enclosure are to be at least 30 times/h. The ventilators are to be qualified as an explosion proof type. All equipment inside the enclosure is to be suitable for use in hazardous zone of Category 2;
- (6) If the equipment inside the enclosure is not capable of meeting the requirements of hazardous zone of Category 2 or the surface temperature exceeds 80% of ignition point of fuel or 280°C (if the ignition point is unknown), the ventilation air changes inside the enclosure is to be at least 90 times/h to turn the space inside the enclosure into a non-hazardous area; besides primary ventilator, the standby ventilator of the same capacity is to be provided for ventilation inside the enclosure. Where the primary ventilator fails, alarm is to be given in the attended control room and the standby ventilator is to be automatically put into operation. The ventilators are to be qualified as an explosion proof type;
- (7) The arrangement of ventilation is to ensure good circulating air inside the enclosure to prevent any dead pocket;

- (8) Measures are to be taken for air pre-purging of not less than 5 times/h of the air inside the enclosure before the combustion equipment is started; when the combustion equipment stops, ventilation is to be stopped with an appropriate time lag to ensure no hazardous high temperature inside the enclosure;
- (9) Flammable gas and fire detection devices are to be provided inside the enclosure;
- (10) The fire-fighting equipment inside and outside the enclosure is to comply with the requirements in 6.12.7 of PART VIII;
- (11) The working pressure of fuel pipes is not to be higher than 1 MPa and if it is over 1 MPa, the requirements of 3.9.3.4 (1) of this Section are to be complied with; the design pressure of fuel pipes is to be at least 50% higher than the working pressure and not less than 1 MPa.

3.9.3.4 Fuel line arrangement within machinery spaces

(1) Fuel line arrangement within the machinery spaces is to comply with one of the following requirements:

- ① Fuel supplied through a double wall piping with the fuel contained in the inner pipe. The space between the concentric pipes is to be pressurized with inert gas at a pressure greater than the fuel pressure. Once fuel exists in the inner pipe, the inert gas pressure is always to be higher than the inner pipe fuel pressure and alarm is to be given in the attended control room in the event of inert gas pressure failure;
- ② The fuel line is to be installed within a gas-tight duct equipped with mechanical ventilation having a capacity of at least 30 air changes per hour. This ventilation capacity can be reduced to 10 air changes per hour provided that automatic nitrogen filling of the duct upon detection of flammable gas in the duct is arranged for. The fan is to be an explosion proof type. The fan prime mover is to be placed outside the ventilated duct if it is not an explosion proof type. The duct ventilation inlet arrangement is to prevent suction of flammable gas and the outlet is to lead to a safe location. When fuel exists in the pipes, the duct fans are to be kept continuously operating. Flammable gas detectors are to be provided in the duct.

(2) Each combustion equipment is to be fitted with a suitable enclosure that accommodates as much as possible the burners and associated valves and pipes, but without restricting the air flow to the burner regulators. The enclosure is to be installed to ensure the ventilation air sweeps across the enclosed detachable pipe joints, valves and combustion control units. Necessary gastight inspection holes are to be provided to allow inspection of piping joints and valves.

3.9.4 Crude fuel system

3.9.4.1 Crude oil is to be processed to meet the quality requirements for the combustion equipment used.

3.9.4.2 Where the crude oil tanks are heated, the temperature is to be automatically controlled and high temperature alarm and shutoff devices are to be arranged.

Where electric heating is applied, measures are to be taken to ensure the electric heating components are always immersed.

Where crude oil is heated by steam or hot water, the outlet of the heating coils is to be led to a separate observation tank. The tank is to be provided in a hazardous area and fitted with a vent pipe to lead the gas to a safe position. Suitable flameproof wire gauze is to be fitted on the vent outlet.

3.9.4.3 Measures are to be taken to prevent the system from waxing.

3.9.4.4 The outlet side of the oil supply pump is to be provided with pressure relief valve so that the released fluid is led to the pump inlet side. The pump is to be capable of being remotely controlled near the combustion equipment and in the control room in addition to local control.

3.9.4.5 The system is to be provided with a tray or gutterway of suitable height to collect the leak from pumps, filters, burners, valves and pipe joints. The oil tray or gutterway is to be provided with drain pipes to discharge oil to independent closed collection tanks, whose vent outlets are to lead to a safe location and provided with flame screens.

3.9.4.6 Measures are to be taken to detect oil leakage for system.

3.9.4.7 The fuel piping is to be installed with an inclination rising toward the combustion equipment. In the event of leakage, oil is to return to the collecting arrangement outside the machinery space.

3.9.4.8 The boiler oil supply line is to comply with the requirements of 3.9.3.1 (3) of this Section but the double block and one bleed device is to be turned into double block and one drainage device.

3.9.4.9 Measures are to be taken for change over between crude oil and diesel oil.

3.9.4.10 Requirements of 3.9.3.1 (2), 3.9.3.2, 3.9.3.3 and 3.9.3.4 of this Section are to be complied with.

Section 10 HELICOPTER REFUELING SYSTEM

3.10.1 Objective

The objective specified in this Section is to safely transfer fuel to the helicopters on the unit.

3.10.2 Functional Requirements

To achieve the objective specified in this Section, the helicopter oil replenishment system is to have the following functions:

- (1) The system design is to satisfy the demand of helicopter oil replenishment;
- (2) The system design is to minimize the hazard of fire and explosion.

3.10.3 Detail requirements of helicopter refueling system

Refer to the relevant provisions of Section 4, Chapter 7 of PART IX of the Rules for the detailed requirements on helicopter refueling system.

Section 11 LUBE OIL SYSTEM

3.11.1 Objective

The objective specified in this Section is to provide safe and suitable lubrication to the equipment on the unit that need lubrication.

3.11.2 Functional requirements

To achieve the objective specified in this Section, the lubrication system is to have the following functions:

- (1) The design capabilities of the system are to comply with all kinds of equipment lubrication and the essential components are to be capable of being lubricated by redundant means;
- (2) The lube oil is to have suitable quality;
- (3) The equipment performance, piping design and arrangement are to be suitable to the intended services and to meet requirements of fire protection;
- (4) The system is to have two levels of protection of alarm and safety.

3.11.3 Lube oil pumps

3.11.3.1 Main engines and their gear assemblies are to be provided with a main lubricating oil pump of sufficient capacity to maintain supply of lubricating oil at the maximum continuous output of the machinery and a standby pump of sufficient capacity to supply lubricating oil for normal operation of the unit. The standby pump is to be of independently power-driven type and to be connected ready for use.

For units fitted with more than one main engine, only one independently power-driven standby pump fitted is acceptable. Where each main engine is fitted with a built-in lubricating oil pump, a complete spare pump available for installation and connection may be accepted as an independently power-driven standby pump.

3.11.3.2 Where power generators and essential auxiliary engines are provided with standby engine, and each engine with its transmission gear are fitted with a built-in lubricating oil pump, the standby pump may be dispensed with. If two or more auxiliary engines are connected to a common lubricating oil system, a standby pump is to be provided.

3.11.4 Lube oil tanks

3.11.4.1 All units are to be provided with lube oil storage tanks with suitable capacity.

3.11.4.2 The setting of valves on tanks and the requirements of quick closing valves are to comply with the requirements of 3.8.7 of this Chapter. If designer confirms mishandling of remote closing valves on lube oil tanks will endanger the operation safety of engines, remote closing devices may be exempted.

3.11.4.3 Settling tanks are to be provided with means for draining water. Drain and sample valves/cocks are to be of self-closing type.

3.11.4.4 The fire prevention arrangements and separation arrangements of oil tanks are to comply with the relevant requirements of 1.2.2 and 1.2.6 of this PART respectively.

3.11.5 Piping system

3.11.5.1 The lube oil piping system is to be separated from other piping systems. The engines and gearboxes should not share a common lube oil system.

3.11.5.2 The lube oil piping system is to be provided with visible and audible alarm devices where the lube oil pressure apparently drops as well as emergency stop device in the event of loss of lube oil pressure.

3.11.5.3 Purification, filtering and heating of lube oil are to comply with the relevant requirements in 3.8.11, 3.8.12 and 3.8.13 of this Chapter respectively.

Section 12 HYDRAULIC SYSTEM

3.12.1 Objective

The objective specified in this Section is to provide safe and qualified hydraulic source for the hydraulic users on the unit.

3.12.2 Functional requirements

To achieve the objective specified in this Section, the hydraulic system is to have the following functions:

- (1) The design capacity of system is to satisfy the demand of all hydraulic users;
- (2) The hydraulic oil is to have qualified quality;
- (3) The equipment performance, piping design and arrangement are to be suitable to the intended services and fire protection requirements;
- (4) The system is to be effectively controlled and protected.

3.12.3 Pumps

The power oil pumps in the essential hydraulic transmission system are to be provided with standby pumps that are capable of being quickly changed over.

3.12.4 Piping system

3.12.4.1 The hydraulic piping system is not to be used for the lubrication of any equipment other than this piping system.

3.12.4.2 The strength of hydraulic pipes and fittings is to be sufficient to withstand the maximum surge pressure that might occur in the piping system.

3.12.4.3 The piping system is to be provided with measures to prevent pressure pulse and the fluid is to be kept in the laminar flow state.

3.12.4.4 Relief valves are to be provided in the hydraulic piping systems. The discharge from the relief valves is in general to be led to the hydraulic fluid tanks.

3.12.4.5 Provision is to be made for de-aeration in the hydraulic piping systems and the hydraulic fluid cylinders, etc. The hydraulic piping system is to be so arranged as to avoid the formation of air pockets.

3.12.4.6 Where hydraulic accumulators are provided in the hydraulic systems, relief valves are to be fitted on the fluid inlet side. For hydro-pneumatic accumulators, safety valves or fusible plugs are to be fitted on the gas side, otherwise they are to be fitted in the piping.

3.12.4.7 The pipes and equipment continued to be used in the event of fire are to be fire-resistant type.

3.12.4.8 Under severe conditions, the hydraulic return piping is to have maximum design return volume. Special attention is given to avoid blockage at filters or vent pipes as well as the blockage caused by mechanical damage or mishandling of valves.

3.12.4.9 The air pipes on circulating tanks and expansion tanks are to be led to a safe location.

3.12.4.10 Pipes are to be flushed and cleaned before use.

3.12.4.11 Hydraulic remote control valves for essential service are to be capable of being operated with a hand pump in emergency condition, and indicators showing whether the valves are open or closed are to be provided at their operating positions.

3.12.4.12 Use of flexible hoses is to comply with the relevant requirements of 2.3.7 of this PART. The flexible hoses are to be so arranged that abrupt bends and twisting are avoided and that they are to be far away from vibration and heat sources.

3.12.4.13 The hydraulic piping system is to be provided with filters and comply with the relevant requirements of 3.8.12 of this PART.

3.12.5 Materials

3.12.5.1 All components in the hydraulic transmission piping systems are to be made of materials which are not corrodible and have no chemical reaction with the hydraulic fluid.

3.12.5.2 The hydraulic fluid is to be of high chemical stability and of good viscosity-temperature property.

3.12.5.3 The main functioning components in the hydraulic power transmission system are generally to be made of steel materials. The tests of materials are to be carried out as per the requirements in CCS Rules for Materials and Welding.

3.12.6 Hydraulic fluid

The performance of hydraulic fluid is to comply with the requirements of ambient temperature of services and is not chemically corrosive to the system components. Its flash point is not to be less than 60°C.

3.12.7 Arrangement

The arrangement of high pressure hydraulic components is to comply with the requirements of 1.2.2.8 of this PART.

Section 13 THERMAL OIL SYSTEM

3.13.1 Objectives:

The objectives specified in this Section are:

- (1) To provide heating energy to the units;
- (2) To prevent the system from fire and explosion.

3.13.2 Functional requirements

To achieve the objectives specified in this Section, the thermal oil system is to have the following functions:

- (1) The design capacity of system is to satisfy the intended heating demand;
- (2) The quality of thermal oil is to satisfy heat transmission and safety during transmission process;
- (3) The equipment performance, piping design and arrangements are suitable to the intended services and to meet fire and explosion protection requirements;
- (4) The system is to be effectively controlled and protected;
- (5) The system is to have reliable tightness to minimize the possibility of occurrence of fire (e.g. boiler pipe damage fire, major leakage fire, insulation fire) and explosion;
- (6) The furnace and heater room are provided with fire extinguishing apparatus.

3.13.3 Definitions

3.13.3.1 Thermal oil temperature: the thermal oil temperature of the center of flow section of thermal oil;

3.13.3.2 Thermal oil film temperature: the temperature of the oil film on the pipe wall at the side of heated surface.

3.13.4 Selection of thermal oil

3.13.4.1 Thermal oil is to be produced in accordance with the international, national or industrial standards.

3.13.4.2 Thermal oil is to be free of toxicity during use.

3.13.4.3 Manufacturers are to provide the parameters of thermal oil like flash point, ignition point, film temperature, viscosity, density, thermal stability, initial boiling point, purity and cleanliness as well as the technical conditions for the use of thermal oil.

3.13.4.4 The solidifying point of thermal oil is to be below the ambient temperature of the thermal oil in storage.

3.13.4.5 Thermal oil is to be compatible with the substance being heated in the event of coming into contact with it due to leakage.

3.13.4.6 Thermal oil is to be used in liquid phase.

3.13.4.7 The service life of thermal oil should be four years but not shorter than one year at minimum.

3.13.5 Prevention of thermal oil deterioration

3.13.5.1 One of the following measures is to be taken to prevent thermal oil oxidation:

- (1) Inert sealing gas is to be provided within the expansion tank;
- (2) If the air pipes on expansion tanks are directly in contact with atmosphere, the temperature of thermal oil coming into direct contact with air is not allowed to exceed 50°C.

3.13.5.2 One of the following measures is to be taken to prevent thermal oil cracking:

- (1) Thermal oil is to be used at the maximum service temperature and permissible maximum membrane temperature as limited by the manufacturer, and a safety margin of at least 50°C is to be kept between heater outlet temperature and permissible maximum membrane temperature.
- (2) Refer to the requirements of 3.13.9.3 of this Section for the measures to ensure there is no individual high temperature point of thermal oil.

3.13.5.3 Thermal oil system is to be filtered and dehydrated before use.

3.13.5.4 Refer to the requirements of 3.13.16.2 of this Chapter for the requirements on materials that prevent thermal oil catalyzing

3.13.6 Oil assay

The frequency of thermal oil assay is to be as follows:

- (1) Generally once every year;
- (2) Once every six months when the temperature of thermal oil approaches the highest use temperature or after two years;
- (3) Once every quarter where thermal oil approaches the abandonment standard;
- (4) Assay is to be carried out immediately in case of abnormal conditions of system.

3.13.7 Reference condemnatory index of oil

Where two of the following items are not met, the thermal oil should be replaced:

- (1) Viscosity change >15%;
- (2) Carbon residue value reaches 15% or n-pentane > 15%;
- (3) Acid value > 0.5 mg KOH/g;
- (4) Flash point reduced > 20%;
- (5) Distillation range change > 20%.

3.13.8 Circulating of thermal oil

3.13.8.1 Turbulence

The flow of thermal oil in the heat exchanger is to reach the turbulence state to improve heat transmission effect.

3.13.8.2 Explosion prevention

- (1) Where thermal oil system enters the hazardous area, the surface temperature of pipes and equipment is to be lower than the spontaneous ignition point of possibly existing flammable oil gas or not higher than 200°C;
- (2) When the thermal oil temperature runs above the flashing point of thermal oil, the space where the terminal oil circulating system is situated is to be classified as a hazardous zone of Category 2 hazardous area, and the equipment inside the space are to be qualified explosion-proof equipment; the spaces that full-welding pipes go through may be regarded as non-hazardous areas;
- (3) To prevent explosive fluid (refer to the definitions in Chapter 1, PART VIII of the Rules) leak into thermal oil system, one of the following measures should be taken:
 - ① The working pressure of thermal oil system is higher than the pressure of heated media. For the heating system of atmospheric crude oil storage tanks, the inlet and outlet locations of the tank heating coils are to be provided with stop valves. When the thermal oil system is not in operation, the heating coil inlet and outlet valves are to be closed to maintain a static pressure in the coil which is always 3 m water column greater than the tank pressure;
 - ② The system is designed as double circuit heating system, i.e. the primary thermal oil heating circulating system is firstly to heat an intermediate heater, which further heats the independent secondary thermal oil circulating system. The secondary circulating system is dedicated to heating of explosive fluid.

3.13.9 Thermal oil heater

3.13.9.1 Installation

- (1) The thermal oil heater is to be installed in a separate room and arranged for easy operation, inspection and maintenance;
- (2) The thermal oil heater room is to be considered as a machinery space of category A and ventilated and protected against fire in compliance with the relevant requirements for machinery spaces of category A;
- (3) The ventilation in the thermal oil heater room is to comply with the relevant requirements of Chapter 4 of this PART;
- (4) The fire extinguishing equipment provided in the thermal oil heater room are to comply with the requirements of 6.12.16, PART VIII of the Rules.

3.13.9.2 Design pressure

The heated surface of heaters in contact with oil is to be capable of withstanding a pressure of at least 1 MPa.

3.13.9.3 Construction design

Heaters are to be so constructed that the surface will be evenly heated and individual high temperature points will not appear.

3.13.9.4 Inspection holes

Heaters are to be provided with inspection holes for examining their combustion chambers.

3.13.9.5 Control of thermal oil inlet and outlet valves

The thermal oil inlet and outlet valves are to be capable of being controlled from outside the compartment where they are situated. As an alternative, an arrangement for quick gravity drainage of the thermal oil into a collecting tank is acceptable.

3.13.9.6 Release valves

Each heater is to be provided with at least one release valve having a release capacity at least equivalent to the increased oil amount at the maximum heating power. The pressure increase is not to exceed 10% of the design pressure of the heater during pressure release.

3.13.9.7 Temperature measuring devices

- (1) Each heater is to be fitted with temperature measuring devices at thermal oil inlet and outlet and smoke outlet.
- (2) Temperature measuring and monitoring sensors are to be led into the system through submersible welded pipes.

3.13.9.8 Flow indicator

Each heater is to be fitted with a thermal oil flow indicator.

3.13.9.9 Furnace fire extinguishment

- (1) A suitable fire extinguishing system (e.g. gas fire extinguishing system) is to be provided for protecting the heater furnace. Such system is to be permanently connected to the furnace and can be controlled from outside the heater space.
- (2) Exhaust-fired heaters are to be provided with a fixed fire extinguishing and cooling system. A water spray system may be accepted for this purpose, provided that means for collecting and draining water are arranged below the heaters.

3.13.9.10 Exhaust-fired heaters are to be designed to:

- (1) avoid damage caused by resonance due to air column oscillation;
- (2) prevent oil from directly leaking into machines or superchargers;
- (3) have access holes at exhaust inlet and outlet for easy inspection and maintenance.

3.13.10 Thermal oil expansion tanks**3.13.10.1 Installation**

An expansion tank is to be situated at the highest point of the system.

3.13.10.2 Design pressure

Expansion tanks are to be designed with a pressure not less than 0.2 MPa even if they are to be used under normal atmospheric pressure.

3.13.10.3 Capacity

The expansion capacity of circulating system is to be calculated according to the thermal oil density and total circulating volume under different temperatures. The design capacity of expansion tanks is to be in compliance with the following minimum requirements:

- (1) 1.5 times of the expansion volume, where expansion tank volume is not greater than 1 m³;
- (2) 1.3 times of the expansion volume, where expansion volume is greater than 1 m³.

3.13.10.4 Venting

The vent of expansion tanks is to be led to a safe location and a flameproof wire gauze is to be fitted.

3.13.10.5 Expansion pipes

To prevent the residual water in the expansion tanks entry into the system through expansion pipes, the pipes should be extended to the location slightly higher than the bottom of tank but lower than the minimum liquid level.

3.13.10.6 Level protection

(1) Expansion tanks are to be fitted with a level indicator, high and low level alarms and a low level limit switch. Where the low level limit switch is actuated, the burner and circulating oil pump are to be shut off and interlocking means is to be provided.

(2) Expansion tanks are to be fitted with an overflow pipe.

3.13.10.7 Pressure protection

Where inert seal gas is supplied in an expansion tank, means is to be provided for indicating pressure and preventing overpressure.

3.13.10.8 Quick drainage valves

Where expansion tanks are provided in the heater room, they are to be provided with quick discharge valves to quickly discharge the thermal oil to collection tanks located in lower position in the event of any fire.

3.13.10.9 Quick closing valves

Where expansion tank is provided outside heater room, a quick closing valve is to be provided on the expansion pipes adjacent to expansion tanks to cut off fire fuel supply in the event of fire in the heater room.

3.13.11 Collection tanks (oil storage tanks)

The collection tanks to collect the thermal oil released from the release valves of heaters, thermal oil overflowing from expansion tanks and thermal oil from quick discharge are to be regularly drained to prevent hazards caused by accumulation of steam. Collection tanks are to be separately arranged in a safe location far from the exit of heater room.

Oil storage tanks, if used as collection tanks, are to comply with the requirements specified herein.

3.13.12 Pumps**3.13.12.1 Provision**

Each circulating system is to comprise at least two circulating pumps; where one of the pumps fails, the other pump is to be put into operation automatically; and the capacity of each pump is to be sufficient for all service conditions.

3.13.12.2 Provision of valves

Stop valves are to be provided at inlet and outlet side of the pump and a non-return valve is also to be provided at the outlet side of the pump.

3.13.12.3 Safe operation

- (1) A thermal oil circulating pump is to be capable of being closed outside of the space in which it is located;
- (2) Where the source of heat input for the heater is out of operation, the thermal oil circulating pump is to continue to operate until the remaining stored heat is absorbed;
- (3) Where the centrifugal pump is to be started in cold state, the viscosity of thermal oil should be lower than $300 \times 10^{-6} \text{ m}^2/\text{s}$ to prevent excessive starting resistance.

3.13.13 Separators

The inlets of pumps are to be provided with vapor/liquid separator to prevent pump depletion. The liquid and vapor chambers of separator are to be connected with the fluid and gas chambers of expansion tanks respectively.

3.13.14 Filters

Each circulating system is to be provided with at least two filters to filter the harmful impurity in the system with pressure meters fitted at the inlet and outlet sides of each filter.

3.13.15 Oil Trays

Thermal oil heaters, pumps, filters and other equipment with possibility of oil leakage are to be provided with oil trays to collect oil leak to a safe location.

3.13.16 Piping materials

3.13.16.1 Pipes, fittings, flanges, valves and other components in thermal oil piping are to be made of steel or equivalent ductile material.

3.13.16.2 Use of nonferrous metals (e.g. copper and copper alloy) having catalytic action on the thermal oil is to be avoided. The materials of equipment in thermal oil system are to be in compliance with the requirements of this paragraph.

3.13.17 Pipe connections

3.13.17.1 Thermal oil piping is to have welded connections except that flanges may be used to the minimum number necessary for inspection and maintenance. Screw joints are not allowed for thermal oil piping.

3.13.17.2 To strengthen piping tightness, flanges, valves and other sealing components with a higher pressure grade than the design pressure are to be selected.

3.13.17.3 Suitable devices are to be provided for avoiding splash of liquids from detachable joints. Drip trays are to be installed where leakage is likely to occur and led to a safe location.

3.13.17.4 Thermal oil piping is to be provided with compensators or expansion joints.

3.13.18 Sampling device

Piping is to be fitted with a thermal oil sampling device having its sampling position at discharge end of pumps.

3.13.19 Heat insulation

3.13.19.1 Thermal oil heaters and piping are to be provided with heat insulation, but flanges are not to be covered by the insulation material. All insulation surfaces are to be protected with stainless steel, galvanized steel or aluminum plating.

3.13.19.2 Insulation materials are to be closed-cell material at possible leakage points (e.g. in way of flange) to prevent the insulation from containing leaked oil. The length of closed-cell insulation on either side of the leakage points is not to be less than 0.5 m and weep holes are to be drilled in the bottom to drain leakage oil.

3.13.20 Valves

If valve installation is permitted, the valve stem is to be side mounted so that the leaked thermal oil leaves piping along the valve stem.

3.13.21 Temperature control

Heaters are to be fitted with means for automatically regulating heat input to control temperature at outlet and to ensure that thermal oil film temperature will not exceed the specified limit in case the circulating pump is inadvertently stopped.

3.13.22 Temperature monitoring

3.13.22.1 Where the temperature at thermal oil outlet of heaters exceeds the permissible limit, the burner is to be automatically shut off and interlocked with a temperature limiter.

3.13.22.2 The thermal oil outlet of each of heated surfaces in parallel is to be provided with temperature monitoring.

3.13.22.3 Where the specified smoke temperature is exceeded, the burner must be shut off and interlocked.

3.13.23 Flow monitoring

3.13.23.1 Precautions are to be taken to keep the maximum thermal oil membrane temperature within the permissible limits.

3.13.23.2 The flame heaters are to be provided with thermal oil flow limiter. Where flow rate drops down to the preset value, the burner is to be shut off and interlocked.

3.13.23.3 The actuation of burners is to be so interlocked with circulating pumps that burners cannot be actuated when circulating pumps are out of operation.

3.13.24 Leakage monitoring

Heaters are to be provided with oil leakage detector and when the detector is activated, the burner is to be shut off and interlocked with it. Where the heater is in standby mode, the burner is not to be capable of being actuated when the detector is activated.

3.13.25 Flame failure and ignition failure monitoring

Heaters are to be provided with flame failure detection and when flame failure or ignition failure occurs, fuel supply is to be automatically shut off.

3.13.26 Forced ventilation monitoring

When the forced ventilation for heater burning fails, fuel supply is to be automatically shut off.

3.13.27 Shut-off means

Heaters are to be fitted with shut-off means capable of being operated from outside heater space.

3.13.28 Unattended thermal oil heaters

The monitoring of unattended thermal oil heaters is to comply with the requirements of Table 3.13.28.

Monitoring Items for Thermal Oil Heaters

Table 3.13.28

Item	Alarm	Remarks
Thermal oil expansion tank level	Low	Burners automatically shut off
Thermal oil flow	Low	Burners automatically shut off
Thermal oil pressure	Low	Burners automatically shut off
Thermal oil outlet temperature	High	
	High high	Burners automatically shut off
Combustion air pressure	Low	Burners automatically shut off
Fuel oil pressure	Low	
Fuel oil temperature/viscosity	Low and high	For heavy oil only
Fuel oil atomizing/air pressure	Low	
Burner flame and ignition	Failure	Each burner to be monitored. Burners automatically shut off *
* Where burner flame and ignition fail, combustion chamber is to be purged before re-ignition.		

Section 14 BOILER WATER FEED, BLOW OFF AND CONDENSATION SYSTEM

3.14.1 Objectives

The objectives specified in this Section are to ensure the feed of boiler water, safe blow off and timely collection of condensate water.

3.14.2 Functional requirements

For the objectives specified in this Section, the system is to have the following functions:

- (1) Reliability of feed system;
- (2) Redundancy of condensation system; and
- (3) Safety of blow-off system.

3.14.3 Feed pumps

3.14.3.1 At least two independently driven feed pumps are to be provided for auxiliary boilers for essential services or steam auxiliary boilers for heating heavy oil. These feed pumps are to be of sufficient capacity to supply the boilers under full load conditions with any one pump out of action.

3.14.3.2 Forced circulation boilers are to be provided with two independently driven circulating pumps, one of which is used as a stand-by pump. For auxiliary forced circulation boilers not used for essential services, only one circulating pump may be accepted.

3.14.4 Feed piping

3.14.4.1 AT least two separate feed water systems (including feed pumps) are to be provided for auxiliary boilers for essential services. The feed systems are to be of sufficient capacity to supply feed water to the boilers with any one system out of action.

3.14.4.2 Feed water systems are to be so arranged that the feed water cannot be contaminated by oil or oily water.

3.14.5 Condensate pumps

At least two independently driven condensate pumps are to be provided for dealing with the condensate from the condensers with one pump on standby. The independently driven feed pump may be accepted as a standby condensate pump.

Section 15 FRESH WATER SUPPLY SYSTEM

3.15.1 General

Freshwater on board a floating installation is mainly divided into production freshwater and living freshwater by purpose. Production freshwater mainly refers to the freshwater used for equipment cooling, pressurization of fire water piping, chemical agent preparation and drilling. Living freshwater mainly refers to the freshwater for drinking, shower, laundry and sanitary purposes.

3.15.2 Objective

The objective specified in this Section is to provide adequate qualified freshwater to the floating installation and assure safe use of production and living freshwater.

3.15.3 Functional requirements

To achieve the objective specified in this Section, the freshwater supply system is to have the following functions:

- (1) The design capacity of the system can satisfy the demands of production, equipment operation and water for daily life;
- (2) The freshwater pressure tank has self replenishing capacity;
- (3) Pumps serving the machinery cooling system and daily living water system have proper redundancy;
- (4) Cooling system has regulating capability and alarm protection.

3.15.4 Freshwater storage tanks

3.15.4.1 The capacity of a freshwater storage tank is to be designed and determined by the designer according to the daily consumption of freshwater for production and living purposes and the self sustaining ability of the floating installation.

3.15.4.2 Each freshwater storage tank should be provided with high/low level suction, level and temperature measuring and indicating apparatus.

3.15.4.3 Floating installation operating in cold regions are to be equipped with heat preservation and heating installation.

3.15.5 Fresh water pressure tank

3.15.5.1 Pressurized water tanks should be provided to supply water to the users and avoid frequent starts of the water supply pump.

3.15.5.2 Pressurized water tanks are to be filled with compressed air of an appropriate pressure and volume and be capable of ensuring water supply pressure while avoiding frequent pump starts.

3.15.5.3 The outlet pressure of a pressurized water tank is to be designed such that the outlet pressure of the most unfavorable (at the highest and farthest positions) users is kept at 3 kPa at least.

3.15.5.4 Each pressurized water tank is to be fitted with a relief valve.

3.15.5.5 Pressurized water tanks are to be fitted with pressure relays to allow automatic replenishment and shutoff of water supply.

3.15.5.6 Hot water pressurized tanks are to be fitted with temperature control devices and their temperature should be controlled within the range of 50°C~70°C.

3.15.5.7 Pressure tanks shall be designed, manufactured and inspected to industry standards (such as CB/T 4482 Marine Pressure Tanks).

3.15.6 Freshwater pumps

3.15.6.1 The discharge rate and pressure of water supply pumps for pressurized water tanks are to be consistent with the capacity and pressure of the said pressurized tanks.

3.15.6.2 The water supply pumps for pressurized water tanks are to be capable of being automatically started, stopped and operated.

3.15.6.3 The water supply pumps for pressurized water tanks are to be provided with standby pumps.

3.15.6.4 To save freshwater consumption, the hot water system is to be fitted with a hot water circulating pump. The material of the pump and its seals are to be capable of withstanding temperature up to 100°C.

3.15.7 Drinking water supply system

3.15.7.1 Drinking water is normally the qualified tap water delivered from an onshore water plant and measures are to be taken to prevent pollution during the delivery. The freshwater from a freshwater generator may also be used as drinking water provided that it meets the applicable standards.

3.15.7.2 Drinking water tanks and piping systems should be constructed of stainless steel. The anti-corrosion coating on the wall surface of drinking water tanks is to be nontoxic.

3.15.7.3 Drinking water from a freshwater generator should flow through the mineralizing filter so that certain trace elements that human body needs can be replenished. The mineralizing filter should have backwash function.

3.15.7.4 Drinking water is to be disinfected and sterilized. Ultraviolet disinfection unit is more commonly used.

3.15.7.5 Piping to be fitted with bypass mineralizing filter and disinfection device is to be capable of ensuring continuous water supply in case these two devices sustain failure or are under repair.

3.15.7.6 Drinking water is to comply with the requirements stated in the latest edition of GB 5749 Sanitary Standards for Drinking Water.

3.15.8 Freshwater cooling system

3.15.8.1 Cooling water pump

(1) Each diesel generator is to be provided with one primary cooling water pump having sufficient capacity to accommodate the maximum output power of the diesel generator and one standby pump having an enough capacity to keep normal operation of the floating installation. The standby pump is to be powered independently and capable of being ready for immediate service.

Where several diesel generators are equipped and each generator has or is provided with a cooling water pump, the standby cooling water pump may be dispensed with.

Diesel engines for other purposes are to be provided with cooling water pumps as appropriate.

(2) For the freshwater pumps of heat exchangers in the oil and gas process system and the freshwater cooling pumps of hydrocarbon compressors, both primary and standby pumps with sufficient capacity are to be provided.

3.15.8.2 Cooling piping system

(1) The cooling piping system is to be so arranged as to be capable of effectively regulating the cooling water inlet temperature.

(2) The closed cooling system is to be provided with a freshwater expansion tank. The expansion pipe is to be led out from the highest point of the piping system and terminated within the expansion tank.

(3) The cooling system is to be provided with temperature alarm devices.

(4) For a diesel engine requiring cylinder warm-up when it starts, its freshwater cooling piping system is to be fitted with an appropriate heating device.

3.15.9 Prevention of cross contamination hazards

(1) The pressures of the cooling side and cooled side of a heat exchanger are to be so designed as to minimize the possibility of seawater seepage into the freshwater.

(2) The freshwater pressure of the freshwater system that heats the process medium directly is to be always higher than the pressure of the heated process system.

(3) For freshwater system for cooling hydrocarbon compressors and the freshwater system for heat exchange with natural gas, reliable means are to be provided to prevent leakage of natural gas into the freshwater system.

(4) The freshwater system for heating diesel fuel is to comply with the relevant requirements in Section 8 of this Chapter.

(5) The freshwater system for heating crude oil is to comply with the relevant requirements in Section 9 of Chapter.

Section 16 SEAWATER SYSTEM

3.16.1 Application

3.16.1.1 The seawater system described in this Section is mainly used for equipment cooling and other miscellaneous purposes.

3.16.1.2 The seawater system used for ballast purpose and fire-fighting seawater system are to comply with Section 4 of this PART and Section 2, Chapter 6, PART VIII of the Rules respectively.

3.16.1.3 The seawater filling system is to comply with the relevant provisions in Chapter 6 Auxiliary Process System of CCS Rules for Classification of Offshore Oil and Gas Process System.

3.16.1.4 Operation of valves, sea valves and sea chests are to comply with the corresponding provisions of 3.1.8, 3.1.9 and 3.1.10, Section 1 of this PART respectively.

3.16.2 Objectives

The objectives specified in this Section are:

(1) To provide suitable and reliable cooling sources to the onboard equipment requiring cooling;

(2) To provide reliable seawater supply for miscellaneous purposes to the unit.

3.16.3 Functional requirements

To achieve the objectives specified in this Section, the cooling system is to have the following functions:

(1) The design capacity of the system is to satisfy the cooling demand of various installation and miscellaneous purposes;

(2) The system is to have corrosion protection ability;

(3) The system is to have certain redundancy;

(4) The system is to have regulating capacity and alarm protection.

3.16.4 Seawater pumps

3.16.4.1 At least two independently powered seawater intake pumps are to be provided on the floating installation. The flow rate of the remaining pumps is to be capable of satisfying the water demands on the floating installation in case any individual pump fails.

3.16.4.2 Based on the users' demand, an independent seawater subsystem may be provided for each seawater user; alternatively, a subsystem may be shared by several users.

3.16.4.3 Primary pumps and standby pumps are to be provided for seawater cooling subsystems serving oil and gas process system and generators and seawater subsystems for other essential services.

3.16.5 Filters

3.16.5.1 The outlet of each sea chest is to be fitted with a coarse filter. Automatic backwash filters should be used in ocean areas with much marine plankton or poor water quality.

3.16.5.2 A fine filter is to be fitted on the suction end of the water supply pump for each user, and a finer filter may be fitted as needed on the inlet end of the user.

3.16.6 Marine growth prevention system

3.16.6.1 The marine growth prevention system is to be provided at the pump inlet to prevent growth of marine organisms.

3.16.6.2 Where a sodium hypochlorite marine growth prevention system is employed, the following requirements are to be complied with:

- (1) The electrode plates are to be pickled periodically due to the fouling thereon. The electrolytic cells are to have 100% backup in order to continue generating sodium hypochlorite during maintenance and repair;
- (2) As sodium hypochlorite is strongly corrosive, all equipment and piping in contact with sodium hypochlorite solution are to be constructed of corrosion resistant materials.
- (3) The hydrogen generated during seawater electrolyzing process is to be directed to a safe location. To prevent hydrogen accumulation, the ventilators are to operate continuously and be provided with 100% standby ventilators.

3.16.7 Seawater pressurized tanks

Where pressurized water tanks are used to supply water on the unit, the applicable requirements in 3.15.5 of this Chapter are to be complied with. In addition to the primary water supply pump, the seawater pressurized tanks are also to be provided with standby water supply pumps.

3.16.8 Seawater desalinization plant

The floating installation far away from the shore should be equipped with a seawater desalinization plant in case the supply ship is unable to deliver water as scheduled under the influence of weather and sea conditions and accidental events.

3.16.9 Corrosion protection

3.16.9.1 The seawater cooling system is to be provided with effective means of corrosion protection.

3.16.9.2 For submarine gates, seawater corrosion resistant materials shall be selected as possible to ensure the availability of submarine gates at any time.

3.16.9.3 Seawater corrosion shall be fully considered in the pipeline between the submarine gate and the first isolation valve, and the corrosion allowance shall not be less than that of the bottom plate.

3.16.10 Freezing protection

Floating installation operating in low temperature environments are to be provided with means for protecting their seawater systems from freezing.

Section 17 COMPRESSED AIR SYSTEM

3.17.1 Objectives

The objectives specified in this Section are to safely provide the unit with the qualified drive power air, diesel engine starting air, instrumentation and control air, bulk transferring air, torch atomizing air and for miscellaneous purposes.

3.17.2 Functional requirements

To achieve the objectives specified in this Section, the compressed air system is to have the following functions:

- (1) The design of main air supply system is to satisfy all air demand in the event of failure of one air compressor and one air receiver;
- (2) The air supply of essential services (e.g. instrumentation and control air) is to have redundancy;
- (3) The quality of air (e.g. requirements of water and oil content) is to satisfy the system services;
- (4) The system is capable of being alarmed and automatically air-filled at low pressure;
- (5) The arrangement of manifolds is to have suitable redundancy;
- (6) The air compressors, receivers and piping are to be provided with overpressure protection and the discharged air is led to a safe location.

3.17.3 Air compressors

At least independently power driven air compressors are to be provided. These air compressors are to be of sufficient capacity to supply the units under full load conditions with any one compressor out of action.

3.17.4 Air receivers

3.17.4.1 There are to be at least two sets of main air receivers.

3.17.4.2 Besides main air receivers, the starting air receivers, instrumentation and control air receivers, soot blower receivers, miscellaneous receivers, etc. are to be individually provided as required.

3.17.4.3 Air receivers are to be fitted with a pressure relay capable of actuating alarm and automatically starting an air compressor for air replenishment or automatic air replenishment from the upstream main air receiver if the pressure is lower than the allowed value.

3.17.4.4 At least two air receivers used to start the diesel generators are to be provided. The total capacity of the two air receivers, without air replenishment, is to be sufficient to support three successive starts of each diesel engine, but the total number of starts does not have to exceed 8;

At least two starting air compressors are to be provided where provision of such compressors is intended. The total capacity of the two compressors is to be capable of pressurizing the air receivers from atmospheric pressure to the pressure level required to support the required number of successive starts within one hour.

3.17.5 Piping

3.17.5.1 The air main for essential services are to be designed as ring main that is fitted with isolating valves of a proper number to isolate damaged pipe sections.

3.17.5.2 Air piping for instrumentation and control is to be isolated from other air piping, unless the quality of the air supplied by other piping complies with the requirements of instrumentation and control air quality.

3.17.5.3 The suction of air compressors are to take air in the safe areas and avoid suction of exhaust gas.

3.17.5.4 The piping in the compressed air system is to be arranged to be completely separate from the air system for liquid-atomizing burner.

3.17.5.5 If the well fluid before entry into flare is atomized by air or steam, the air or steam piping is to be fitted with non-return valves. Such valves are to be easily accessible and as close to the flare arm as possible.

3.17.6 Pressure reduction

If pressure reduction is needed, the piping is to be provided with two sets of pressure reduction devices in parallel, with one for main service and the other on standby. Safety valves and pressure meters are to be fitted after each set of pressure reduction valves.

3.17.7 Filtering and drying

3.17.7.1 A filter is to be fitted on the suction side of the air compressor.

3.17.7.2 Filters and driers are to be fitted on air piping for instrumentation and control.

3.17.7.3 Air driers are to be fitted on the compressed air piping for bulk blowing.

3.17.7.4 All filters (except the filters fitted at compressor inlets) and driers are to be of a parallel double set and full flow design to facilitate repair.

3.17.8 Instrumentation and control air system

3.17.8.1 Requirements on instrument air quality.

(1) To prevent blockage and wear of the air piping and throttling orifice plate, the maximum granular size of dust particles contained in the instrument air is not to be greater than 3.2 μ m.

(2) To prevent instrument air maloperation caused by blockage and wear of instrumentation elements, the maximum oil content of instrument air is not to be higher than 1 ppm.

(3) Instrument air is to be dry air. The dew point of air at working pressure is to be at least 10°C lower than the ambient temperature.

3.17.8.2 Means are to be provided to ensure stable pressure of the instrumentation and control air receivers.

3.17.8.3 The capacity of instrumentation and control air receivers is to be capable of ensuring 20 minutes' continuous air supply under maximum air consumption conditions without air replenishment.

3.17.8.4 To prevent fluid accumulation in the piping, headers are to be arranged in an inclined way and fitted with drainage devices at the lowest point.

3.17.8.5 Reduction valves and filters are to be duplicated when serving more than one functions (e.g. two control loops).

3.17.8.6 Local accumulators that are used as back up air supply for essential systems are to be capable of avoiding inadvertent isolation or mechanical damage that could prevent correct operation.

3.17.8.7 Piping is to be cleaned and dried before being put into operation.

3.17.9 Air filling of air receivers of firefighter's outfit, emergency escape breathing device (EEBD) and anti-hydrogen sulfide breathing apparatus

Dedicated breathing air system should be provided to fill the firefighter's air receivers, EEBDs and anti-hydrogen sulfide breathing apparatus (refer to the requirements of 6.1.7 of PART VIII, and Sections 6 and 7, Chapter 12 of PART VIII).

Section 18 EXHAUST GAS DISCHARGE SYSTEM

3.18.1 Objectives

The objectives specified in this Section are to make the exhaust gas of the unit meet the economic, safe and environmental-friendly requirements.

3.18.2 Functional requirements

To achieve the objectives specified in this Section, the exhaust gas system is to have the following functions:

- (1) The piping design is not to make combustion equipment yield unacceptable backpressure;
- (2) The exhaust gas discharge is not to yield unacceptable noise;
- (3) The exhaust gas discharge is not to yield igniting sparks;
- (4) The exhaust gas discharge among different combustion equipment is not to interfere with each other;
- (5) The design and installation of exhaust pipes are not to make combustion equipment yield unacceptable additional stress;
- (6) The heat energy of exhaust gas is to be utilized as far as practicable.

3.18.3 Arrangements

3.18.3.1 Uptakes of boilers except exhaust gas boilers are not to be connected with exhaust piping of diesel engines.

3.18.3.2 Each internal combustion engine is to have a separate exhaust pipe. Where the exhausts of two or more engines are led to a common silencer or exhaust gas-heated boiler, an isolating device is to be provided in each exhaust pipe.

3.18.3.3 For alternately fired furnaces of boilers using exhaust gases from internal combustion engines and oil fuel, the exhaust gas inlet pipe is to be provided with an isolating device and interlocking arrangements whereby oil fuel can only be supplied to the burners when the isolating device is closed to the boiler.

3.18.4 Silencers

3.18.4.1 The exhaust gas pipes of internal combustion engines are to be fitted with silencers on which suitable cleaning and draining devices are being provided.

3.18.4.2 The external portion of silencers is to be packed with suitable thermal insulation materials.

3.18.5 Sparking arresters

Each exhaust pipe is to be provided with sparking arresters.

3.18.6 Drainage devices

3.18.6.1 Exhaust pipes are to be provided with suitable and easily accessible drainage devices.

3.18.6.2 The drained fluid should be led to water seals while the drainage of water seals is to be led to bilge wells.

3.18.7 Protection of water-cooled exhaust pipes

Water-cooled exhaust pipes are to be protected against overpressure and dry burning of water-cooled spaces.

3.18.8 Protection from rain

Means is to be provided to protect engines from rainwater.

3.18.9 Positions of exhaust outlet

The exhaust outlets are to be located in a safe place and to be as far from living quarters and helicopter decks as practically possible.

3.18.10 Water heaters

3.18.10.1 If the water heater is fitted on the exhaust pipe or uptake, it is, in general, to be of open type. If closed water heaters are fitted, they are to comply with the relevant provisions on boilers and pressurized vessels.

3.18.10.2 The open-type water heaters are to have vent pipes of sufficient diameter and no closing device is to be provided on the vent pipes.

CHAPTER 4 VENTILATION SYSTEM

Section 1 GENERAL PROVISIONS

4.1.1 Objectives

The objectives specified in this Chapter are:

- (1) To provide comfortable air environment to the personnel in the enclosed accommodation and working spaces on the unit;
- (2) To provide sufficient oxygen to the combustion equipment;
- (3) To bring off the heat from heat generating equipment to maintain the temperature within limits;
- (4) To prevent the enclosed spaces from being flooded through ventilation ducts;
- (5) Refer to the relevant requirements of Chapter 3 of PART VIII for the purposes of fire and explosion prevention of ventilation system.

4.1.2 Functional requirements

To achieve the objectives specified in this Chapter, the ventilation system is to have the following functions:

- (1) The design of ventilation system is to satisfy the demand of human breathing, combustion and heat dissipation of all kinds of spaces;
- (2) Effective ventilation shall be provided in living places, service offices, control stations, machine places where people work, machine repair rooms, electrical rooms, etc., and air conditioning systems shall be set according to the environmental conditions of the working areas;
- (3) The air ventilators in the open spaces are provided with weathertight devices;
- (4) Where the unit is under the normal dynamic and static heeling and assumed damage conditions, the ventilation inlets and outlets are not to lead to flooding in the served spaces;
- (5) Refer to the relevant requirements of Chapter 3 of PART VIII for the purposes of fire and explosion prevention of ventilation system.

4.1.3 Arrangement of ventilation inlets and outlets

4.1.3.1 The arrangement of outdoor inlets and outlets of enclosed spaces is to ensure the exhaust gas will not be inhaled by suction fans.

4.1.3.2 The arrangement of indoor inlets and outlets of enclosed spaces is to prevent short circuit circulation and ensure effective ventilation of the entire spaces.

4.1.3.3 The outdoor inlets of enclosed non-hazardous spaces are to be arranged in the non-hazardous areas with a distance of 3 m from the hazardous areas so as to prevent suction of flammable gas.

4.1.3.4 The outdoor outlets of enclosed hazardous spaces are to be away from all openings of enclosed non-hazardous areas as well as all equipment with ignition sources; such outdoor outlets may be arranged in the open hazardous areas with the same hazardous area category as the ventilated spaces.

4.1.4 Design basis of compartment ventilation

4.1.4.1 The requirements of ventilation design of a space are based upon the maximum number of air changes, fresh air volume required by each person or temperature increase limit, whichever is the greatest.

4.1.4.2 The compliance calculation of space air changes is to be based upon the gross volume enclosed by the external dimensions of spaces (volume occupied by equipment and furniture within the spaces is not to be deducted)

4.1.4.3 The calculation of mud tank air changes is to be based upon the gross volume enclosed by the external dimensions of this tank with no mud assumed.

4.1.5 Ventilation of generally not accessed compartments

For the generally not accessed spaces like void spaces, double-bottom tanks and pipe tunnels etc., they are to be effectively ventilated by mechanical means when human enters. Hydrodynamic or mobile ventilators may be used.

4.1.6 Air Conditioning system

4.1.6.1 All air conditioning equipment are to be suitable for ocean environment.

4.1.6.2 The air conditioning systems are to be designed and manufactured in accordance with the recognized standards.

4.1.6.3 The indoor temperature of each space is to be capable of being regulated individually.

4.1.6.4 The design of type selection and air velocity is to be considered to minimize the noise to an acceptable range.

4.1.7 Watertight and weathertight requirements

Refer to the relevant provisions of Chapter 4, PART III of the Rules for the watertight and weathertight requirements of air ventilators and ventilation inlets/outlets.

Section 2 VENTILATION OF LIVING QUARTER AREAS

4.2.1 General requirements

4.2.1.1 The accommodation spaces, service spaces and control stations within the living quarter areas are to be provided with cold and warm air conditioning systems.

4.2.1.2 The galley is to be provided with independent air conditioning system and if the central air conditioning system is applied, the requirements of 11.2.1.2, Chapter 11 of PART VIII are to be complied with.

4.2.1.3 Besides the air conditioning ventilation system for normal service, the central control station is to be provided with a set of independent air conditioning ventilation system.

4.2.1.4 To prevent entry of flammable or toxic gas into the living quarter areas, the ventilation openings of living quarter areas are to be far from the hazardous areas (e.g. oil and gas process areas) and flammable gas and hydrogen sulfide detectors are to be provided at the inlets.

4.2.1.5 The living quarter areas are to be provided with positive pressure ventilation to prevent penetration of external harmful gas.

4.2.1.6 The pressure of corridors and escape passageways within the living quarter areas is to be slightly higher than the pressure of adjacent compartments to facilitate fume control in the event of fire.

4.2.1.7 The galleys, air conditioner rooms, laundry rooms, lavatories, bathrooms and locker rooms in the living quarter areas are to be kept under a slightly lower pressure to prevent external dirty air from penetrating into the adjacent compartments.

4.2.1.8 The exhaust of clinic room and sickroom is to be directly discharged outdoor, which is not to be used as the return air of air conditioners.

4.2.1.9 The exhaust of smoking room, galley, lavatories and bathrooms is to be directly discharged outdoor individually or in sets, which is not to be used as the return air of air conditioners.

4.2.1.10 In the event of emergency, the power supply of ventilation system is to be capable of being shut off from one or several locations outside the accommodation rooms.

4.2.1.11 In case of fire, the main inlets and outlets of ventilation system are to be capable of being shut off from the locations outside the ventilator room.

4.2.1.12 The ventilation openings of bedrooms are not to be directed towards the beds.

4.2.2 Air exchange rate (ventilation rate)

The ventilation capacity or air changes in various spaces of living quarter areas should comply with the following requirements:

(1) The fresh air volume of living room shall be at least 30m³/h per person, and the fresh air volume of public area shall be at least 18m³/h;

(2) The air changes of messroom and entertainment room are to be at least 6 times/h;

(3) The air changes of galley are to be at least 20 times/h;

(4) The air changes of sanitary spaces are to be at least 20 times/h;

(5) The air changes of clinic spaces are to be at least 10 times/h.

Section 3 VENTILATION OF MACHINERY SPACES

4.3.1 General requirements

4.3.1.1 All machinery spaces are to be effectively ventilated to prevent accumulation of harmful gas and lack of oxygen.

4.3.1.2 The ventilation of combustion equipment spaces is to be independently arranged.

4.3.1.3 The ventilation of oil separator spaces is to be independently arranged.

4.3.1.4 The ventilation of CO₂ storage room and clean extinguishing medium storage room is to comply with the relevant requirements of Section 9 and Section 10 of Chapter 6 of PART VIII respectively.

4.3.1.5 The design of velocity in the ventilation ducts is to be considered to minimize the noise to an acceptable range.

4.3.2 Ventilation of machinery equipment spaces

4.3.2.1 The ventilation of machinery spaces where the internal combustion engines, boilers and other combustion equipment are located is to:

(1) Provide adequate air for combustion of equipment operating at full load and under all weather conditions;

(2) Ensure normal operation of the main engine and generators in the event of any one ventilator failure for the main generator room;

(3) Ensure the pressure within the machinery spaces is slightly higher than the outdoor pressure.

4.3.2.2 There shall be effective ventilation in general machinery places, switchboard rooms, machine repair rooms, electrical repair rooms and places where people often work.

4.3.2.3 Control stations, switchboards and other places with temperature requirements shall be equipped with air conditioning, and appropriate redundancy shall be considered.

Section 4 VENTILATION REQUIREMENTS FOR FIRE AND EXPLOSION PREVENTION

Besides compliance with the provisions of this Chapter, refer to the provisions of Chapter 3, PART VIII of the Rules for the specific ventilation requirement for on ventilation of fire and explosion prevention.