CHINA CLASSIFICATION SOCIETY

RULES FOR CLASSIFICATION OF MOBILE OFFSHORE UNITS

PART FOUR MACHINERY INSTALLATIONS AND SYSTEMS

CONTENTS

CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.1 Application

1.1.1.1 This PART is applicable to utility machinery installations and systems; the general safety requirements of this Part, such as for the general piping design requirements are applicable to other machinery installations and systems.

1.1.1.2 Detailed requirements for drilling units, oil, gas and water treatment (process) systems, oil storage units and fishery and aquaculture facilities shall comply with CCS Guidelines for Inspection of Offshore Drilling Units, Rules for Classification and Construction of Offshore Floating Units, and Standards for Construction and Inspection of Shallow Sea Fixed Units, and Guidelines for Inspection of Offshore Fishery and Aquaculture Facilities, respectively.

1.1.1.3 For the unit with the class notation of CSM, its requirements of propulsion machinery are to comply with the CCS Rules for Classification of Sea-going Steel Ships.

1.1.2 Purpose

The requirements specified in this Chapter is to provide the safe and effective support for drilling, oil production, storage and moving, positioning, jacking, fixation as well as accommodation to the units.

1.1.3 Functional requirements

To achieve the objective of specified in this chapter, the utility machinery installations 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 propulsion arrangements are to satisfy propelling, maneuvering and positioning requirements under the design conditions;

(5) The jacking and fixation mechanisms are to satisfy the needs of jacking and fixation for self-elevating units and legs, and ensure the safety for such jacking and fixation;

(6) The capacity of air compressors, pumps and ventilators is to satisfy the needs of transferring fluid to the served systems;

(7) The equipment is firmly and securely installed;

(8) 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 equipment 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.

Inclination Angle of Unit **Table 1.1.4.1**

Equipment type	Unit type							
	Column-stabilized unit (including cylindrical type, etc.)		Self-elevating and bottom-sitting units		Surface unit and bottom-sitting box unit			
	Any direction (o)		Any direction (o)		Horizontal (o)		Vertical (o)	
	Static inclination	Dynamic inclination	Static inclination	Dynamic inclination	Static inclination	Dynamic inclination	Static inclination	Dynamic inclination
Safety-related equipment	15	22.5	10	15	15	22.5	5	7.5
Emergency power supply, ballast system	25	22.5	15	15	22.5	22.5	10	10

Note: ① For non-self-propelled units, it is only required to operate under static inclination conditions;

② For surface unit and bottom-sitting box unit, transverse static inclination and longitudinal static inclination and transverse dynamic inclination and longitudinal dynamic inclination may occur simultaneously;

③ Ballast system is only suitable for column-stabilized unit.

1.1.4.2 For the machinery equipment 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 service region.

Ambient Temperature **Table 1.1.4.2**

Ambient	Position	Temperature (℃)
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 unit 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, 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℃
Relative humidity	60%
Seawater temperature (charge air coolant inlet)	32℃

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 Vibration

The propulsion plant is to be so designed, constructed and installed that any mode of vibrations will not induce excessive stresses within the normal speed range.

1.1.6 Strengthening for navigation in ice

For units navigating in ice with corresponding additional notations, the propulsion plant and auxiliary machineries are to comply with the relevant requirements specified in Chapter 14 of PART THREE of CCS

Rules for the Classification of Sea-Going Steel Ships.

1.1.7 Astern power

1.1.7.1 In order to maintain sufficient maneuverability and secure control of the unit in all normal circumstances, there is to be sufficient reversing power.

1.1.7.2 For the main propulsion systems with reversing gears, controllable pitch propellers or electric propeller drive, running astern is not to lead to the overload of propulsion machinery.

1.1.8 Overload power

1.1.8.1The prime movers of main engines and electric generators are to be capable of running at an overload power corresponding to 110% of their rated power.

1.1.9 Dead ship starting

1.1.9 The machinery equipment is to be so arranged 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.

1.1.10 Human-machinery interface

1.1.10.1 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.

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

1.1.10.3 The design and arrangements of control panel should to comply with the recognized international standards on ergonomics.

1.1.10.4 During service, the equipment or components (such as valves and instruments) need to be operated, tested and repaired are to be installed in the positions where are accessible for the above personnel activities.

1.1.10.5 pares and tools are to be stored in the positions where are facilitate for use.

1.1.11 Failure protection

1.1.11.1 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.

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

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

1.1.12 Anti-corrosion

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

1.1.13 Materials

1.1.13.1 The materials fabricated for machinery installations 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 passing necessary surveys and tests and approved by relevant authorities.

1.1.13.2 Asbestos material is prohibited on the unit.

1.1.14 Automation

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

1.1.15 Communication

The communication in machinery spaces or between control room of engine and navigation bridge is to comply with the relevant requirements of Section 6, Chapter 3 of PART FIVE of the Rules.

1.1.16 Detailed requirements of machinery equipment

1.1.16.1 The diesel engines, gear transmission arrangements, shafting system and propellers, shafting vibration and alignment as well as boilers and pressure vessels are to comply with the relevant requirements of PART THREE of the CCS Rules for Classification of Sea-going Steel Ships.

1.1.16.2 The air compressors and pumps are to comply with the relevant requirements of Section 1 Chapter 3 of this part.

1.1.17 Test

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

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

1.1.18 Plans and information

1.1.18.1 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;

(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 compression 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 installations 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 required by CCS.

1.1.18.2 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 requirements of Chapter 8 of PART EIGHT for the separation requirements of dynamic positioning system on engine room and propulsion module as well as the subdivision requirements of cooling water pumps, lube oil pumps and oil fuel pumps.

1.2.1.5 Refer to the relevant requirements on fire water system, bilge system and ballast system for the individual subdivision requirements of fire pumps, bilge pumps and ballast pumps.

1.2.1.6 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.

1.2.1.7 Where boilers are arranged on the tween' deck of machinery space, and the boiler room is not separated from the machinery space by watertight bulkhead, the tween' deck is to be provided with coaming of 200 mm in height. The oily water of this area may be drained to the bilges. The drain tank is not to constitute a part of an overflow system.

1.2.2 Arrangements of fire prevention

1.2.2.1 Where the surface temperature may exceed 220℃, 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, filers and other detachable connectors to heat surfaces.

Any place of potential oil leakage (e.g. beneath the oil tanks that do not constitute parts of main structure, oil pumps, oil filters, boiler burners, fuel devices t) is to be provided with oil trays that lead to collectors.

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 (see the definitions in PART SEVEN) 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 are 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℃ (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 Installation of thrusters

1.2.4.1 The installation of thrusters and shafting alignment are to ensure the best performance of thrusters under all operation conditions.

1.2.4.2 The installation of shaft seal boxes is to prevent water gaining access into the unit or internal parts of the thrusters.

1.2.4.3 The seal arrangements are to prevent seawater from contacting with steel shafts, unless such shafts are made of anti-corrosion materials.

1.2.4.4 The seal arrangements are to facilitate inspection.

1.2.5 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.

1.2.6 Repair of equipment

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

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

1.2.6.3 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.

1.2.7 Separation of tanks

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

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

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

1.2.7 Separation of liquid tanks

1.2.7.1 When oil daily tanks, oil circulation tanks or hydraulic oil tanks of important equipment affecting safety are adjacent to any other liquid tanks, they shall be separated by isolated empty tanks. If the oil tanks and fuel tanks are directly adjacent, the welding of adjacent walls shall be in the form of full penetration.

1.2.7.2 When the fuel daily tanks, sedimentation tanks and water tanks of important equipment affecting safety are adjacent, they shall be separated by isolated empty tanks.

1.2.7.3 When fresh water tanks are adjacent to any oil tanks, they shall be separated by isolated empty tanks.

1.2.7.4 When oil tanks exceeding 30m3 are adjacent to other water tanks, the risk of oil entering the tanks shall be taken into account. If the risk of oil entering the water tank is controllable and there are control measures, a cofferdam may not be set, but the welding of adjacent walls shall be in the form of full penetration.

1.2.8 Personnel protection

1.2.8.1 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.

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

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

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

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

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

The surfaces below 0℃ are to be properly insulated.

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

1.2.8.8 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.

1.2.9 Prevention of inadvertent operations

1.2.9.1 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.

1.2.9.2 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.

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

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

1.2.9.5 The on/off positions of valves are to be conspicuously.

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

1.2.10 Escape passageways of ategory A machinery space

The escape passageways of category a machinery space is to comply with the relevant requirements of Chapter 12 PART SEVEN 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 tight-enclosed system and convenient for dismantling, inspection and maintenance;

(4) The piping are to be provided with separation and drainage media as well as measures to control flow as required;

(5) The piping are to be located at the places not easy to damage and not to cause fire or hazard of electrical equipment and instruments if leakage occurs.

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, gaskets, bolting, 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, shown in Figure 2.1.4.2 and Table 2.1.4.2.

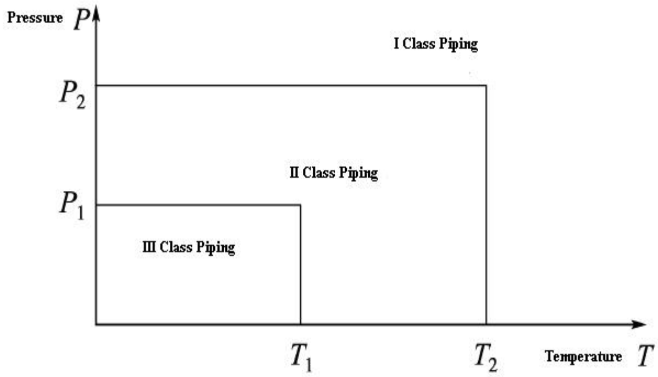


Figure 2.1.4.2 Class of Piping

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, lub. 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℃ 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 releasing 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 on completion of all construction, 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℃. 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℃ 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 requirements of Chapter 4 and Chapter 9 of PART ONE and Chapter 4 of PART TWO in the 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 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 relieve device is provided for the piping, the design pressure is to be taken not less than the set pressure of such safety relieve device.

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

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

Design Pressure for Oil Fuel Piping **Table 2.2.1.2**

Working pressure / Working temperature	$T \leq 60$ ℃	$T > 60$ ℃
$P \leq 0.7$ MPa	0.3 MPa or maximum working pressure, whichever is greater	0.3 MPa or maximum working pressure, whichever is greater
$P > 0.7$ MPa	Maximum working pressure	1.4 MPa or maximum working pressure, whichever is greater

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℃.

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 Calculation of minimum wall thickness

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

$\delta = \delta_0 + b + c$ 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:

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

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

D – external diameter of pipes, in mm;

[σ] – permissible stress, in N/mm^2.

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

2.2.3.3 Permissible Stress

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

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

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

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

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

Where: σ_b — specified minimum tensile strength of material at ambient temperature (20℃), in N/mm^2;

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

σ_D^T — average stress of material to produce rupture in 100000 h at design temperature, in N/mm^2;

σ_c^T — average stress of material to produce 1% creep in 100000 h at design temperature, in N/mm^2;

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 depend 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 (℃)										
			50	75	100	125	150	175	200	225	250	275	300
Copper	Annealed	215	41	41	40	40	34	27.5	18.5	—	—	—	—
Aluminium brass	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 CuNi30	Annealed	365	81	79	77	75	73	71	69	67	65.5	64	62

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

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, 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:

$$\delta_m = 100\delta/1 - a \text{ mm}$$

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 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	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) Copper-nickel alloys (with Ni not less than 10%)	0.8 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 D	Minimum Nominal Thickness δ			
	Pipes in general③④⑥⑧	Venting, overflow and sounding pipes for structural tanks①②③④⑥⑦	Bilge, ballast and general seawater pipes①③④⑤⑥⑦	Bilge, air, overflow and sounding pipes through ballast and fuel tanks, ballast lines through fuel tanks and fuel lines through ballast tanks①②③④⑤⑥⑦
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	
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.	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℃, 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 thicknesses 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 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 For surface-type unit, the minimum wall thickness of deck water discharge pipes and scupper pipes is to comply with paragraph 3.3.1.2, 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 of Section 5, Chapter 3 of this part.

2.2.4.6 The wall thickness of CO_2 fire-fighting steel pipes is to comply with the requirements of Table 6.9.4.1(5) of Section 9, Chapter 6 of PART SEVEN.

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
l2～20	1.2	1.0
25～44.5	1.5	1.2
50～76.1	14.0	1.5
88.9～l08	14.5	14.0
133～159	3.0	14.5
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 to 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 1m/s and the maximum speed should 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
70/30 copper-nickel alloy	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 of 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℃. 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℃
Copper-nickel alloy	380℃
Special bronze suitable for high temperature services	260℃

2.3.4 Grey cast iron pipes, valves and fittings

2.3.4.1 Grey cast iron pipes, valves and fittings are 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℃ respectively.

2.3.4.2 Grey cast iron pipes, fittings and valves may, in general, be accepted in Class III piping, in oil piping 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℃;

(3) Piping intended for conveying media having temperatures above 220℃;

(4) Piping subjected to pressure shock, excessive strains 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℃.

2.3.5.3 Where ferritic nodular graphite iron castings are used for ship-side pipes, fittings 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 Table1.4.1.3 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, physical and 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℃ or below 0℃.

2.3.6.4 The design, construction, usage and test of the plastic pipes 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 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 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 0.8mm. A gap 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.

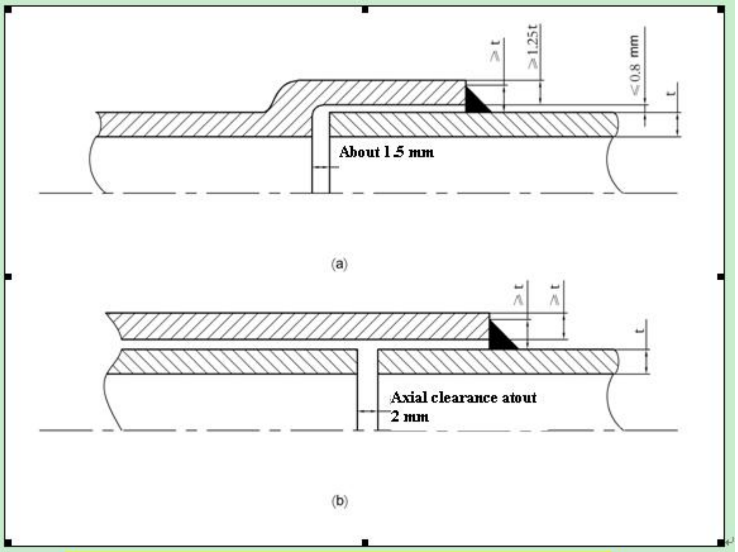


Figure 2.4.2.2 Socket Weld Connection and Sleeve Weld Connection

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 1mm, when the nominal diameter of connection pipe ≤ 50mm;

② 2mm, when the nominal diameter of connection pipe > 50mm but ≤ 200mm;

③ 3mm, when the nominal diameter of connection pipe > 200mm.

(4) The ends of connection pipes are to be within the middle of the sleeve fittings with a clearance of about 2 mm;

(5) The minimum length of sleeves is to comply with the following formula:

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

Where: Ls – 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 Off loading 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	II, III	

	provisions for a high quality of root side		
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≤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 2.4.3.2D) and loose (or lap joint) flanges (Figure 2.4.3.2A_2, F);

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

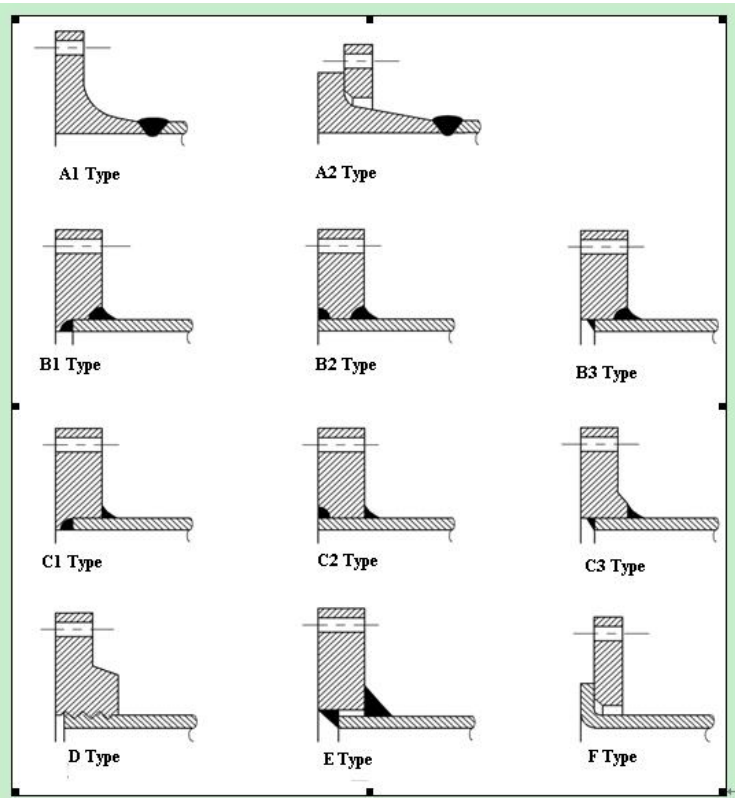


Figure 2.4.3.2 Flange Connectors of Approved Types

2.4.3.2 Welded Flanges

(1) The butt-welded flanges are generally of full penetration weld type. When backing rings are employed in A_1 and A_2 flanges, such backing rings are to be closely fit to the pipe bore and immediately moved after welding. The ring materials are 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 5mm;

(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 5mm;

(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 to be not 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℃, 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 VariousFlanges **Table 2.4.3.4**

Class of piping	Toxic or corrosive media④, Flammable media④, LG	Lube oil, fuel oils	steam③and thermal oil	Other media①②③
I	A、B⑥	A、B	A、B⑥	A、B
II	A、B、C	A、B、C、E⑦	A、B、C、D⑤、E⑦	
III		A、B、C、E	A、B、C、D、E	A、B、C、D、E、F②

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℃;

④ Only type A when design pressure exceeds 1 MPa;

⑤ Types D and E are not be used when design temperature exceeds 250℃;

⑥ Type B for external diameter < 150 mm only;

⑦ Type E for oil piping when design temperature < 150℃ 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 CO_2 systems are allowed only for protected spaces and CO_2 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.

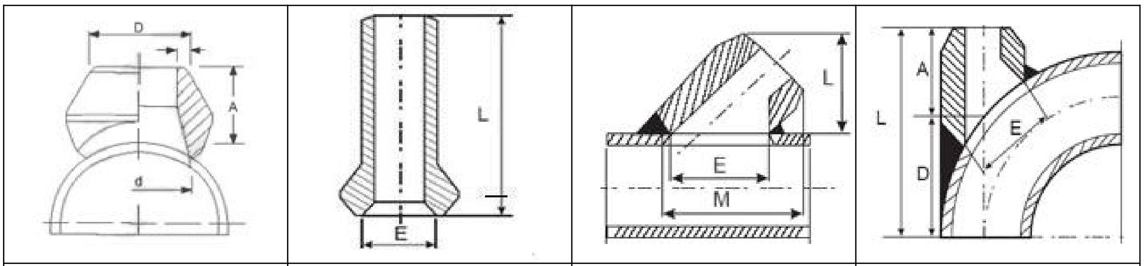
2.4.5 Olet connection

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.



Standard	Nipolet	Latrolet	Elbolet

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 THREE 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 are 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 The piping laid on the bridge between units is to be provided with displacement compensation measures.

2.4.7.4 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 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 indicates showing the opening and closing states.

2.5.2.4 The housing of check valve is to be provided with permanent and clear marking indicating the flow direction.

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 immerged 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 The sea-opening valves, cocks and nozzles installed on the outer plate below the load waterline shall be hydraulically tested at a pressure not less than 0.5MPa. The test pressure of sea valve of self-elevating unit shall not be less than 0.2MPa.

2.5.5.3 Flow test of relief valve

For the displacement pump with relief valve, their adjustment 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 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 horizontally 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. The pipes are fixed on watertight bulkheads by bolts and 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 fresh-water 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 are to be provided with reliable protection measures.

2.6.2 Damage protection

2.6.2.1 Requirements of damage stability

Piping are 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 the essential functions of units 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 fire source 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 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 cannot readily be observed. The machinery spaces in way of such parts of the oil fuel system 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 its inside high pressure oil pipes are to compose 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 are to be reasonably supported and secured. Piping is not to be supported each other and consideration is to be given to 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, 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 0.35 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℃, 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 to be not less than that determined by the following formula, but need not exceed 2 p:

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

Where: P – as defined in 2.5.1.2 of this Section;

$[\sigma]_{100}$ – permissible stress for 100℃, in N/mm^2;

$[\sigma]_t$ – permissible stress for design temperature, in N/mm^2.

The test pressure may be reduced to 1.5 p 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 Fuel oil piping, heating coils in tanks, bilge piping in way of double bottom tanks or deep tanks and hydraulic piping are to be tested by hydraulic pressure in accordance with Table 2.7.2.3.

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 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 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 PVC and fiber reinforced plastics;

(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 on 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 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℃).

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 Pn int, the following is to be taken whichever is smaller:

$$Pn_{\text{int}} \le P_{sth} / 4 \text{ 或 } Pn_{\text{int}} \le P_{lth} / 2.5$$

Where: Psth — short-term hydrostatic test failure pressure, in MPa;

Plth — long-term hydrostatic test failure pressure (100,000 h), in MPa.

(2) External Pressure

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

For an external pressure: $Pn_{ext} \leq P_{col} / 3$

Where: Pcol — 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 specified with due regard for maximum possible working temperatures in accordance with manufacturer's recommendations.

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℃ 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℃.

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 required 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 duration of a minimum 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 duration of a minimum 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 duration of a minimum 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 1×10^5 Ω/m.

Fire-resistance Requirements **Table 1.4.1**

N Piping systems	Locations								
	A	B	C	D	E	F	G	H	I
	Machinery spaces of category A	Other machinery spaces & pump rooms	Crude oil pump	Crude oil tank	Oil fuel tank	Ballast tanks	Cofferdams, Voidspaces, pipe tunnels & ducts	Accommodation, service & control spaces	Open decks
OIL (flash point≤60℃)									
1 Crude oil lines	NA	NA	L1	O	NA	O[10]	O	NA	L1[2]
2 Crude oil washing lines	NA	NA	L1	O	NA	O[10]	O	NA	L1[2]
3 Vent lines	NA	NA	NA	O	NA	O[10]	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[6]
7 Distribution line	NA	NA	L1	O	NA	NA	O	NA	L1[2]
OIL (flash point＞60℃)									
8 Base oil lines	×	×	L1	NA[3]	O	O[10]	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[7]	L1[7]	L1	NA	O	O	O	NA	L1
13 Fire main & water spray	L1	L1	L1	NA	NA	O	O	×	L1
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

N Piping systems	Locations								
	A	B	C	D	E	F	G	H	I
	Machinery spaces of category A	Other machinery spaces & pump rooms	Crude oil pump	Crude oil tank	Oil fuel tank	Ballast tanks	Cofferdams, Voidspaces, pipe tunnels & ducts	Accommodation, service & control spaces	Open decks
16 Ballast system	L3	L3	L3	O⑩	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	L3②
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)	L1④	L1④	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)	O①⑧	O①⑧	O①⑧	O	O	O	O	O①⑧	O
Sounding/air									
26 Water tank/dry space	O	O	O	O⑩	O	O	O	O	O
27 Oil tank (flash point＞60℃)	×	×	×	×③	O	O⑩	O	×	×
Other piping systems									
28 Air piping for control	L1⑤	L1⑤	L1⑤	NA	O	O	O	L1⑤	L1⑤
29 Service air pipe (no-essential service)	O	O	O	NA	O	O	O	O	O
30 Salt water pipe	O	O	NA	NA	NA	NA	O	O	O
31 Auxiliary low pressure steam pipe (≤0.7MPa)	L2	L2	O⑨	O	O	O	O	O⑨	O⑨

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℃.

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℃, "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 For accommodation units, “×” is to replace “L1”;

⑧ 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;

⑨ For essential services, such as fuel oil tank heating and unit’s whistle, “×” is to replace “O”.

⑩ For oil storage units where compliance with paragraph 3(f) of regulation 13F of Annex I of MARPOL 73/78 is required, “NA” is to replace “O”.

Location Definition:

A — Machinery spaces of category A

Machinery spaces of category A as defined in paragraph 1.2.6.4, Chapter 1, ART SEVEN of this Rule;

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 oil pump rooms

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

D—Crude 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

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

G —Cofferdams, voids, etc.

Cofferdams and voids are those empty spaces between two 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[2] ;

I - Open decks

Open deck spaces as defined in Reg. II-2/3.50 of SOLAS[3].

1.5 Material approval and quality control during manufacture

(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 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;

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

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

(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) In case the manufacturer has not established an approved quality system complying with ISO 9000 series or equivalent, pipes and fittings are to be tested in accordance with IACS UR to the satisfaction of the Surveyors for every batch of pipes.

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 to be considered.

1.6.1.2 Each support is to evenly distribute the load of the pipe and its contents 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 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 1×10^6 Ω/m. 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.

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 Electrically conductive;

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 epoxide resins are employed;

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 employ 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[4] acceptable to CCS.

APPENDIX 2 FLEXIBLE HOSES

1.1 Definition

Flexible hose assembly[5] 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 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.

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4 For the list of standards refer to IACS Recommendation No.86.

5 Flexible hoses are to be designed and manufactured according to the recognized national or international standards.

(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.

(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[6]:

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 is to be kept to minimum and to be limited for the purpose stated in 1.2.1.

(4) Where flexible hoses are intended to be used in piping systems conveying flammable fluids that are in close proximity of heated surfaces the risk of ignition due to failure of the hose assembly 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 installation of flexible hose assemblies is 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 radii.

1.5 Tests

(1) Acceptance of flexible hose assemblies is subject to satisfactory prototype testing. Prototype test programs for flexible hose assemblies are to be submitted for approval and are to be sufficiently detailed to demonstrate performance in accordance with the specified standards.

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

(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[7].

(3) All flexible hose assemblies are to be satisfactorily prototype burst tested to an international standard8 to demonstrate they are capable of withstanding a pressure not less than four times its design pressure without indication of failure or leakage.

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.

7 The following standards are to be used as applicable:

(1) ISO 6802 –Metallic wire reinforced rubber and plastics hoses and hose assemblies with wire reinforcements– Hydraulic pressure impulse test withflexing;

(2) ISO 6803 – Rubber and plastics hoses and hose assemblies – Hydraulic pressure impulse test without 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.

8 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 of systems on the unit except fire protection. Refer to the provisions of PART SEVEN of this Rule for the requirements of fire protection systems.

3.1.1.4 This Chapter excludes the systems relating to drilling plants, oil gas process plants and oil storage units. For the systems relating to these plants and units, refer to the relevant requirements of the CCS Guidelines for Certification of Drilling Plants, Rules for Classification and Construction of Floating Production Storage and Offloading Units and Rules for Construction and Survey of Offshore Fixed Platform.

3.1.1.5 The fixed piping systems for the purpose of drilling services are to comply with the acceptable standards or regulations.

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

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 characteristic (head-capacity) design curve is to be verified to the satisfaction of 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 operational 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 direct 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 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) are 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 arrangements

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

3.1.7 Electrostatic control

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

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 450mm above the floor.

3.1.8.3 All remote control valves shall be provided with devices independent of the remote control mechanism and capable of being manually operated in place (including extension lever manual control devices or replaced by permanent hand pumps). After opening and closing with a manual device, the function of remote control system of valve shall not be affected.

3.1.8.4 Each valve control position is to be provided with indicators showing whether they are 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 to ensure watertight integrity provided at the watertight boundaries is to comply with the relevant provisions of Section 1 Chapter 4 PART THREE of this Rule.

3.1.9 Unit side valves

3.1.9.1 Besides the requirements of this paragraph, the **unit side** 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 sea 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 sea 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 sea inlet and outlet valves under remote control of ballast systems are to be designed as automatic shutoff when incurred failure of power supply.

(4) The water inlet and outlet valves of seawater system that serves main engine, generators and power positioning are to be designed to keep position in loss of power supply (i.e. fail to set).

(5) On column-stabilized unit, the sea inlet remote control valve designed as f 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 and outlet.

(7) If the self-elevating unit side valves are provided within the attended spaces and easily accessible, the bilge water alarm arrangements may replace the remote control of valves.

(8) The drainage outlets of pre-ballast tanks on self-elevating units are to be provided with positively closing valves and automatic check valves (or a set of valves with both functions). If the valves are remotely controlled, they are to be designed as automatic closing in loss of power supply.

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 The side valves of surface units are to be complied with the relevant requirements of CCS Rules for Classification of Sea-going Steel Ships.

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
l25	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 chests

3.1.10.1 Sea chests are to be fitted with strainer plates at the shell. The direction of strainer plates is to be in line with the length of the unit. The strainers are to have a clear area of at least 2 times the area of the sea valves, and efficient means are to be provided for clearing the strainers, such as useing 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) For column-stabilized unit, an air pipe is fitted at the top of sea chest with stop valve at the root and its opening ends at the place not easily damaged above the lower hull top deck, plus stop valve inside the top deck.

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 At least two sea chests of different purposes are to be provided and the arrangement and location are to ensure they are not easily to fail concurrently.

Section 2 BILGE SYSTEM

3.2.1 Application

The provisions of this Section are applicable to the bilges system on the units other than surface-type units, whose bilge systems are to comply with the relevant provisions of CCS Rules for Classificationof Sea-going Steel Ships.

3.2.2 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 immerging in water and further causing malfunctions.

3.2.3 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 1.1.4.1 of Chapter 1 of this part.

(4) For both column-stabilized and foundation-type units, flooding in any compartment including bilge pump room is not to result in failure of bilge system;

(5) Flooding in any watertight space is not to cause flooding in other spaces through bilge piping;

(6) The arrangements of suction piping and suctions of main engine room, main generator room, propulsion room and pump rooms are of redundancy;

(7) The bilge water system of hazardous area and that of non-hazardous area are mutually independent;

(8) The slop system and bilge water system are mutually independent.

3.2.4 Installation requirements

3.2.4.1 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 and the spaces with another effective drainage facility are to be excluded.

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

3.2.5 Number of bilge pumps

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

3.2.5.2 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 fit with self-priming devices and properly connect with bilge piping system.

3.2.5.3 A bilge water ejector in combination with a proper pressure sea water pump may be accepted as a substitute for an independent power bilge pump.

3.2.6 Arrangement of bilge pumps

For both column-stabilized and submersible units, flooding in any one compartment including bilge pump room is not to result in failure of both bilge pumps. The control and display systems of valves of bilge system are to be operable even when valves are immerged.

3.2.7 Type of bilge pumps

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

3.2.8 Capacity of bilge pumps

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

$$Q = 5.66 d_1^2 \times 10^{-3}$$

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

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

3.2.9 Dimensions of bilge pipes

3.2.9.1 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.

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

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

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.

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

3.2.10 Connection of bilge pumps and bilge pipes

3.2.10.1 The connection of bilge pumps and bilge pipes is so arranged to ensure at least one pump in service when other bilge pumps are dismantled for inspection and repair.

3.2.10.2 All bilge suction pipes till to valve chest are not to be connected with any other purpose piping.

3.2.11 Control of bilge pumps and relevant valves

3.2.11.1 For column-stabilized and submersible units, each bilge pump and the valves of system are to be capable of being controlled in the centralized ballast control room as well as local control. Attention is to be given to compliance with the relevant requirements of 3.1.8 of this Chapter.

3.2.11.2 All distribution valve chests and manual operating valves connected with bilge water pumping arrangements are generally fitted in easily accessible locations. If these valves are installed in the usually unattended spaces below the load line and with no bilge water high-level alarm, these valves are to be capable of being operated from outside the compartments where the valves are located .

3.2.12 General arrangements of suctions

3.2.12.1 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 suctions.

3.2.12.2 The suctions are to be located to make water easily flow to the suctions.

3.2.13 Arrangement of suctions in machinery spaces

3.2.13.1 The essential machinery spaces below the waterline e.g. main engine space, generator space, propulsion unit room and pump room are to be arranged with bilge branch suctions, direct suctions and one emergency suction for water drainage. The number of branch suctions and direct suctions are determined by the compartment sizes and bottom shapes.

Emergency suctions in pump rooms of submersible unit may be exempted.

Direct suctions on column-stabilized unit may be exempted, provided that flooding in any propulsion and pump rooms does not affect the normal operation of propulsion, ballast and bilge systems.

3.2.13.2 The emergency suction is to be connected to the suitable pump of maximum capacity on the unit. No sludge box and filter is to be fitted on the emergency suction pipe.

3.2.14 Non-return arrangements

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 sea or with tanks, screw-down non-return valves or equivalent are to be provided in the following fittings:

(1) bilge valve distribution chests;

(2) bilge suction hose connections, whether fitted direct to the bilge pump or on the main bilge line;

(3) direct bilge suctions;

(4) emergency suctions;

(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.

3.2.15 Bilge suction pipes through double-bottom and deep tanks

3.2.15.1 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.

3.2.15.2 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 will be specially considered.

3.2.15.3 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.

3.2.15.4 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.

3.2.16 Bilge fittings

3.2.16.1 In machinery space, the bilge suctions are to be fitted in bilge wells. The bilge wells are made of steel with capacity not less than $0.3m^3$.

3.2.16.2 Each branch bilge suction and each direct bilge suction in machinery spaces and tunnels 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 bilge wells to ensure unrestricted flow of water.

3.2.16.3 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 that required for the suction pipe. The strum boxes are to be so constructed that they can be easily removed and replaced for cleaning.

3.2.16.4 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.

3.2.17 Void spaces

The void spaces adjacent to sea water 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 in compliance with the required bilge drainage system, the unit stability analysis and calculation are to be carried out.

3.2.18 Chain lockers

3.2.18.1 The chain lockers are to be drained by fixed bilge drainage system or mobile facilities and meanwhile to be provided with measures to drive out sludge and debris from bilge drainage system.

3.2.18.2 For column-stabilized units, the chain lockers where flooding may seriously affect the unit stability are to be provided with bilge water remote control indicators and fixed drainage arrangements. The bilge water remote control indicators are to be provided at the centralized ballast control station.

3.2.19 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.

3.2.20 High-level alarm

3.2.20.1 Normally unattended main engine rooms, generator rooms, boiler rooms and pump rooms below the waterline are to be provided with high-level water alarm devices.

3.2.20.2 For column-stabilized units, propulsion rooms and pump rooms in lower hull and the spaces in lower hull that flooding may affect unit stability are to be provided with two sets of independent high-level water monitoring and alarm systems with visual and audible displays at the centralized ballast control station.

3.2.21 Pollution prevention

The installation of bilge system is to comply with the relevant regulations to prevent pollution by the units.

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 scuppers, inlets, discharges and ship side valves of surface-type units are to comply with the relevant provisions of CCS Rules for Classification of Sea-going Steel Ships.

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 leakage oil to reduce the possibility of fire;

(4) To collect polluted leakage;

(5) To drain harmless sewage water.

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 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 oil and leading to the safe containment places;

(5) Draining toxic fluid to dedicated collection vessels;

(6) Collecting sanitary water and discharging overboard after treatment in 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 may be separately arranged with one common open drain tank (sump) applied, but all inlet headers of non-hazardous area at this tank (sump) are to be provided with water seals. The ends of all inlet pipes are to be extended below the minimum liquid level of the drain tank (sump).

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 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 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 760 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.

3.3.7.3 Means to protect water seal from freezing and maintain the required liquid level of the water seal are to be provided.

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 to the main deck.

3.3.8.2 The water on the main deck is to be collected and drained to the open drain tanks and if the capacity of such tanks is exceed, it may be drained overboard through bypass piping.

3.3.8.3 The oil-free rain on the main deck may also be directly drained i overboard. The drain pipes are preferably to be arranged along the outer side of shell plates, and if along the inner shell plates, the following conditions are to be satisfied:

(1) The scuppers on the shell plates are not to be located at the places where sea water enters inboard easily ;

(2) If not avoidable, upper return valves are to be provided on the drain pipes.

3.3.8.4 The water on the helicopter deck is to be directly drained overboard.

3.3.8.5 The open drains at the drilling area, well test area and oil process area are to be collected to the open drain tanks, and if the capacity of such tanks is exceed, it may be bypassed overboard .

3.3.8.6 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 25mm/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 treatment and compliance with the discharge standards of Annex I of MARPOL 73/78.

3.3.9 Open drain within enclosed spaces of accommodation area

3.3.9.1 All sanitary water and sewage water in the accommodation area are to be collected and may be discharged into sea only after treatment and compliance with the discharge standards of Annex IV of MARPOL 73/78, but the bathroom water may be directly bypassed to sea.

3.3.9.2 Each scupper in the accommodation area is preferably to be provided with water seals to prevent bad smell.

3.3.10 Open drain of bilge water in enclosed spaces other than accommodation area above waterline

The bilge water in the enclosed spaces other than the accommodation area above the waterline is generally extracted by bilge pumps. If open drain is employed, one of the following measures is to be taken:

(1) It may be directly drained to oily water tanks but water seals are to be provided on the drain piping;

(2) It may be directly drained to the bilge wells with bilge pump suctions in the lower spaces but non-return valves are to be provided on the drain piping.

Section 4 BALLAST SYSTEM

3.4.1 Column-stabilized units

3.4.1.1 Objectives

The objectives of ballast system provided are:

(1) To execute ballasting and de-ballasting of units to ensure the drafts under all operating conditions;

(2) To ensure the inclined units to recover to upright and safe draft state under conditions of assumed damage, seaside watertight compartment failure flooding and seawater piping failure flooding in watertight compartments.

3.4.1.2 Functions

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

(1) The ballast system is capable of being quickly turned the units from operating draft to severe storm draft when facing the upcoming severe storm;

(2) The ballast system possesses redundancy feature;

(3) The ballast system possesses safety feature to prevent excessive inclination due to negligence of operation;

(4) The ballast system possesses fail-safe feature;

(5) The ballast system is capable of being operated under the assumed damage or flooding conditions (e.g. accidental flooding of pump rooms, rooms where seawater system located, tanks adjacent to seawater, etc.);

(6) Emergency power supply is available to ballast system at all time;

(7) The ballast system is capable of being remotely and locally controlled.

3.4.1.3 Capabilities

(1) Intact state

The design and arrangements of ballast system could take suction from any ballast tank and execute any necessary ballast changes in a reasonable period of time when the unit is intact and has an inclination angle no more than 5° in any direction. The system is capable of being de-ballasted from maximum operating draught, either a distance of 4.6m or to the survival draught, whichever distance is greater, within 3 hours.

(2) Damage and flooding state

① The ballast system (including pumps, valve actuators, valve position indicators, tank contents gauges, flooding and bilge alarms, draught and inclination indicators, their various power sources, and any other ballast system control equipment) is to be designed to be capable of being operated in the event of assumed damage or flooding to enable the system to recover the unit to a condition of level trim at maximum operating draught, whilst not exceeding maximum damage displacement and within a reasonable period of time.

② The above recover ability refers to the ability with one pump inoperable. Such circumstance includes pump room flooding and any physical damage to the ballast system caused by tank damage or flooding;

③ The above objective is to be achieved by pumping instead of depending upon counter-flooding. For design purposes it is to be assumed that the unit has reached its final equilibrium position after damage④ Procedures for recovery are to be worked out to demonstrate the capability of the system. As part of a damage control plan, details of these recovery procedures including their duration and any precautions to be taken to maintain adequate stability during recovery are to be provided.⑤ Where pumps are required to operate under adverse pressure conditions, care is to be taken to ensure that the pumps have an adequate margin to prevent severe loss of performance..

3.4.1.4 Redundancy

(1) It is to be considered for the design and construction of ballast system that remainder of the system continues to be capable of being effectively operated in the event of the failure of any single part (e.g. pumps and their power supplies, valves and their actuator and control of pumps and valves). For the purpose, the specific measures below are to be taken:

① The centralized remote control of ballast pumps, control of ballast valves, valve position indicator, tank level indicator and draft indicator are to fuction independently of one another such that , a failure in one system will not cause malfunction or loss of operation of any of the other systems.;

② Where microprocessor or computer operated or multiplex type systems are installed, secondary or redundant control systems are to be provided to ensure continued operational capability;

③ The ballast pump numbers and their locations are to be satisfactory with the requirements of ballast capability in the event of flooding or fire of any single compartment;

④ At least two independent ballast pumps are to be capable of being taken suction on each ballast tank;

⑤ Ballast pump and ballast valve control systems are to be designed and arranged such that the loss of any one component in the control system will not result in loss of operation of other pumps and valves;

⑥ System is capable to of using two independent power supplies and under assumed damage or flooding conditions, at least one power supply is to be ensured.

(2) Failure effect analysis is to be carried out to demonstrate that uncontrolled transfer of water between tanks or through sea-connected inlets or discharges is to be avoided under the following, but not limited to, single failure conditions:

① Failure of any single valve or valve actuator;

② Failure of any single control and indication devices including loss of power supply and internal leakage of hydraulic control system;

③ The flooding of any space containing equipment associated with the ballast system, in which the risk of flooding is present.

3.4.1.5 Safety Protection

(1) The ballast system is to be arranged to prevent inadvertent transfer of ballast water from one quadrant to any other quadrant of the unit so as to avoid excessive heeling and trimming;

(2) The communication between two tanks or between any tank and the sea is to be via at least two independently remotely controlled valves.

(3) The system is to be arranged such that in the event of a burst pipe in any part of the system connected to the sea, the flooding can be brought quickly under control. For this purpose, the installation and control of unit side valves are to comply with the relevant requirements of 3.1.9 of this Section;

(4) The valves to transfer ballast are to be designed as fail-close type in case of loss of control or power supply. Upon reactivation of power, the fail-close valves are to be kept closing until the ballast operator assumes control of the reactivated system;

(5) Measures are to be taken to prevent any valve or pump from being inadvertently activated by a system fault or by any interference of external systems;

(6) All ballast operations are to be conducted by ballast operators unless overriding operational requirements dictate that the system be automatically controlled. Where the system is arranged for automatic or semi-automatic control (e.g. by microprocessor), particulars of the control system and its program logic are to be reviewed.

3.4.1.6 Control and display

(1) The unit is to be provided with centralized ballast control station which is to be located above the worst damage waterline and in a space not within the assumed damage zone and properly protected from the weather. The control station is to be provided with the following systems and equipment:

① Control and indication system of ballast pumps, ballast valves and sea chest valves;

② Level indication system of ballast and other tanks;

③ Draft and heeling/trimming indication system;

④ Power availability indication system (main and emergency);

⑤ Ballast system hydraulic or pneumatic pressure indication system;

⑥ All alarm failure audible and visible indication systems including power failure;

⑦ Control and indication system of remote watertight closing apparatus;

⑧ Bilge level alarm and indication system;

⑨ Control and indication system of bilge pumps and relevant valves;

⑩ Monitoring and indication system of tension of mooring lines;

⑪ Apparatus to separate or isolate the ballast pumps and ballast valve control system from their sources of electrical, pneumatic or hydraulic power;

⑫ Fixed internal communication apparatus which is independent of main power.

(2) In addition to remote control of pumps and valves at the centralized ballast control station, all ballast pumps and valves are to be provided with independent local control devices operable in the event of remote control failure. The independent local control devices of each ballast pump and its relevant ballast tank valves are to be in the same location;

(3) The tank level indication system of centralized ballast control station is to:

① indicate the levels of all ballast tanks. Auxiliary devices are to be added to measure the level of each ballast tank, which may be sounding pipes. The level sensors for tank indication are not to be provided in the suction pipes of tanks;

② indicate the levels of other tanks, e.g. fuel oil tanks, freshwater tanks, drilling water tanks or liquid storage tanks as well as the tanks that may affect unit stability. The level sensors for tank indication are not to be provided in the suction pipes of tanks.

(4) The draft indication system is to indicate the draft at each corner of the unit.

(5) The draft and trimming angle of unit are capable of being monitored in the centralized ballast control room with necessary accuracy so as to perform calculation of stability and monitor the effect of ballast exchange. The equipment is to remain operable despite the effects of waves and resulting motions of the unit, and after any assumed damage and flooding. However, it is not intended that such accuracy be maintained in storm conditions.3.4.1.7 Equipment and components

(1) The ballast pumps are to be self-priming unless it can be demonstrated that this requirement would be unnecessary;

(2) The closing speed of valve is to be considered to prevent harmful pressure fluctuation generated in the system. Any restrictions on adjustment is to be indicated;

(3) The open/close indication of each control valve is to comply with the requirements of 3.1.8.4 of this Chapter;

(4) Where practicable, level gauges are to be positioned to minimize inaccuracy induced as a result of inclination of the unit;

(5) Air pipes are to be self-draining under all normal conditions of trim, and the tank contents sensing method are not to be by comparison of pressure head at the bottom of the tank with atmospheric pressure;

(6) The arrangement of suctions of ballast pumps is to be effectively emptied the water in ballast tanks;

(7) The internal structure of tanks is to be incorporated with air holes and limber holes as necessary for efficient venting and flow to suction pipes (8) Enclosures housing ballast system electrical components, the failure of which would cause unsafe operation of the ballast system upon liquid entry into the enclosure. Therefore, such enclosures are to comply with the requirement of IPx8;

(9) The equipment, components, piping and electrical circuits are not to be located in the assumed damage zones.

3.4.2 Submersible unit

3.4.2.1 The unit is to be provided with effective ballast systems to perform ballast and deballast services of each ballast tanks of the units.

3.4.2.2 The unit is to be provided with at least two ballast pumps, one for main service while one standby. Failure of any compartment is not to cause failure of both ballast pumps concurrently.

3.4.2.3 Besides local control, the ballast pumps and valves required in ballast/deballast services are to be remotely controlled above the waterline.

3.4.2.4 Controllable gravity ballast is also allowed.

3.4.2.5 The provisions of 3.4.1.7 of this Section are also applicable to the submersible unit.

3.4.3 Self-elevating unit

3.4.3.1 The unit is to be provided with effective ballast systems to perform ballast and deballast services of each ballast tanks of the units.

3.4.3.2 The unit is to be provided with at least two ballast pumps where the capacity of each ballast pump is to satisfy the demand of ballast and deballast services of the unit. If the submersible pump of the primary seawater system is independently arranged at the different location on board and with ballast functions, it may used as a substitute.

3.4.3.3 The requirements of 3.4.1.7 of this Section are also applicable to the self-elevating unit.

3.4.4 Surface-type unit

The ballast systems of surface-type unit are to comply with the relevant requirements of Chapter 3 PART 3 of the CCS Rules for Classification of Sea-going Steel Ships.

3.4.5 Unit side valves and sea chest

The unit side valves and sea chest of each unit ballast system are to comply with the relevant requirements of 3.1.9 and 3.1.10 of this Chapter.

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 goes to the spaces required to be watertight;

(5) 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 to store flash point no higher than 60℃ under atmosphere conditions are to be provided with venting devices (breathing valves).

3.5.3.3 Where the pressure pipes pass through the bracings of floating structure, air pipes are to be provided.

3.5.4 Arrangement

3.5.4.1 Air pipes are to be fitted at the highest part of the tanks.

3.5.4.2 The exit location of air pipes on tanks is to be far apart from the filling pipes.

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 will be decided in each case and approved by CCS.

3.5.4.4 Tanks with cathode 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 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 piping is to be such that in the event of any one of the tanks being damaged, tanks situated in other watertight compartments of the unit cannot be flooded from the sea through combined air pipes.

3.5.5 Termination

3.5.5.1 The air pipes of oil storage tanks and the adjacent cofferdam void spaces are to be terminated at the exposed safe locations (where not to induce hazards 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 lubricating oil storage tanks or fuel oil draining tanks with a volume less than 0.5 m^3 and which cannot be pumped up may terminate in the machinery space, provided that the open ends are so situated that issuing 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 All 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 Where a tank is pumped, the total cross-sectional area of air pipe flow shall not be less than 1.25 times the effective flow area of the tank injection pipe, but in any case the inner diameter of air pipe shall not be less than 38mm for fresh water tank, 51mm for ballast tank and 63mm for oil tank. When multiple cabinets share an air pipe, the cross-sectional area of the shared air pipe shall be at least the sum of the maximum required air pipe cross-sectional areas of two tanks.

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 to shaft tunnels and 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 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	6.0mm
pipes of 160 mm external diameter or greater	8.5mm
Intermediate minimum thickness may be determined by linear interpolation	

3.5.8 Height above decks

The height of air pipes extending from the freeboard deck to the point where water may have access is to be not 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 Wire gauze diaphragm

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 wire gauze diaphragm.

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.

3.5.10 Bug screen

3.5.10.1 The freshwater tanks and other tanks with high requirement of cleanness for stored fluid are to 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 weather-tight requirements

Refer to the relevant provisions of Chapter 4 PART THREE of this Rule 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 overflow from air pipes where overfilling;

(2) To prevent water entry via overflow pipes when the unit is damaged.

3.6.2 Functional requirements

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

(1) The design of overflow pipes is to satisfy the demand of overflow of the tanks they are being served;

(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 that for which the tanks are suitable, or when the 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 Arrangements

3.6.5.1 In the case of oil and toxic fluid tanks, the overflow pipe is to be led to an overflow tank of adequate capacity or to a storage tank having a space reserved for overflow purposes.

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 allowed to be fitted to the overflow pipes.

3.6.5.4 A well illuminated sight glass is to be provided in the overflow pipe, and so far as possible at a place where the transfer pump can be stopped, or alternatively, an alarm device is to 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 system is to be such that in the event of any one of the tanks being bilged, tanks situated in other watertight compartments of the unit cannot be flooded from the sea through the overflow main.

3.6.6 Equivalent measures

For the objectives of this Section, the tanks provided with high level alarm and ultra-high level stop filling devices provided on the tanks may 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 leakage of 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 tankers 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℃ are to be provided with closing sounding devices with approved types; the approved-type closing sounding devices are to 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 or magnetic flap type and the cylindrical gauge glasses is prohibited to be used. The valves used for level indicators are to be of self-closed 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 tested as qualified.

3.7.3.4 If the stability-related tanks within the lower hull of column-stabilized units are provided with remote sounding devices, the sounding pipes could not to be exempted; if two sets of independent sounding devices are provided, the sounding pipes may be exempted.

3.7.4 Arrangements

3.7.4.1 All sounding pipes are to be led to positions above the bulkhead deck which could be accessible are at any time.

3.7.4.2 The sounding pipes are to be fitted as near the suctions as practicable.

3.7.4.3 All sounding pipes exposed to sea and weather are to be provided with permanently attached effective means of closing to prevent the free entry of water.

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 to be not less than 32 mm. Where a sounding pipe exceeds 20 m in length, the minimum internal diameter is to be increased to at least 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.

Section 8 OIL FUEL SYSTEM

3.8.1 Objective

The objective specified in this Section is to provide suitable combustion oil for combustion equipment and not to provide fuel resource for fire.

3.8.2 Functional requirements

To achieve the objectives specified in this Section, the fuel 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 fuel 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 Flash point of oil fuel

3.8.3.1 The flash point (closed-cup test) of oil fuels for the main propulsion machinery and generator prime movers or boilers is, in general, to be not less than 60℃. For the prime movers of emergency generating sets, the flash point of oil fuels is to be not less than 43℃.

3.8.3.2 In units intended for restricted services, where additional precautions are taken so that the ambient temperature of the space in which oil fuels are stored or used will not be allowed to rise to within 10℃ below the flash point of the oil fuels, CCS may permit the general use of oil fuels having a flash point of less than 60℃ but not less than 43℃.

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

3.8.3.4 The heating temperature of fuel oil is to comply with the requirements of 3.8.12.1 of this Section.

3.8.4 Oil fuel pumps

3.8.4.1 Where an oil fuel feed pump for diesel engine is fitted, one main feed pump of sufficient capacity and independent power driven and one standby pump are to be provided. Where two or more engines are fitted, each with its own booster pump, only one standby pump connected ready for immediate use is needed, or alternatively, a complete spare pump may be accepted, provided that the capacity of each pump is sufficient to satisfy the concurrent demand of two engines.

3.8.4.2 Oil Fuel transfer pumps, oil fuel delivery pumps, oil fuel booster pumps and oil sprayer cooling pumps, etc. are to be provided with main pumps and standby pumps.

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

3.8.5 Oil fuel tanks

3.8.5.1 The structure and arrangements of oil fuel tanks are to comply with the requirements of 1.2.2.5 Chapter 1 of this part.

3.8.5.2 Two oil fuel service tanks for each type of fuel used on board necessary for propulsion generating power and vital systems or equivalent arrangements are to be provided. The arrangement of oil fuel service tanks is to be such that one tank can continue to supply oil fuel when the other is being cleaned or opened up for repair. Each tank is to have a capacity of at least 8h at maximum continuous rating of the propulsion plant and normal operating load of the generator plant.

3.8.5.3 The service tanks only refer to the fuel tanks carrying quality oil fuel ready for immediate service, i.e. the grade and quality of oil fuel are to comply with the specifications required by the equipment manufacturers.

3.8.5.4 Settling tanks are to be provided with means for draining water from the bottom of the tanks. If settling tanks are not provided, the oil fuel bunkers or daily service tanks are to be fitted with water drainage.

3.8.5.5 Drain valves or cocks fitted to the oil fuel tanks are to be of self-closing type, and suitable provision is to be made for collecting the oily discharge. The sampling valves or cocks on the tanks are also to be of self-closing type.

3.8.5.6 The fire prevention and separation arrangements of oil tanks are to comply with the relevant requirements of 1.2.2 and 1.2.7 of this part.

3.8.6 Valves on fuel oil tanks

3.8.6.1 Oil fuel pipes ,which, if damaged would allow oil to escape from a tank (including but not limited to storage tank, settling tank or service tank) situated above double bottom is to be provided with a cock or valve directly 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 500L may be exempted from this requirement.

3.8.6.2 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 type.

3.8.6.3 The installation of valves on oil tanks is to comply with the requirements of 2.5.6.1 of this part.

3.8.6.4 The controls and locations of oil fuel valves of remote shutoff of emergency generators and diesel oil fire pumps are to be separated from the remote shutoff controls of other pumps.

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

3.8.7 Oil fuel piping

3.8.7.1 Oil fuel piping is to be separated from other piping.

3.8.7.2 Oil fuel pipes fittings and their valves are to be made of steel or other approved materials. Nodular graphite cast iron may be used for valves under static head fitted on the outside of fuel tank walls. Grey cast iron valves may be used in oil fuel piping system with design pressure of less than 0.7 MPa and design temperature of less than 60℃.

3.8.7.3 The filling piping on the unit 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 led to a level as low as practicable inside the tank.

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

(3) Where filling stations are fitted on board, 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.

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

3.8.7.5 Pipes conveying heated oil to boilers under pressure are to be of seamless steel or other suitable material having flanged or welded joints, and are to be placed in sight above the floor in well lighted parts. The number of flanged joints is to be kept to a minimum. The flanges are to be machined. The jointing material is to be oil-proof and impervious to oil heated to 150℃, and is to be as thin as possible. The scantlings of the pipes and their flanges are to be suitable for a pressure of at least 1.37 MPa.

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

3.8.7.7 Flexible hoses of approved materials and design may be used for the burner pipes, provided that spare lengths, complete with couplings, are carried on board. The flexible hoses are to comply with 2.3.7 of this part.

3.8.7.8 The fire prevention requirements of the piping are to comply with the requirements of 3.6.3 of this part.

3.8.8 Oil supply of generators

The two or more engine installations 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 inoperable due to fire of any engine. The shutoff arrangements are capable of being manual closed reliably.

3.8.9 Oil supply of boilers

3.8.9.1 This provision is applicable to auxiliary boilers. The oil supply to main boilers is to comply with the relevant requirements in Chapter 3 of the CCS Rules for Classification of Sea-going Steel Ships.

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

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

3.8.9.4 A quick-closing master valve is to be fitted on each boiler oil supply line and suitably located so that the valve can be readily operated in an emergency, either directly or by means of remote control.

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

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

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

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

3.8.10 Purification of fuel oil

3.8.10.1 The unit is to be provided with oil fuel purification system as required to remove the water and harmful impurity in the oil fuel.

3.8.10.2 At lease two sets of fuel oil purification systems should be provided with each capacity capable of satisfying with the maximum continuous load of main and auxiliary engines; failure of any system is not to affect the normal operation of another system.

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

3.8.10.3 If the oil fuel purification system needs to be heated, each system is to be equipped with heater where each set of heaters is to satisfy the demand of purification system.

3.8.11 Filter

3.8.11.1 The fuel oil supply pipes of diesel engines and boilers are to be installed with oil fuel filters and their arrangements are to ensure continuous supply of filtered oil fuel when filters are being cleaned. For this purpose, duplex filters are generally to be installed.

3.8.11.2 The arrangement of duplex filters is to minimize the possibility of filter opening due to mal-operation 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.

3.8.11.3 Pressure meters or differential gauges are to be installed before and after the filters.

3.8.12 Heating of fuel oil

3.8.12.1 The temperature of fuel oil heating media in fuel oil tanks, heaters or separators is not to be higher than 220℃. The maximum temperature of fuel oil heating in fuel storage tanks is to be at least 10℃ lower than the flash points.

But if all the conditions listed in the below (1) to (5) are satisfied, the fuel oil in fuel oil service tanks, settling tanks and other oil tanks in fuel supply systems may be heated above the temperature limit:

(1) The length of vent pipes of such oil tanks or cooling arrangements are sufficient to cool the oil gas below

60℃, or the exhaust openings of ventilation pipes are to be at least 3 m away from the areas with fire danger;

(2) The vent pipes are to be provided with flameproof wire gauze;

(3) The vapor space of oil tanks is not provided with the openings leading to machinery space (but the manholes secured by bolts are acceptable);

(4) Enclosed spaces are not to be directly above such fuel oil tanks except well-ventilated cofferdam spaces;

(5) The vapor space of fuel oil tanks is not to be provided with electrical equipment unless such electrical equipment is approved intrinsically safe.

3.8.12.2 The condensate from steam or return hot water within the pipes used for heating the oil fuel (lubricating oil) are to be led to a separate observation tank in a well lighted and accessible position where it can be readily seen whether or not it is free from oil.

3.8.12.3 Relief valves are to be fitted on the oil side of heaters. The discharge from the relief valves is to be led to the suction of a related pump or to a safe position.

3.8.12.4 For the unit with oil fuel pipes and oil transfer pipes intended for conveying heated oil fuel are to be provided with suitable heating means if necessary.

3.8.12.5 Oil fuel tanks in which oil is heated and heaters are to be provided with suitable means for ascertaining the temperature of the oil.

3.8.12.6 Where steam heaters or heaters using other heating media are provided in fuel oil systems, they are to be fitted with at least a high temperature alarm or low flow alarm in addition to a temperature control, except where the temperature dangerous for the ignition of the medium cannot be reached.

3.8.12.7 Electric heating of fuel oil or lubricating oil is to be avoided as far as practicable. When electric heaters are fitted, means is to be provided to ensure that heating elements are permanently submerged during operation. In order to avoid in any case element surface temperature of 220℃ and above, a safety temperature switch, independent from the automatic control sensor, is to be provided. The safety switch is to cut off the electrical power supply in the event of excessive temperature, and is to be provided with manual reset.

3.8.12.8 The exhaust gas of diesel engines is not to be directly used for heating oil fuel

3.8.13 Changeover of oil fuel

The diesel engines using heavy oil as fuel are to be capable of being immediately changed over to light oil.

3.8.14 Application of fuel oil with flash point lower than 60℃ but not lower than 43℃

3.8.14.1 The oil storage tanks other than double bottom are not to be located within category A machinery space.

3.8.14.2 The suction side of pumps are to be provided with temperature measurement devices.

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

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

3.8.15 Installation of oil leakage collection and oil trays

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

3.8.16 Galley ranges

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

3.8.16.2 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.

3.8.16.3 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 of fuel supply in the event of leakage, fire or ventilation failure;

(3) The fuel piping are independent of other piping and provided with reliable leakage prevention measures;

(4) The storage and carriage equipment of natural gas and crude oil are to be installed within the hazardous areas;

(5) Combustion equipment is suitable to use natural gas or crude oil and being burned completely, and their stable operation is ensured.

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 of 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 being located;

③ Detection of flammable gas 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 is in series with gas 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 combustion equipment located could be vented.

The valves are to be arranged such that when under the conditions described in 3.9.3.1(2) and failure of air supply to boiler combustion, flameout in boilers, abnormal pressure of fuel supply, will automatically shut off the two valves in series and meanwhile automatically open the vent valve. Alternatively, the function one of the valves in series and of the valve in the vent line can be incorporated into one valve body (three-way valve) so arranged that when one of the above condition occurs, fuel supply is to be shut off and the vent is to be opened. I 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 gas-freeing and inerting.

3.9.3.2 The sections of fuel pipes prior to the space where combustion equipment 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 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 designed to prevent entry of seawater and rain and to meet the Class A-0 fire division standard;

(3) Internal combustion engine enclosure where only the internal combustion engine and their necessary equipment are to be installed is to be separated from generator enclosure;

(4) For boilers, only the burner control unit is to 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 suitably used 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℃ (if the ignition point unknown), the ventilation air changes inside the enclosure is to be at least 90 times/h to turn the space inside the shells into 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 SEVEN;

(11) The working pressure of fuel pipes is not 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; 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 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 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 under pressure 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 automatic filling of the duct with nitrogen upon detection of gas is arranged for. The fan is to be an explosion proof type. The fan motor 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 of combustion equipment is to be fitted with a suitable enclosure that accommodates as much as possible of the burners and associated valves and pipes, but without restricting the air flow to the burner registers. 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 doors are to be fitted for 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 immerged.

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 venting pipe to lead to the atmosphere in a safe position. Suitable flameproof wire gauze is to be fitted on the 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 train 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 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 10 PART EIGHT of this Rule for the detail requirements of 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 capable of being lubricated by redundant means;

(2) The lube oil is to have suitable quality;

(3) The equipment performance, piping design and arrangements are to be suitable to the intended services and to meet requirements of fire protection;

(4) The system is to have two level 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 under normal navigating condition. 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 each generator and essential auxiliary engine is 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 needed.

3.11.4 Lube oil tanks

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

3.11.4.2 The setting of valves on tanks and requirements of quick closing valves are to comply with the requirements of 3.8.6 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 from the bottom of the tanks. Drain valves/cocks and sample valves 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 1.2.7 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 are not to apply the same lube system.

3.11.5.2 The lube 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 for loss of lube oil pressure.

3.11.5.3 Purification, filtering and heating of lube oil are to comply with the relevant requirements in 3.8.10, 3.8.11 and 3.8.12 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 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 good quality;

(3) The equipment performance, piping design and arrangements 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 could be quickly changed over.

3.12.4 Piping system

3.12.4.1 The hydraulic transmission piping is not to be used for the lubrication of other equipment.

3.12.4.2 The strength of hydraulic pipes and fittings is to be sufficient to withstand the pressure fluctuations which might occur in the system.

3.12.4.3 The piping system is to be provided with measures to prevent pressure pulse and the flow state of fluid is to keep laminar flow.

3.12.4.4 Relief valves are to be provided in the hydraulic transmission 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, safety valves are to be fitted on the liquid inlet side. For hydro-pneumatic accumulators, safety valves or fuse 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 are 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 will not occur in the laying of the hoses and they are to be far away from vibration and hot sources.

3.12.4.13 The hydraulic piping system is to be provided with filters and comply with the relevant requirements of 3.8.11 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 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 corrodible to the system components. Its flash point is not to be less than 60℃.

3.12.7 Arrangements

The arrangements of high pressure hydraulic components are 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 meet 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, 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 centre 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, heat stability, initial boiling point, purity and cleanliness as well as the technical conditions 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 is preferable four years but not shorter than one year.

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 tank is directly in contact with atmosphere, the temperature of thermal oil coming into direct contact with air is not allowed to exceed 50℃.

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℃ 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 approaching the abandonment standard;

(4) Assay is immediately to be carried out 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 is preferably to be replaced:

(1) Viscosity change >15%;

(2) Carbon residue value reaches 15% or n-pentane > 15%;

(3) Acid value > 0.5mg 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℃;

(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 Hazardous zone of Category 2 hazardous area, and the equipment inside the space are to be qualified explosion-proof equipment; the space that full-welding pipes go through may be regarded as non-hazardous areas;

(3) To prevent explosive fluid (refer to the definitions of Chapter 1 of PART SEVEN of this Rule) leak into thermal oil system, one of the following measures is preferably to be taken:

① The working pressure of thermal oil system is higher than the pressure of heated media. For the system to heat the normal pressure crude oil storage tanks, the inlet and outlet locations of tank heating coils are to be provided with stop valves. The system is so arranged that a positive pressure in the coil is to be at least 3 m water column above the static head of the heated liquid when circulating pump is not in operation;

② The system is designed as double circuit heating, 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 of PART SEVEN of this Rule.

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 heated surface and oil will not produce individual high temperature points.

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 maximum heating power. The pressure is not to be increased 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 is to be provided for protecting the heater furnace. Such system is to be permanently connected to the furnace and can be activated from outside the heater space.

(2) Exhaust-fired heaters are to be provided with a fixed fire extinguishing and cooling system. A water spry 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 $1m^3$;

(2) 1.3 times of the expansion volume, where expansion volume is greater than $1m^3$.

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 are preferably extend to the location a little 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 he provided with quick discharge valves to quickly discharge the thermal oil to collection tanks being located in lower position.

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 from the release valves of heaters and the overflow or quick discharged thermal oil of expansion tanks are to be regularly water-drained to prevent danger 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 are to comply with the requirements if used as collection tanks.

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, the capacity of each pump being 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 a non-return valve is also to be provided at the outlet side of the pump .

3.13.12.3 Safety 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 starts in cold state, the viscosity of thermal oil is to be lower than $300 \times 10^{-6} m^2/s$ to prevent overlarge 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 at fore and aft sides of each filter.

3.13.15 Oil Trays

Thermal oil heaters, flanges, 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, valves and other components in thermal oil piping are to be made of steel or equivalent ductile material.

3.13.16.2 Nonferrous metals having a catalytic action on thermal oil, such as copper and copper alloy are 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 are to be selected with a higher pressure than the design pressure.

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 liable to occur. These drip trays are to be drained to a collection tank.

3.13.17.4 Thermal oil piping are to be provided with compensators or expansion joints.

3.13.18 Sampling device

Piping are 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 permitted to be protected by the insulation material. All insulation surfaces are to be covered by stainless steel, galvanized steel or aluminum plating. 3.13.19.2 Insulation materials are to be closed-cell material at possible leakage points, such as 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 less than 0.5m 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 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

Oil-fired heaters are to be provided with oil leakage detection 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

Oil-fired 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	Oil supply to burners automatically shut off
Thermal oil flow	Low	Oil supply to burners automatically shut off
Thermal oil pressure	Low	Oil supply to burners automatically shut off
Thermal oil outlet temperature	High	
	High and high	Oil supply to burners automatically shut off
Combustion air pressure	Low	Oil supply to burners automatically shut off
Oil fuel 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. Oil supply to burners automatically shut off *
* Where burner flame and ignition fails, combustion chamber is to be purged before re-ignition.		

Section 14 BASE OIL SYSTEM

3.14.1 Objectives

The objectives specified in this Section are:

(1) To provide suitable base oil for drilling operations;

(2) To prevent base oil from unnecessary overflow and leakage that offer fuel to fire or cause pollution.

3.14.2 Functional requirements

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

(1) The quality of base oil is to comply with the requirements of drilling liquid and its flash point is to be not less than 60℃ (closed cup test);

(2) The base oil system is to be capable of collecting of leaked oil.

(3) Besides main pumps, the base oil pumps are to be provided with standby pumps of the same capacity as that of the main pumps based on demands.

(4) Besides local control, the base oil pumps are to be capable of remote shutdown outside the spaces where they are located.

(5) The base oil piping systems are independent of other piping systems;

(6) Oil filling is to be capable of performing at both sides of units and the filling pipes are to be fitted with measurement instruments and facilities to prevent overpressure.

(7) For the base oil pipes that base oil may leak from the storage tanks above the double bottom if damaged, quick closing valves are to be fitted on the storage tanks;

(8) The piping materials are required to be the same as oil fuel piping.

Section 15 BOILER WATER FEED, BLOW OFF AND CONDENSATION SYSTEM

3.15.1 Objectives

The objectives specified in this Section are to ensure the feed of boiler water, safe blow off and timely collection of condensation water.

3.15.2 Functional requirements

For the objectives specified in this Section, the system is to have the following functions of:

(1) Reliability of feed system;

(2) Redundancy of condensation system; and

(3) Safety of blow-off system.

3.15.3 Feed pumps

3.15.3.1 Two or more power 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.

3.15.3.2 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, one circulating pump will be accepted.

3.15.4 Feed piping

3.15.4.1 Two separate feed water systems are to be provided for auxiliary boilers for essential services, including feed pumps. The feed systems are to be of sufficient capacity to supply feed water to the boilers with any one system out of action.

3.15.4.2 Feed water systems are to be so arranged that the feed water cannot be contaminated by oil or oily water.

3.15.5 Condensate pumps

Two or more independently driven condensate pumps are to be provided for dealing with the condensate from the condensers with one pump standby. The independently driven feed pump may be accepted as a standby condensate pump.

Section 16 COOLING WATER SYSTEM

3.16.1 Objectives

The objectives specified in this Section are:

(1) To provide suitable cooling source to the equipment on the unit that need cooling;

(2) To prevent cross-contamination of heat exchange sources.

3.16.2 Functional requirements

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

(1) The design capacity of system is to satisfy the cooling demand of various equipment;

(2) The design of system is to minimize the hazard of cross-contamination.

(3) The system is to have certain redundancy ability.

(4) The system is to have regulating capacity and alarm protection.

3.16.3 Seawater cooling pumps

3.16.3.1 Two or more independently power driven seawater cooling pumps are to be provided on the unit. These pumps are to be of sufficient capacity to supply the units with any one pump out of action.

3.16.3.2 The arrangements of seawater pumps on column-stabilized unit are to ensure that two pumps will never be concurrently out of action in case of flooding in any watertight compartment of the unit.

3.16.3.3 The self-elevating units are to comply with the following requirements:

(1) In the elevated state, two independent water sources are to be fed to seawater cooling pumps;

(2) During the lifting or lowering operation, the supply of cooling seawater is not to be affected.

3.16.4 Freshwater cooling pumps

3.16.4.1 Each propulsion and generation diesel engine is to be provided with one main freshwater cooling pump with sufficient capacity under the maximum output of diesel engine and one standby pump of sufficient capacity to ensure normal operation of unit. The standby pump is to be independently driven and immediately put into operation.

3.16.4.2 Where several propulsion and generation diesel engines are installed and each having or provided with cooling water pumps, the standby cooling water pump may be exempted.

3.16.5 Cooling piping

3.16.5.1 Not less than two sea inlets, which are to be fitted on both sides of the unit as far as practicable, are to be provided for the cooling water pumps of seawater cooling system or circulating system. The suction of any cooling water pump or circulating pump under normal operating and transit conditions is to be supplied from either one of the sea inlets.

3.16.5.2 The self-elevating units are to be provided with at least two submersible pumps to supply water far from each other.

3.16.5.3 Strainers are to be provided to the suction pipes between the sea inlets and the suctions of seawater cooling pumps. The strainers are to be so arranged that they could be cleaned without interrupting the cooling water supply.

3.16.5.4 The seawater piping on the column-stabilized units are preferably to be designed as below:

(1) The seawater main is preferably designed as ring main and arranged at the protected locations that are not easily damaged. The outlet pipes of main and standby pumps are to be connected to ring main and the connection points are to be far from each other;

(2) The ring main is preferably to be fitted with at least 4 isolation valves to isolate possibly damaged pipe sections;

(3) The seawater for cooling of diesel engine freshwater system is preferably to be supplied dually from the ring main The feed branches are to be led from both sides of the ring main as far as practical and to form the ring branches of cooling seawater of diesel engine.

3.16.5.5 The cooling water piping for diesel engines is to be capable of effectively regulating the inlet cooling water temperature. For closed circuit fresh water cooling system, expansion tanks are to be provided and it is recommended that an alarm for high temperature be fitted.

3.15.5.6 Where necessary, the main diesel engine with closed circuit fresh water cooling system is to be provided with suitable means for warming the engine.

3.16.6 Prevention of cross-contamination hazard

It is to be considered for the pressure design of the heat exchange cooling edge and cooled edge that the possibility of seawater leakage into freshwater is minimized.

3.16.7 Corrosion protection

Provision is to be made for the protection of all equipment cooled by seawater against corrosion.

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, 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) 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 discharge air is led to a safe location.

3.17.3 Air compressors

Two or more 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.

Consideration may not be given to the stand-by air compressors for the air irrelevant with safety.

3.17.4 Air receivers

3.17.4.1 There are at least two sets of main air receivers.

3.17.4.2 Besides main air receivers, the 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 replenishment or replenishment from the upstream main air receiver if the pressure is lower than allowed.

3.17.5 Piping

3.17.5.1 The air main for essential services are to be designed as ring main that are fitted with isolating valves of proper number to isolate damaged pipe sections.

3.17.5.2 Air piping for instrumentation, control or emergency service is to be isolated from other air piping, unless the air quality supplied by other piping complies with the requirements of instrumentation and control air quality.

3.17.5.3 The suctions of air compressors are to take air in the safe areas and avoid suction of exhaust.

3.17.5.4 The piping in the compressed air system are 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 are 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 press reduction is needed, the piping are to be provided with two sets of pressure reduction devices in parallel, one for main service while the other 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 Filers and driers are to be fitted on air piping for instrumentation and control.

3.17.7.2 Driers are to be fitted on the compressed air piping for bulk delivery material.

3.17.8 Pneumatic control system

3.17.8.1 Components that require better than instrument air quality for operation are not to be used. Extremely small openings in air passages are be avoided.

3.17.8.2 To prevent accumulation of fluid in the pipes, main pipes are be inclined relative to the horizontal, and drainage is to be arranged..

3.17.8.3 The instrumentation air is to be free of oil, moisture, contamination or condensation.

To prevent occurrence of condensation, the dew point of air transferred in pipes is to be at least 10℃ lower than the ambient temperature but generally the dew point of air transferred in the indoor pipes is not necessarily to be lower than 5℃.

3.17.8.4 Reduction valves and filters are to be duplicated when serving more than one function (e.g. more than one control loop)..

3.17.8.5 Local accumulators that are used as back up air supply for essential systems are to be designed and located or protected to avoid inadvertent isolation or mechanical damage that could prevent correct operation on demand.

3.17.8.6 Piping is to be cleaned and dried before being put into operation.

3.17.9 Air filling of firefighter’s outfit, EEBDs and anti-hydrogen sulfide breathing apparatus

Dedicated breathing air system is preferably used to fill the firefighter’s air receivers, EEBDs and anti-hydrogen sulfide breathing apparatus (refer to the requirements of 6.1.7 and Section 6 and 7 of Chapter 12 of PART SEVEN).

3.17.10 Compressed air stating system of diesel engines

The compressed air starting system of diesel engines is to comply with the relevant requirements of starting of diesel engines in the CCS Rules for Classification of Sea-going Steel Ships. Besides that, the air starting of generation diesel engines is to be:

(1) Provided with at least two starting air receivers, and the total capacity of these two receivers can enable each diesel engine to continuously start three times with no replenishment, but the total starting times are not necessarily to exceed eight times;

(2) Provided with at least two air compressors. These two compressors are capable of filling air from atmospheric pressure to the required pressure in the receivers within 1 h. The required pressure is to meet the staring times of the engine.

Section 18 EXHAUST GAS SYSTEM

3.18.1 Objectives

The objectives specified in this Section are to make the exhaust gas of the unit meet the economical, 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 discharged from drilling unit, oil production unit or storage unit is not to yield sparking capable of igniting an explosion;

(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 alternatively fired furnaces of boilers using exhaust gases 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 on drilling unit, oil production unit or storage unit 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 is preferably 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 of 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.

Section 19 Steam System

3.19.1 Arrangement

3.19.1.1 Generally, steam pipeline is not to be through the luminaire storage room, paint room, or supplies storage compartment. But when through storage compartment is inevitable, effective measures are be taken to prevent the leakage of steam. The steam pipeline in storage compartment is to be matched with reliable measures to prevent the mechanical damage. And the detachable joints in piping are to be reduced to a minimum required as possible, and full penetration butt welded joints are to be used as possible.

3.19.1.2 When laying steam pipeline with work pressure no more than 0.98 MPa along the fuel bulkhead, the distance between the pipeline and fuel bulkhead is not to be less than 250 mm.

3.19.1.3 The steam pipeline is to be arranged in the machine and boiler chamber where easily to see and access. Steam pipeline generally is not to be laid under floor except the heating coils and blowing pipeline.

3.19.1.4 Provision for condensate and water hammer is to be provided.

3.19.1.5 If two or more boilers are connected to a common header or steam manifold, the steam connection branch pipes to each boiler are to be provided with a non-return valves and drain cocks.

3.19.2 Condensate water Drainage

3.19.2.1 When units in the conditions of trim, upright or heeling no more than 5 ℃, the inclination of pipe and the number and positions of drain valves or cocks are to be make the steam pipeline effectively discharge condensate in any section. The arrangement of drain valves and cocks is to be easy to access.

By-pass pipeline is to be set if there is a condenser.

3.19.2.2 If the condensed water of the steam pipe which is used for heating crude oil storage tank or fuel gas is designed into back in the safe zone, the condensed water is to be through the degassing facility first located in the hazardous zone. The facility is to be equipped with combustible gas alarm sensor, and its vent pipe is to be lead to a safety place and fit a flame screen.

3.19.3 Pressure-reducing Pipeline

3.19.3.1 The pipeline behind the pressure-reducing valve is to be equipped with pressure gauge and safety valve with sufficient discharge capacity. The pipeline need to fit pressure-reducing valve is to be provided with by-pass pipeline or a parrallel standby pressure-reducing valve.

3.19.3.2 The low pressure pipeline which is connected with a high-pressure pipe system with a pressure-reducing valve is to be fitted with a proper pressure relief valve and a pressure test device if the design pressure is lower than the pressure of the high-pressure pipe system.

3.19.4 Thermal Expansion Stress

The influence of the thermal expansion stress for the steam pipeline at working temperature over 350 ℃ is to be considered.

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 SEVEN 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) Living premises, service offices, control stations, machine places where people work, machine repair rooms, electrical rooms, etc. shall be equipped with heating and cooling air conditioning systems. If the operation area is restricted, heating and cooling air conditioning systems can be equipped according to the restricted operation environment;

(3) The air ventilators in the open spaces are provided with weather-tight devices;

(4) In the event of flooding in assumed damage zone, it is not to lead to flooding into other spaces through the ventilation ducts;

(5) Where the unit is under the normal dynamic and static heeling and assumed damage conditions, the inlet and outlets are not to lead to flooding in the service spaces;

(6) Refer to the relevant requirements of Chapter 3 of PART SEVEN 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 not 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 value of air changes, fresh air volume required by each person or temperature increase limit.

4.1.4.2 The compliance calculation of space air changes is to be based upon the gross volume enclosed by the shape dimensions of spaces (volume of equipment and furniture within the spaces is not to be deducted)

4.1.4.3 The calculation of mud tank air changes is based upon the gross volume enclosed by the shape 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 spaces, shaft tunnels, bracing members, etc., they are to be effectively ventilated by mechanical means when human enters. Hydrodynamic or mobile ventilators could be applied.

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 weather-tight requirements

Refer to the relevant provisions of Chapter 4 of PART THREE of this Rule for the watertight and weather-tight 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 of Chapter 11 of PART SEVEN 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 area are to be far from the hazardous areas (e.g. wellhead area) 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 kept 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 keep slight low pressure to prevent external dirty air 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 smoke 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 directly against the beds.

4.2.2 Air Changes (ventilation capacity)

The ventilation capacity or air changes in various spaces of living quarter areas are preferably as below:

(1) The fresh air quantity of bedrooms is to be at least 30 m^3/h per capita.

(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 CO_2 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 SEVEN 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 combustion equipment spaces

The ventilation of machinery spaces where the internal combustion engines, boilers and other combustions equipment are located is to:

(1) Provide adequate air to equipment combustion and human comfort where combustions equipment are operated with full load and under all weather conditions;

(2) Ensure normal operation of main engine and generators in the event of any one ventilator failure for the main engine room and main generation room;

(3) Ensure the pressure within the machinery spaces a bit higher than the outdoor pressure.

4.3.3 Ventilation of columns and lower hull onboard column-stabilized unit

4.3.3.1 The ventilation of columns and lower hull is preferably to use the common supply and exhaust ventilation system.

4.3.3.2 The exposed duct inlets and outlets are to be arranged above the damage waterline.

4.3.3.3 The ducts arranged below assumed damage waterline are to be kept watertight in the event of flooding.

4.3.3.4 The common supply and exhaust ducts in the columns are to be located outside the assumed damage zones; the supply and exhaust branches of each space are to be fitted with watertight dampers, whose locations are to be fitted at the branches close to common duct or at the branches passing through the bulkheads of the ventilation served space.

The fire damper is to be provided (upward rounding value) in accordance with the requirements of 3.2.3 of Chapter 3 of PART SEVEN.

4.3.3.5 Each watertight damper and branch between damper and common duct are not to be fitted in the assumed damage zone.

4.3.3.6 Ventilated spaces in the upright posts and lower hull shall have proper ventilation to meet the normal operation of electromechanical equipment.

4.3.3.7 The ventilation spaces of columns and lower hull are to be provided with moisture removal system.

4.3.4 Ventilation of upper hull onboard column-stabilized unit

4.3.4.1 The control rooms (generator control room, mud control room, etc.), switchboard rooms, machine repair rooms, electric repair rooms in the upper hull and frequently attend spaces are to be provided with cold and warm air conditioning ventilation.

4.3.4.2 Besides central air conditioning system, the essential spaces like generator control rooms, switchboard rooms, etc. are to be equipped with respective independent air conditioning ventilation.

Section 4 VENTILATION REQUIREMENTS FOR FIRE AND EXPLOSION PREVENTION

Besides compliance with the provisions of this Chapter, refer to the provisions of Chapter 3 of PART SEVEN of this Rule for the specific requirements of ventilation of fire and explosion prevention.

CHAPTER 5 STEERING GEARS AND ANCHORING GEARS

Section 1 STEERING GEARS

5.1.1 Application

The provisions of this Section are applicable to the steering gears of self-propelling units.

5.1.2 Steering

5.1.2.1 Besides the conditions referred to in 5.1.2.18, the unit is to be provided with a main steering gear and an auxiliary steering gear. Such main steering gear and auxiliary steering gear are to be arranged within reasonable and practicable range and when one gear is out of action, the other gear will not be rendered ineffective.

5.1.2.2 The main steering gear is to have sufficient strength and capable of maneuvering the unit at the maximum service speed, which is to be testified in trial navigation. The design of main steering gear and rudder stock is to ensure no damage at the maximum astern speed, but such design requirement is not necessarily to be proved by the trial under maximum astern speed and maximum rudder angle.

5.1.2.3 The main steering gear is to be capable of putting the rudder over from 35º of one side to 35 º of the other side with the unit at its deepest sailing draft and running ahead at maximum ahead service speed and under the same conditions, from 35 º either side to 30 º the other side within 28 s. 5.1.2.4 If the requirements of 5.1.2.3 are to be executed and in any case, the diameter of rudder stock at the tiller is over 120 mm, the main steering gear is to be driven by power.

5.1.2.5 The arrangement of power plant of main steering gear is to automatically restart when the power is restored after supply power failure.

5.1.2.6 The auxiliary steering gear is to be of sufficient strength and capable of steering the unit at navigable speed and being brought speedily into action in an emergency.

5.1.2.7 The auxiliary steering gear is capable of putting the rudder over from 15 º one side to 15 º the other side within 60 s with the unit at its deepest navigation draft and running ahead at one half of maximum ahead service speed or 7 knots whichever is the greater.

5.1.2.8 If the auxiliary steering gear complies with the requirements of 5.1.2.7 and in any case, the diameter of rudder stock at the tiller is over 230 mm, the auxiliary steering gear is to be r driven by power.

5.1.2.9 Where the main steering gear comprises two or more identical power units and the main steering gear is capable of being operated rudder as required in 5.1.2.3, while operating with all power units, the auxiliary steering gear need not be provided. Within reasonable and practicable scope, the arrangement of main steering gear is not detrimental to the integrity of other components of steering gears in the event of single failure in its piping or in one of power unit out of action.

5.1.2.10 Steering gear control for the main steering gear is to be provided both on the navigation bridge and in the steering gear compartment. The steering gear control system operable from the bridge, if electric driven, it is to be supplied from a steering gear power circuit from a point within the steering gear compartment.

5.1.2.11 Where the main steering gear is arranged in accordance with 5.1.2.9, two independent control systems are to be provided and each system is capable of being controlled in the bridge. Where the control system consists of a hydraulic telemotor, the second independent control system need not be fitted.

5.1.2.12 Where the auxiliary steering gear is power-operated, one set of control system operable from the bridge is to be provided and is to be independent of the control system for the main steering gear.

5.1.2.13 Means is to be provided in the steering gear compartment for disconnecting any steering gear control system from the circuit.

5.1.2.14 A means of communication is to be provided between the bridge and the following :

(1) Steering gear compartment;

(2) Emergency steering locations (if fitted).

5.1.2.15 If the steering gear is power-operated, the angular position of the rudder is to be indicated on the bridge. The rudder angle indication is to be independent of the control system of steering gear.

5.1.2.16 The angular position of the rudder is to be recognized in the steering gear compartment..

5.1.2.17 An emergency power supply in conformity with the requirements of 2.2.3.2 of Chapter 2 of PART FIVE is to be provided.

5.1.2.18 If non-ordinary rudder is provided, or the unit is operated by non-rudder arrangements, special consideration is to be given to the steering system to ensure reliability and effectiveness requirements of 5.1.2.1.

5.1.3 Electric and electric hydraulic steering gear

5.1.3.1 The indicators displaying that the motors of electric and electrohydraulic steering gear are running are to be installed on the bridge and at proper main machinery control positions.

5.1.3.2 Each electric or electrohydraulic steering gear comprising one or more power units is be served by at least two exclusive circuits fed directly from the main switchboard; however, one of the circuits may be supplied through the emergency switchboard. An auxiliary electric or electrohydraulic steering gear associated with a main electric or electrohydraulic steering gear may be connected to one of the circuits supplying this main steering gear. The circuits supplying an electric or electrohydraulic steering gear are to have adequate rating for supplying all motors which can be simultaneously connected to them and may be required to operate simultaneously.

5.1.3.3 Short circuit protection and an overload alarm are be provided for such circuits and motors. Protection against excess current, including starting current, if provided, is to be for not less than twice the full load current of the motor or circuit so protected, and is to be arranged to permit the passage of the appropriate starting currents. Where a three-phase supply is used an alarm is to be provided that will indicate failure of any one of the supply phases. The alarms required in this paragraph are be both audible and visual and are to be situated in a conspicuous position on the bridge.

Section 2 WINDLASSES

5.2.1 Temporary windlasses

5.2.1.1 Temporary windlass devices shall comply with the requirements of windlass devices in Section 2 of Chapter 13 of Part Three of CCS Rules for Classification of Steel Seagoing Vessels.

5.2.1.2 Windlasses for position mooring complying with the requirements of 5.2.1.1 may be used in place of temporary windlasses.

5.2.1.3 See Section 1, Chapter 8, PART TWO of the Rules for the definitions of temporary anchoring equipment and position mooring equipment.

5.2.2 Windlass used for position mooring

5.2.2.1 If windlass is the only positioning device, it is to be with sufficient safety coefficient, and designed to keep the position of the unit in various conditions. In case of any single component failure, windlass is not to be cause further damage to the residual mechanism.

5.2.2.2 Anchor, anchor cable, shackle, and other associated connection accessories, and installation is to be designed, constructed and tested in accordance with internationally recognized offshore mooring equipment standards. If applicable, measures are to be taken to keep the certification documents of tests. The unit is to be with the record of the equipment change and inspection.

5.2.2.3 Anchor cable can be used in steel wire, rope, chain or any combination thereof.

5.2.2.4 Emergency system is to be provided making anchor cable out of the unit when the windlass loses the main power.

5.2.2.5 Fairleader and sheave is to be designed into preventing the anchor cable excessive bending and wear. The attachments to the hull or structures are to be strong enough to withstand the stress imposed when an anchor cable is loaded to its breaking strength.

5.2.2.6 Suitable anchor stowage arrangements are to be provided to prevent movement of the anchors in a seaway.

5.2.2.7 The windlass is to be designed to have two independent power operation and braking system .The each system is to be capable of holding against a static load equivalent to at least 50% of the anchor cable's breaking strength. With the approval of CCS, a manually operated brake can be used as one of the power operation and braking systems.

5.2.2.8 The windlass is to be designed to have adequate dynamic braking capacity to control normal combination loads from the anchor, anchor cable and anchor handling vessel.

5.2.2.9 On loss of power to the windlasses, the power-operated braking system is to automatically act and be capable of withstand 50% of the total static braking capacity of the windlass.

5.2.2.10 Each windlass is to be capable of being operated from a position where a clear view of its operation is available.

5.2.2.11 Means is to be provided at the windlass control position to monitor cable tension and windlass power loads and to indicate how many the cable has been paid out.

5.2.2.12 A manned control station is to be provided to indicate and automatically record the cable tension and the wind speed and direction.

5.2.2.13 Reliable means of communication are to be provided at the each crucial operation locations of windlass.

5.2.2.14 Special consideration is to be given to the design which combines use of the anchoring systems and propellers to maintain the unit positioning."

CHAPTER 6 JACKING AND FIXATION SYSTEM

Section 1 GENERAL PROVISIONS

6.1.1 Application

6.1.1.1 This Chapter applies to the design, manufacturing, installation and testing of jacking gear machinery, fixation mechanism and associated systems for the hull of self-elevating units.

6.1.1.2 This Chapter covers mainly the relevant requirements for yoke and pin type and rack and pinion type jacking systems as well as fixation mechanism usually employed in self-elevating unit. For other types of jacking systems, the requirements of this Chapter may be applied as appropriate.

6.1.2 Terms and definitions

The following terms and definitions are applicable to this Chapter.

6.1.2.1 Jacking system

It means the mechanical system (mainly including power source, control system and mechanical elevation arrangements) that lifts and lowers the hull of self-elevating unit and transfers the load between unit hull and legs. The system is also applied to lift and lower legs where the hull is in the afloat condition. The most commonly used jacking system is the rack-and-pinion type and yoke and pin type hydraulic jacking system.

6.1.2.2 Fixation system

It means the mechanical system to maintain the hull of self-elevating unit and legs stationary where the unit is in the elevated and/or the afloat condition. The fixation system may be the in-built fixation mechanism in jacking system or an independent fixation system or the combination of both. The common used independent fixation system mainly includes independent power source, control system and mechanical fixation mechanism, which after elevation of self-elevating units or legs uses drive components for engagement of racks of fixation mechanism with leg racks that establishes rigid connection between hull and legs and then partially or wholly transfers the unit weight and environment and service loads upon the elevation arrangements to the fixation mechanism.

6.1.2.3 Rack-and-pinion type jacking system

A jacking system with main pinions, most commonly driven by electric or hydraulic motors through a jacking gearbox, to engage with racks attached to the legs of the unit in order to lift or lower the hull in relation to the legs in the elevated condition or to lift or lower the legs in relation to the hull in the afloat condition.

6.1.2.4 Yoke and pin type jacking system

A jacking system with yokes with pins, both operated by hydraulic cylinders, to engage with holes on the legs of the unit in order to lift or lower the hull in relation to the legs in the elevated condition or to lift or lower the legs in relation to the hull in the afloat condition.

6.1.2.5 Rated capacity of jacking unit

Vertical effective force delivered to the leg by the jacking system per jacking unit when lifting or lowering the hull.

6.1.3 Plans and information

6.1.2.1 The following plans and information, as appropriate for the type of jacking gear machinery and fixation systems, are to be submitted in quadruplicate to CCS for approval:

(1) Schematic diagrams and specifications of jacking and control systems;

(2) General arrangement of jacking system;

(3) Diagrams and material specifications of principal parts of jacking system;

(4) Calculations for jacking system (including rack strength, shutting pin and pin structure);

(5) Strength calculations for principal parts of jacking system;

(6) Fatigue strength calculations, if necessary;

(7) Diagrams of control systems (electrical, pneumatic, hydraulic and computer controls)

(8) Construction and installation diagrams of main and auxiliary hydraulic cylinders;;

(9) Construction of shutting pins;

(10) Arrangement of hydraulic piping system;

(11) Construction of gear transmission devices

(12) Jetting leg system;

(13) Arrangement and specifications of fixation and control systems;

(14) Diagrams and material specifications of principal components of fixation system;

(15) Calculations for fixation system (including fixation racks, leg rack strength calculation);

(16) Strength calculations for principal components of fixation system;

(17) Recommended best industrial practices are to be adopted in the failure mode and effect analysis for jacking and fixation systems, and the information to be submitted is to include but not limited to the following:

① Description of systems related to jacking and holding operation and function block diagrams showing their interactions. These systems will include jacking system, fixation system, power distribution system, hydraulic system, control system (including programmable system) , monitor and alarm system and their accessories;

② All significant failure modes related to the purpose of FMEA;

③ Each predictable cause in relation to each failure mode;

④ Means to detect occurrence of failures;

⑤ Effect of failure on the capacity of the remaining systems to jack up the unit;

⑥ Analysis of possible common failure modes.

Where any system component is identified as non-redundant and its redundancy is not practical, the reliability and machinery protection of such components are to be further studied and the study report including the results is to be submitted for review;

(18) Other plans and information as deemed necessary by CCS.

6.1.4 General requirements

6.1.4.1 Jacking systems and fixation systems are to be designed and constructed with Failure Mode and Effect Analysis (FMEA) to ensure certain redundancy such that a single failure of any component will not impair the safety of the unit. The jacking systems and fixation systems are to be designed and constructed to safely maintain the relative height of legs to the unit in case of loss of power (e.g. electric, hydraulic or pneumatic).

6.1.4.2 The control station from which the jacking and fixation gear machinery is operated, is to be provided with all necessary monitoring, alarms and controls, including hull alignment, pressure, liquid level, pin position, running indication, overload alarms and indication of availability of applicable power sources as appropriate. Meanwhile, the requirements of 2.6.7 of Chapter 2 of PART FIVE are to be complied with.

6.1.4.3 Inclination indicators for hull are to be provided on the unit. The inclination of hull during elevating is to be displayed continuously by the indicators. Where the inclination of hull exceeds a permissible maximum value, audible and visual alarms are to be given.

6.1.4.4 Jacking systems are to be provided with control means at side of each leg and the central control station and a device is to be provided at the central control station to change control space. Fixation systems are to be provided with control means at side of each leg. Means of two-way communication are to be provided between the control room at side of each leg and the central control station.

6.1.4.5 Emergency switches capable of stopping the operation of hull elevating system are to be provided at the central control station and the control room at side of each leg. These switches are to be affixed with a red mark and a nameplate.

6.1.4.6 For jacking systems capable of being remotely controlled, a display clearly showing the legs or the hull during elevating is to be provided at the central control station.

6.1.4.7 The working space of jacking systems is to be well illuminated and provided with safe access for maintenance of all devices.

6.1.4.8 Each leg or bottom mat is to be provided with a fixed jetting leg device and it is recommended that blowing drainage equipment be provided.

6.1.4.9 The materials of main components of jacking and fixation systems are to be selected in accordance with the service load environment, purposes and design temperature. Transmission gears are to be made of forged carbon or alloy steel. The use of other materials is subject to agreement of CCS.

(1) The gear forged steel pieces and other essential forged steel pieces of jacking and fixation systems are to comply with the requirements on gear forged pieces of the CCS Rules for Materials and Welding.

(2)The Charpy V notch impact tests of the racks of elevating gears and fixation mechanisms arerequired to be consistent with the requirements of the leg rack panel of unit; for forged alloy steel pieces that have been quenched and tempered, the average impact energy of Charpy V notch impact tests at temperatures of the designed working temperature minus (—)20° is to be no less than 41(J) in the longitudinal direction and no less than 24(J) in the tangential direction.

(3) The Charpy V notch impact test values of the gears and essential alloy forged steel pieces of jacking and fixation systems under the design temperature are to comply with the requirements of Table 6.1.4.9

Requirements of Impact Tests of Gears and Essential Alloy Forged Steel Pieces of Jacking and Fixation Systems **Table 6.1.4.9**

Tensile Strength Rm（N/mm2）			600	700	800	900	1000	1100
The average impact energy (J) of Charpy V notch impact test under design working temperature is to be not less than	Normalizing plus tempering	Longitudinal	25	20	15	—	—	—
		Tangential	15	12	9	—	—	—
	Quenching plus tempering	Longitudinal	41	32	30	27	25	21
		Tangential	24	22	20	18	16	13

Note: If the required minimum tensile strength is the intermediate values in the table, the corresponding minimum value of average impact may be determined by linear interpolation.

6.1.4.10 The strength analysis of jacking and fixation systems is to include at least the possible maximum load under the following conditions:

(1) Normal lifting of unit;

(2) Normal holding of unit;

(3) Pre-load lifting and lowering;

(4) Pre-load holding of unit;

(5) Normal lifiting and lowering of legs;

(6) Normal holding of legs;

(7) Severe storm holding (elevating and afloat conditons).

Section 2 YOKE AND PIN TYPE HYDRAULIC JACKING SYSTEMS AND FIXATION SYSTEM

6.2.1 General requirements

6.2.1.1 For each hydraulic jacking system, shutting pin system and control system, at least two independent power pumps are to be provided. Where any one pump is out of operation, the other pump or pumps are to operate to the required minimum design power of the system.

6.2.1.2 The hydraulic piping is not to be connected with any other piping outside the system. If safety and redundancy are fully considered, the hydraulic power source may be employed in other systems after special safety risk analysis is carried out.

6.2.1.3 The oil temperature in the hydraulic piping system is generally not to exceed 60℃ in service condition.

6.2.2 Oil Cylinders and fixation mechanisms

6.2.2.1 Oil cylinders are to be provided with cushions or other means for limiting position.

6.2.2.2 The jacking system of each leg is to be provided with a synchronous device.

6.2.2.3 Provision is to be made for the protection of the piston rod of cylinders against corrosion.

6.2.2.4 At least two sets of positioning fixation mechanism are to be provided on each leg. The calculated load (in accordance with yield strength) is to be not less than the maximum working load which the leg is capable of withstanding. Shutting pins are to be made of high quality carbon or alloy steel or other ductile material.

6.2.2.5 Hydraulic fixation mechanisms are to be provided with a self-fixation or other fixation means. Where positioning fixation mechanism is not provided, it is to be agreed by CCS.

6.2.2.6 The external loading, to which the hydraulic system is subjected, is to be transferred to legs by exclusive supporting members after the unit is lifted.

6.2.2.7 The off actions of main and auxiliary shutting pins of legs are to be interlocked. Pilot lamps displaying whether main and auxiliary shutting pins are on or off are to be provided at the central control station and the control room at side of each leg.

6.2.2.8 The spacing of shutting pins of jacking systems is to be designed for easy inserting of the pins into pinholes on uneven seabed.

6.2.3 Hydraulic piping

6.2.3.1 The strength of hydraulic pipes and fittings is to be sufficient to withstand the maximum fluctuation pressure which might occur in the system.

6.2.3.2 Hydraulic oil current velocity is, in general, to be:

(1) 1 ~ 1.5 m/s for oil suction pipes;

(2) 1.5 ~ 2.5 m/s for oil return pipes;

(3) 2.5 ~ 5.5 m/s for pressure oil pipes.

6.2.3.3 The minimum wall thickness of pipes is to comply with the relevant requirements of Section 2 Chapter 2 of this part.

6.2.3.4 The internal wall of pipes is to be subject to acid washing so as to be clean, smooth and even.

6.2.3.5 The bending portions of pipes are to be free of serration, torsion, crushing, corrugation or other defects. The ellipticity is to be not more than 10% of the external diameter of the pipe and the radius of curvature is in general to be more than three times the external diameter of the pipe.

6.2.3.6 The pipes are not to be used in one of the following cases:

(1) The depth of corrosion or scratch is equal to or exceeds 10% of wall thickness of pipes; or

(2) The depth of cavities is equal to or exceeds 20% of external diameter of pipes.

6.2.3.7 Hydraulic piping is to be arranged in parallel or vertically to avoid bending and cross connection as far as possible.

6.2.3.8 Hydraulic piping is to be secured on pipe racks and suitable provision for compensation is to be made to permit pipe expansion and contraction. The linings used to secure pipes are to be made of lead or rubber to prevent the pipe rack from direct contact with the pipe.

6.2.3.9 Slim hydraulic pipes of control systems, if arranged at positions where they are liable to mechanical damage, are to be efficiently protected by reliable and removable casings.

6.2.3.10 Hydraulic piping is to be so arranged as to avoid the formation of air pockets, and provisions are to be made for air release and oil drainage on highest and lowest positions of the piping.

6.2.3.11 When used in the hydraulic system, rubber hoses are to comply with the following requirements:

(1) The bursting pressure of rubber hoses is to be not less than four times the maximum working pressure;

(2) Abrupt bends of the hoses are to be avoided, and the radius of curvature is in general to be not less than 10 times the external diameter of the hose. Bending is to be avoided in the connecting end of hoses, and the distance from the connecting end to bending point is to be not less than six times the external diameter of the hose;

(3) Rubber hoses are to be arranged to avoid twisting and contact with other pipes so as to prevent wear; and

(4) Rubber hoses are to be far away from any hot source as possible.

6.2.3.12 Hydraulic cylinders and piping in the hydraulic system are to be protected against overpressure.

6.2.4 Spare parts

Spare parts for the hydraulic jacking system are as follows:

(1) Piston sealing races: 100% of the amount used to a leg;

(2) Hydraulic cylinder sealing races: 100% of the amount used to a leg;

(3) Oil cylinder cover studs and nuts: 100% of the amount used to a leg;

(4) Shutting pins of fixation mechanism: 100% of the amount used to a leg;

(5) Pressure gauges of each type fitted: 2 for each;

(6) High pressure rubber hoses: 100% of the amount used to a leg;

(7) Pipes, flanges, bolts, nuts and valves of each specification are to be provided with adequate amount of spare parts.

6.2.5 Inspections and tests

6.2.5.1 All hydraulic components and control instruments are to be inspected before assembly.

6.2.5.2 All hydraulic pipes are to be connected and cleaned by oil for at least 12 hours in workshop.

6.2.5.3 All hydraulic piping systems and oil tanks are to be cleaned by oil for at least 12 hours after installation. Before cleaning, the overflow valves and hydraulic valves in the piping system are to be inspected for adequate pressure to prevent returning oil. On completion of cleaning, no-load operation is to be carried out only after the oil in the system is drained and a complete inspection is satisfactorily made.

6.2.5.4 After completion of manufacture, hydraulic pipes (including rubber hoses) are to be hydraulically tested in workshop and the test pressure is to be twice the working pressure. After assembly on the unit, tightness test is to be carried out and the test pressure is to be 1.5 times the working pressure. In no case is any test pressure allowed to exceed 85% of the specified yield strength of the material used.

6.2.5.5 Jacking systems are to be tested in accordance with a test program. On completion of the test, a test report and relevant technical documents are to be furnished by the manufacturer.

Section 3 RACK-AND-PINION TYPE JACKING SYSTEMS AND FIXATION SYSTEM

6.3.1 General requirements

6.3.1.1 The hydraulic system in rack-and-pinion type jacking systems is to comply with the relevant requirements of Section 2 of this Chapter.

6.3.1.2 If electrically driven, the power and construction of the electrical jacking system for each leg are to be such that a single failure of a motor or a transmission mechanism will not render the system inoperable.

6.3.1.3 An automatic fixation mechanism and a manual relief device are to be provided on each transmission shafting.

6.3.1.4 Braking devices of jacking system are to fail-safe in the engaged position in the event of a failure or interruption of the power supply to the lifting machinery. The capacity of braking fixation mechanism is not to be less than 120% maximum braking torque required.When the rotation speed of the jacking gears exceeds 1.1 times of its maximum rated speed, its braking mechanism is to be automatically engaged into the fixation position to prevent fall of the unit due to stall of the jacking gearing.

6.3.1.5 The jacking system, together with the fixation system if fitted, is to be capable of adequately lifting and supporting the hull, or leg installation under all operating, survival and tow conditions.

6.3.1.6 In selecting the prime movers for the elevating machinery, consideration is to be given to the effects of friction at the mesh of the pinion and rack, and between legs and guides, together with uneven load distribution.

6.3.1.7 For the rated load of lifting device, the friction between lifting assembly and rack as well as tooth profile error shall be properly considered.

6.3.2 Enclosed gearing

6.3.2.1 All enclosed transmission gearing is to be designed in accordance with a standard acceptable to CCS.

6.3.2.2 The gearing is to have sufficient load capacity to meet the requirements of Tables 6.3.2.2(1) and 6.3.2.2(2).

Minimum Safety Factor for Tooth Root Bending Stress Table 6.3.2.2(1)

Tooth root bending stress	Minimum Safety Factor $S_{F\min}$
Dynamic operation：	
Normal jacking of hull and legs	1.5
Pre-load jacking of hull (See note ①)	1.5
Staic operation：	
Normal holding load (without fixation system engaged) (See note ②)	1.5
Pre-load holding	1.5
Other	1.5
Symble	
$S_{F\min} = \sigma_{FP}/\sigma_F$ σ_{FP} = allowable tooth root bending stress σ_F = calculated tooth root bending stress	
Note： ① Based on 50 hours operation； ② It is considered that where a fixation system is properly engaged. The loading applied to the jacking gears will be reduced.	

Minimum Safety Factor for Tooth Flank Hertzian Stress Table 6.3.2.2(1)

Tooth Flank Hertzian Stress	Minimum Safety Factor $S_{F\min}$
Dynamic operation：	1
Staic operation：	1
Symble	
$S_{H\min} = \sigma_{HP}/\sigma_H$ ① σ_{HP} = allowable Hertzian contact stress ② σ_H = calculated Hertzian stress	

6.3.2.3 Unless otherwise agreed, the following values are to be used in the gear design:

Application factor, K_A:

Electric motor drive 1.0

Load sharing factor, Kr:

With pinion load monitoring 1.0

Without pinion load monitoring 1.2

6.3.3 Main pinion and rack

6.3.3.1 The design of the main pinion and rack is to be specially considered and the following requirements are to be complied with:

(1) The material hardness of the pinion is to be not less than that of the rack tooth material;

(2) The pinion is to have a safety factor on tooth root bending of not less than 1.5 for both static and dynamic loading conditions;

(3) The ultimate strength (collapse load) of the main pinion tooth is not to be less than 1.1 times that of the rack tooth.

(4) Consideration is to be given to the loads being applied to the main pinion mesh during wet/dry tow conditions where full load reversal may be expected.

6.3.3.2 Refer to the requirements of Section 4, Chapter 3 of PART TWO of this Rule for the strength calibration of leg racks, elevating gears, fixation racks and main fixture components.

6.3.4 Shafting

6.3.4.1 Nominal shaft stresses are to be calculated as follow:

$$\sigma_b = \frac{32000M}{\pi d_0^3}$$

$$\tau = \frac{16000T}{\pi d_0^3}$$

Where: τ – calculated torsional shaft stress, in N/mm^2;

T – shaft torque, in Nm;

d_0 – shaft outside diameter, in mm;

σ_b – calculated bending shaft stress, in N/mm^2;

M – bending moment, in Nm.

6.3.4.2 The maximum stresses due to bending and torsion are not to exceed the values shown in Figure 6.3.4.2. The assessment of the maximum stresses is to take into account the system overload conditions. The allowable stress limits in Figure 6.3.4.2 include an allowance for stress concentration at keyways or other areas of stress concentration, not exceeding 3.0. Where an effective stress concentration exceeds this value, the design will be specially considered.

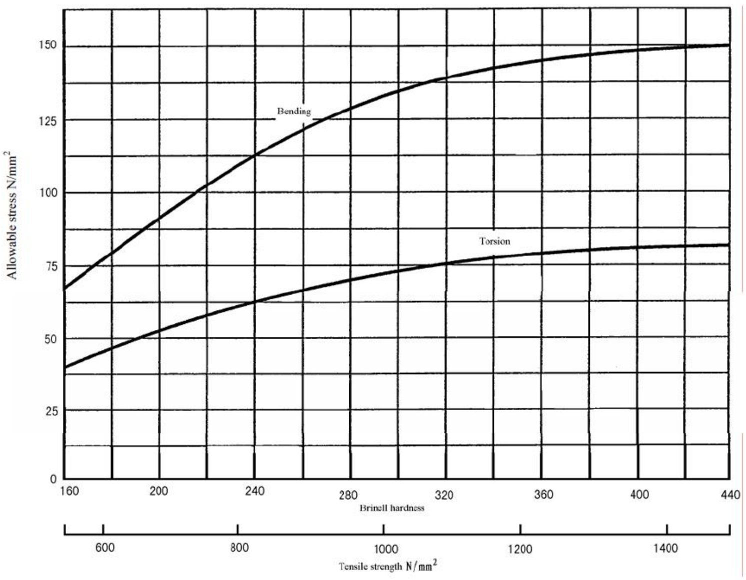

Figure 6.3.4.2 Allowable shafting stresses

6.3.4.3 When designing a shaft for a finite number of rotating cycles, the allowable stresses may be increased by the factors in Table 6.3.4.3.

Factors for Shaft Stresses **Table 6.3.4.3**

Cycles	Coefficient
Up to103	2.4
103 to104	1.8
104 to105	1.4
105 to 106	1.1
Over 106	1.0

6.3.4.4 Shaft materials with the properties beyond the range covered by Figure 6.3.4.2 are to be specially considered.

6.3.5 Bearings

6.3.5.1 The capacity of the sleeve or antifriction shaft bearings is to be such as to adequately carry the radial and thrust loads which would be induced under all operating conditions.

6.3.5.2 Hydrodynamic radial bearings are to be lined with babbitt or other material suitable for the intended application and duty. They are to be properly installed and secured in the housing against axial and rotational movement.

6.3.5.3 Selection of rolling element bearings is to be based upon the bearing manufacturer's recommendations for the design loading and application as well as recognized standard requirements.

6.3.6 Other requirements

6.3.6.1 Means are to be provided such that in the event of failure of one or more of the elevating machinery units, the defective unit(s) could be mechanically isolated such that the effectiveness of the remaining units in lifting/lowering the hull is not impaired.

6.3.6.2 The individual jacking gear units are to be designed such that each unit could be removed separately for inspection, maintenance and repair.

6.3.6.3 Main pinions and racks are to be supplied with a suitable lubricant during all jacking operations.

6.3.7 Inspection and tests

6.3.7.1 The inspection and tests of jacking and fixation systems during the manufacturing and assembling process of manufacturers are to be carried out in accordance with the drawings, survey/test program approved by CCS.

6.3.7.2 The new designed systems are to be type tested at the manufacturers in accordance with the approved test program. The test load is not to be less than 1.5 times of design rated jacking load or 1.1 times of maximum static support load, whichever is greater. After the tests, all primary components are to be dissembled for inspection and crack testing. For factory test of the systems, load test of the entire systems is to be carried out at their designed rated lifting load.

6.3.7.3 Installation inspection of jacking and fixation systems is to be carried out and effectiveness test is to be performed in accordance with the approved test program, including the followings:

(1) Jacking trials to verify satisfactory operation of the jacking mechanism under all design jacking and holding load conditions; fixation trials to verify satisfactory operation of the fixation mechanism under all design static supporting load conditions;

(2) Jacking of hull/legs to the full extent of design travel to demonstrate satisfactory alignment of legs, racks, pinions and guides;

(3) Operation of the fixation system at various positions of leg/hull travel.