RULES FOR CLASSIFICATION

Ships

Edition July 2021

Part 4 Systems and components

Chapter 6 Piping systems

DNV AS

FOREWORD

DNV rules for classification contain procedural and technical requirements related to obtaining and retaining a class certificate. The rules represent all requirements adopted by the Society as basis for classification.

Any comments may be sent by e-mail to *rules@dnv.com*

CHANGES – CURRENT

This document supersedes the July 2020 edition of DNVGL-RU-SHIP Pt.4 Ch.6.
The numbering and/or title of items containing changes is highlighted in red.

Changes July 2021, entering into force 1 January 2022

Topic	*Reference*	*Description*
Thermal oil installations	Sec.1 Table 2	Documentation requirements included.
Bilge water systems	Sec.1 Table 2	Clarification of documentation requirements that only refrigeration rooms with toxic installations need to submit separate drawing of the associated bilge system.
Certification of valves	Sec.1 Table 3	Requirements for compliance documents moved from Sec.9 to avoid duplication of requirements.
Carbon and low alloy steels	Sec.2 [1.2.1]	Reference to use within temperature limits in Sec.9 deleted due to duplication in Sec.9.
Nodular cast iron of the ferritic type	Sec.2 [1.5]	Removed use of nodular cast iron of ferritic type on ship's side and bottom and collision bulkhead.
Plastic pipe penetrations	Sec.2 [1.7.6]	Added prescriptive requirements to both plastic pipes and the actual penetrations.
Local manual operation of sea valves	Sec.3 [1.2.1]	Opens up for use of hand pump fitted to actuator as local manual operation for hydraulically actuated sea suction and discharge valves.
Local manual operation of inaccessible valves	Sec.3 [1.2.4]	All hydraulically or pneumatically actuated valves in voids and tanks shall have local manual operation by means of a hand pump connected to the control system.
Collision bulkhead penetrations	Sec.3 [1.4.2]	SOLAS requirements have been reflected in the rules.
Plastic pipes in relation to fire	Sec.3 [1.4.6]	Added guidance note with specification for which arrangement this rule paragraph is applicable.
Thin walled pipes penetrating watertight bulkheads	Sec.3 [1.4.7]	Added requirements for valves to be installed at the watertight bulkheads if thin walled metallic pipes are penetrating.
Bilge system	Sec.4 [1.1]	Removed references to requirements covered elsewhere.
Deep tanks	Sec.4 [2.2.6]	Replaced reference to requirement with updated requirement to drain pipes through cargo holds.
Drainage of refrigerated cargo spaces	Sec.4 [3.1.5]	Clarification that refrigerated cargo spaces shall comply with **RM** notation even if vessel is not assigned **RM** notation.
Door sill height	(previous) Sec.4 [4.1.4]	Removed reference Pt.3 Ch.12 for sill heights below the uppermost load line. .
Drainage openings	(previous) Sec.4 [4.1.7]	Removed reference Pt.3 Ch.12for drainage opening for cargo deck spaces.
Grating	Sec.4 [4.2.5]	Grating open area ratio requirement limited to spaces protected by fire water system.

Topic	Reference	Description
Drainage	Sec.4 [6.1.1]	Removed requirement of bilge drainage arrangements in machinery space to comply with Sec.4 [2].
Bilge suction	Sec.4 [6.4.1]	Requirement for suction in specially formed machinery spaces changed.
Bilge pumps	(previous) Sec.4 [8.1.6]	Requirement removed.
Bilge system	Sec.4 [8.1.6]	Requirements for bilge pumps for ships carrying dangerous goods applies to complete bilge system, not only cargo hold.
Bilge pipes through tanks	Sec.4 [8.5.1]	Same requirements as for deep tanks have been set forth for other double bottom tanks containing water ballast or fuel oil.
Air pipes from thermal oil tanks	Sec.4 [10.1.19]	Air pipes from thermal oil tanks shall be led to open deck.
LF liquids	(previous) Sec.5 [4.1.3]	Requirement to store liquids with flash point outside machinery space removed.
Fuel oil system	(previous) Sec.5 [4.3.9]	Removed requirement.
Fuel supply for stand pipes	(previous) Sec.5 [4.6]	Removed requirements to fuel supply through stand pipes and mixing tanks
Fuel supply to burners and boilers	Sec.5 [4.9]	Included the requirements for fuel oil supply to burners and boilers.
Thermal oil installations	Sec.5 [5]	— Expansion bellows no longer allowed. — Requirements to spare storage tank removed. — Clarification of alarms required in the system.
Pre-pressurized thermal oil	Sec.5 [5.6.1]	Removed requirement for content in expansion vessel to be blanketed with inert gas.
Thermal oil circulation system	(previous) Sec.5 [5.7.4]	Removed cross reference to other parts of the rules.
Thermal oil system	(previous) Sec.5 [5.11]	Removed requirement for test cocks.
Feed water inlet valves	(previous) Sec.5 [6.2.2]	Requirement removed.
Feed water tanks	Sec.5 [6.4.2]	Removed the term 'in the double bottom'.
Feed water piping	Sec.5 [6.4.2]	Feed water piping not to be routed through tanks containing oil.
Hydraulic systems	(previous) Sec.5 [8.1.5]	Removed requirement.
Instrument air	Sec.5 [9.2]	Prohibiting components requiring 'extremely clean air' removed.
Air lubrication systems	Sec.5 [9.3]	Added requirements to air lubrication systems.
Refrigeration systems	Sec.6 Table 3	Changed low pressure side of system to be designed for 17 bar.
Refrigeration systems	Sec.6 Table 3	Footnote 2 deleted; allowing lower design pressure than 18 bar.

Topic	Reference	Description
Refrigeration machinery	Sec.6 [4.1]	Numerous deletions and additions related to ventilation.
Refrigeration machinery	Sec.6 [4.2.3]	Deleted 'low pressure side of compressor'.
Copper pipes and flexible hoses	Sec.6 [5.1]	Acceptance of copper tubes and flexible hoses removed. Prohibiting grip type couplings relocated.
Safety valve outlet	Sec.6 [5.3.7]	Changes to safety valve outlet position.
R717 refrigerant leakage detection	Sec.6 [7.1.5]	Removed de-energizing requirement for 5000 PPM level of R717 in this part of the rules.
Air emission reduction	Sec.8	Removed subsection on air emission reduction.
Pipe thickness	Sec.9 [1.2.2]	Open up for special consideration of pipe thickness.
Bolt assembled valves	Sec.9 [3.1.3]	Included prohibiting bolt assembled valves outside class III piping systems and at ship's side or bottom.
Valve position observation	Sec.9 [3.1.6]	Valve positions shall always be shown by indicators.
Pipe couplings	Sec.9 [5.2.5]	Clarification that grip type couplings are not permissible in refrigeration systems
Application of mechanical joints	Sec.9 Table 9	Added not permanently filled fire main to the table.
Welding of titanium alloys	Sec.10 [1.1.1]	Clarification that WPQT is required for welding of titanium alloys regardless of piping class.
NDT of titanium alloys	Sec.10 [1.5.2]	Added requirements to NDT for titanium alloys
Cold bending of steel pipes	Sec.10 [3.2.2]	Aligned the cold bending requirements with industry standards and established table for limitations to cold bending of steel pipes to improve readability.
Hydrostatic testing of piping	Sec.10 [5.2.1]	Allowing hydrostatic testing to be performed before onboard installation, and onboard testing may be waived if no additional welding has been carried out.
Rebranding to DNV	All	This document has been revised due to the rebranding of DNV GL to DNV. The following have been updated: the company name, material and certificate designations, and references to other documents in the DNV portfolio. Some of the documents referred to may not yet have been rebranded. If so, please see the relevant DNV GL document.

Editorial corrections

In addition to the above stated changes, editorial corrections may have been made.

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SECTION 1 GENERAL

1 Classification

1.1 Application

1.1.1 The rules in this chapter apply to piping systems for ships and barges for the assignment of main class.

1.1.2 The rules of this chapter shall be applied to all installations and equipment required to be approved according to Table 2, covering:

1) installations and equipment necessary for performing the main functions given in Pt.1 Ch.1 Sec.1 [1.2]
2) specifically identified installations and equipment supporting non-main functions.

For other installations and equipment, not specified in Table 2, see Ch.1.

1.1.3 For installations and equipment not listed in Table 2, the requirements of this chapter shall be applied as required by Ch.1.

1.2 Scope

The rules in this chapter give system requirements and prescribe minimum requirements for materials, design, manufacture, inspection and testing of piping systems.

2 Definitions

2.1 Terms

2.1.1 Piping is defined to include the following components:

— pipes
— flanges with gaskets and bolts and other pipe connections
— expansion elements
— valves, including hydraulic and pneumatic actuators, and fittings
— hangers and supports
— flexible hoses
— pump housings.

2.1.2 A piping system is defined to include piping, as well as components in direct connection to the piping such as pumps, compressors, heat exchangers, evaporators, independent tanks, etc. with the exception of main components such as steam and gas turbines, diesel engines, reduction gears and boilers.

For components which are subject to internal pressure and are not included in the piping, the requirements in Ch.7 apply.

2.1.3 Pipe tunnel indicates a space that can be entered via doors or hatches and shall be ventilated.

2.1.4 Pipe duct is a space which is normally not entered, but can be entered via manholes and is provided with air pipes.

2.1.5 Classes of piping systems. For the purpose of testing, type of joint to be adopted, heat treatment and welding procedure, piping is subdivided into three classes as indicated in Table 1.

Table 1 Classes of piping systems

Piping system for	*Class I* [1]		*Class II* [1]		*Class III* [1]	
	p [bar]	*t [°C]*	*p [bar]*	*t [°C]*	*p [bar]*	*t [°C]*
Steam	> 16	or > 300	≤ 16	and ≤ 300	≤ 7	and ≤ 170
Thermal oil	> 16	or > 300	≤ 16	and ≤ 300	≤ 7	and ≤ 150
Fuel oil, lubricating oil, flammable hydraulic oil	> 16	or > 150	≤ 16	and ≤ 150	≤ 7	and ≤ 60
Other media [2]	> 40	or > 300	≤ 40	and ≤ 300	≤ 16	and ≤ 200

p = design pressure, as defined in Sec.9 [1.3.3]

t = design temperature, as defined in Sec.9 [1.3.4]

1) For class II and III piping both specified conditions shall be met, for class I piping one condition only is sufficient.
2) Cargo oil pipes on oil carriers and open ended pipes (drains, overflows, vents, boiler escape pipes, etc.), independently of the pressure and temperature, are pertaining to class III.
3) Cargo piping systems for flammable liquids on offshore supply vessels are pertaining to the same pipe class as fuel oil systems. Outside machinery spaces of category A, class II piping is sufficient.
4) Piping for toxic or corrosive media are pertaining to class I piping.

Note: cargo piping for chemicals or liquefied gases are not covered by the table. Requirements for these piping systems are given in Pt.5 Ch.6 and Pt.5 Ch.7.

2.1.6 Independent operation of a component is when the function of the component and the power supply of the component is independent of main engine.

3 Documentation

3.1 Documentation requirements

3.1.1 Documentation shall be submitted as required by Table 2.

3.1.2 For general requirements to documentation, including definition of the info codes, see DNV-CG-0550 Sec.6.

3.1.3 For a full definition of the documentation types, see DNV-CG-0550 Sec.5.

Table 2 Documentation requirements

Object	*Documentation type*	*Additional description*	*Info*
Bilge handling systems	S010 – Piping diagram (PD)		AP
	S030 – Capacity analysis	Pump capacity and size of bilge pipes. For passenger ships the bilge pump numeral shall be included. See SOLAS Ch. II-1 Reg. 35-1.	AP
	I020 – Control system functional description	Control and monitoring system for valves and pump.	AP
	I150 – Circuit diagrams	For valves and pumps.	FI

Ballast system	S010 – Piping diagram (PD)		AP
	I020 –Control system functional description	Control and monitoring system for valves and pumps.	AP
	I150 – Circuit diagrams	For valves and pumps.	FI
Sounding systems	S010 – Piping diagram (PD)		AP
Air pipes	S010 – Piping diagram (PD)		AP
	S020 – Pressure drop analysis	Back pressure in tank when overfilling with largest available pump.	FI
Overflow system	S010 – Piping diagram (PD)		AP
Internal drain system	S010 – Piping diagram (PD)		AP
External drain system	S010 – Piping diagram (PD)		AP
Propulsion steam piping system	S010 – Piping diagram (PD)	Pipes conveying steam with a temperature exceeding 400°C, the plans shall show particulars of flanges and bolts and details of welded joints with specification of welding procedure and filler metals.	AP
	S080 – Thermal stress analysis	Only for pipes conveying steam with a temperature exceeding 400°C. See also Sec.9 [1.4].	FI
	I200 – Control and monitoring system documentation	Control and monitoring system for valves and pumps.	AP
Propulsion feed water system	S010 – Piping diagram (PD)		AP
Propulsion condensate piping system	S010 – Piping diagram (PD)		AP
Auxiliary feed water system	S010 – Piping diagram (PD)		AP
Auxiliary steam piping system	S010 – Piping diagram (PD)		AP
Auxiliary condensate system	S010 – Piping diagram (PD)		AP
Lubrication oil system	S010 – Piping diagram (PD)		AP
	I020 – Control system functional description	Control system functional description for valves and pumps	AP
	I150 – Circuit diagrams	For valves and pumps.	FI
Fuel oil system	S010 – Piping diagram (PD)	Including all fittings on settling and daily service tanks.	AP
	I020 – Control system functional description	Control system functional description for valves and pumps.	AP
	I150 – Circuit diagrams	For valves and pumps.	FI

Fresh water system	S010 – Piping diagram (PD)	Cooling system.	AP
	I020 – Control system functional description	Control system functional description for valves and pumps.	AP
	I150 – Circuit diagrams	For valves and pumps.	FI
Thermal oil system	S010 – Piping diagram (PD)	Thermal oil system.	AP
	I020 – Control system functional description	Control system functional description for valves and pumps.	AP
	I150 – Circuit diagrams	For valves and pumps.	FI
Sea water system	S010 – Piping diagram (PD)	Cooling system.	AP
	I020 – Control system functional description	Control system functional description for valves and pumps.	AP
	I150 – Circuit diagrams	For valves and pumps.	FI
Compressed air systems	S010 – Piping diagram (PD)		AP
	I020 – Control system functional description	Control system functional description for valves and pumps.	AP
	I150 – Circuit diagrams	For valves and pumps.	FI
Quick closing arrangement	S010 – Piping diagram (PD)	Oil tank valves.	AP
Sea water inlets	S050 – Connections to the shell and to the sea chests	Arrangement of sea water inlets and discharges.	AP
Anchor windlasses hydraulic system	S010 – Piping diagram (PD)		AP
Valve control hydraulic system	S010 – Piping diagram (PD)		AP
Internal watertight doors / ramps hydraulic system	S010 – Piping diagram (PD)		AP
Sludge handling arrangement	S010 – Piping diagram		AP
	S030 – Capacity analysis	Sludge tanks.	FI
Engine rooms	Z030 – Arrangement plan	Shall show layout of machinery components such as engines, boilers, fans, heat exchangers, generators, switchboards, pumps, purifiers, filters, etc., but excluding pipes, valves and accessories.	FI
	Z090 – Equipment list		FI
Exhaust gas systems	S010 – Piping diagram	Arrangement of exhaust system with outlet through ship side or stern is subject to approval.	FI
Documentation for refrigeration systems, see Sec.6			
Refrigeration systems	Z030 – Arrangement plan	Refrigeration machinery room including access and exits.	AP
	Z030 – Arrangement plan	Personnel protection appliances. In case refrigerant R717 is used, include water curtains, number and location of gas masks.	AP

	Z030 – Arrangement plan	Control and monitoring system, including location of refrigerant leakage detectors.	AP
	S011 – Piping and instrumentation diagram (P & ID)	Refrigerant and brine circuits.	AP
	I200 – Control and monitoring system documentation	Leakage detection/safety system as specified in Sec.6 [6].	AP
	S030 – Capacity analysis	For pressure relief valves, including calculation of back pressure in vent lines.	FI
Refrigerated sea water system	S011 – Piping and instrumentation diagram (P & ID)		AP
Ventilation systems	S012 – Ducting diagram (DD)	In refrigeration machinery room, including specification of fan capacities.	AP
Bilge water system	S010 – Piping diagram (PD)	In refrigeration machinery room with refrigerating plants using group 2 refrigerants, R744 (CO_2) or group 1 refrigerants with a total prime mover effect of 100 kW and above.	AP
Documentation for ozone ship installations, see Sec.7			
Object	*Documentation type*	*Additional description*	*Info*
Ozone system	S010 – Piping diagram (PD)	Including: — oxygen generator — nitrogen disposal, if applicable — oxygen storage — ozone generator — ozone injection point — ozone purging or destruction, if applicable.	AP
	Z030 – Arrangement plan	Including: — components and pipes — ventilation openings — access and escape routes — personal protective equipment.	FI
	G130 – Cause and effect diagram	Covering all safety functions and interfaces to other safety and control systems.	AP
	I200 – Control and monitoring system documentation	Leakage detection/safety system as specified in Sec.7.	AP
	Z161 – Operation manual	See Sec.7 [2.5].	AP
	Z265 – Calculation report	Leakage calculations. As applicable according to Sec.7 [2.2] or Sec.7 [1.1].	FI
Ventilation systems	S012 – Ducting diagram (DD)	For spaces containing ozone piping, as applicable according to Sec.7 [2.2].	AP

AP = For approval, FI = For information

3.2 Required compliance documentation

3.2.1 Compliance documents required for piping components are summarised in Table 3.

Table 3 Compliance documents – piping components

Object	*Compliance document type*	*Additional description*
Pumps		
Sea-water cooling pumps	PC	For propulsion drivers.
Fresh-water cooling pumps	PC	For propulsion drivers.
Circulating pumps	PC	For boilers with forced circulation and main condenser.
Air pumps	PC	For main condenser.
Feed water pumps	PC	
Condensate pumps	PC	For main condenser.
Fuel oil pumps	PC	Transfer, booster, service and fuel injection valve cooling pumps.
Lubricating oil pumps	PC	Propulsion driver and reduction gear.
Bilge pumps	PC	Bilge pumps additional to the ones required by these rules need not be certified.
Ballast pumps	PC	
Fire pumps	PC	Main and emergency.
Hydraulic pumps	PC	For gears, windlasses, variable pitch propellers, side thrusters, and hydraulically operated valves.
Thermal oil circulation pumps	PC	
Cargo pumps	PC	Not applicable for non-flammable liquids on offshore supply vessels.
Other pumps considered necessary for performing of the main functions	PC	Main functions defined in Pt.1 Ch.1.
Fans		
Force draft fans	PC	Propulsion boilers
Ventilation fans	PC	Serving hazardous spaces. For battery rooms, paint stores and gas bottle stores, a certificate from a notified body, showing compliance with EN 13463-1, EN 13463-5 and EN14986, together with manufacturers works certificate may replace a Society product certificate.

Valves		
Valves	PC	Nominal diameter > 100 mm and design pressure > 16 bar.
Ship side valves	PC	Nominal diameter > 100.
Other valves	PD	
Vent heads	TAC	
Hydraulic cylinders		
Hydraulic cylinders	PC	Only cylinders where pD > 20 000 p = design pressure [bar] D = internal diameter of cylinder tube [mm]. The cylinders shall be certified according to DNV-ST-0194.
Hydraulic cylinders for cleating and manoeuvring of watertight doors and hatches	PC	All cylinders regardless of pressure and size. The cylinders shall be certified according to DNV-ST-0194.
Cleating cylinders where the locking mechanism is placed inside the cylinder	TAC	All cylinders regardless of pressure and size. The cylinders shall be type approved according to DNV-ST-0194.
Flexible hoses		
Flexible hoses with couplings	TAC	Hose assemblies shall be delivered from the TAC holder; unless the company is certified by the Society as a hose assembling company, see DNV-CP-0183 Sec.3.
Plastic piping	TAC	
Pipe couplings		
Pipe couplings	TAC	Other than flanges.
Expansion bellows	TAC	For rubber compensators, see class programme DNV-CP-0183 Sec.2 [3.6].
Refrigeration systems		
Safety and monitoring system	PC	Instrumentation referred to in Sec.6 [7] shall have compliance documents as per Ch.9.

3.2.2 For general compliance documentation requirements, see DNV-CG-0550 Sec.4.

3.2.3 For a definition of the compliance document types, see DNV-CG-0550 Sec.3.

4 Signboards

4.1 General

4.1.1 Signboards provide information or certain conditions to be complied with for the safe handling of engine installations and systems.

Some signboards are required by the rules, others may be required by the Society in each particular case.

4.2 References

4.2.1 Signboards are required by the rules in Sec.4 [10.3.2] oil overflow.

SECTION 2 MATERIALS

1 Piping systems

1.1 General

1.1.1 The materials to be used in piping systems shall be suitable for the medium and service for which the system is intended.

Guidance note:

The traditional stainless steels, including type 316 or 316L, should not be considered suitable for use in seawater systems. However, certain stainless steels with higher contents of chromium, molybdenum and nitrogen have improved resistance to localised corrosion. These include high molybdenum austenitic steels and ferritic-austenitic (duplex) steels. Even these steels cannot be considered immune to attack under all situations; avoidance of stagnant seawater conditions and removal of welding oxides are some of the important factors to the successful use.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.1.2 Non-ferrous metallic materials with melting points higher than 925°C may be accepted in piping systems as an alternative to steel except where specific limitations are given elsewhere in the rules.

Non-ferrous metallic materials with melting point lower than 925°C may be used under the same restrictions as for plastic pipes. See [1.7].

1.2 Carbon and low alloy steels

1.2.1 Steel pipes for classes I and II shall be seamless drawn or fabricated by a welding method considered equivalent to seamless pipes. See Pt.2 Ch.2 Sec.5.

1.3 Copper and copper alloys

1.3.1 Copper and copper alloy pipes for classes I and II shall be seamless drawn.

1.3.2 Copper and copper alloys shall not be used for media having temperature above the following limits:

— copper and aluminium brass: 200°C
— copper nickel: 300°C.

Special bronze suitable for high temperature service may be used for media having temperature up to 260°C.

1.3.3 Pipes for starting air shall not be of copper or copper alloys when the outer diameter exceeds 44.5 mm.

1.4 Grey cast iron

1.4.1 Grey cast iron shall not to be used for piping subject to pressure shock, excessive strains and vibration.

1.4.2 Grey cast iron shall not be used for class I and II piping with the following exceptions:

— components in hydraulic piping systems where failure would not render the system inoperative or introduce a fire risk
— pump and filter housings in fuel and lubrication oil systems where the design temperature does not exceed 120°C.

1.4.3 Grey cast iron may be used for class III piping, with the following exceptions:

— pipes and valves fitted on ship sides and bottom and on sea chests
— valves fitted on collision bulkhead
— valves under static head fitted on the external wall of fuel tanks, lub. oil tanks and tanks for other flammable oils
— valves for fluids with temperatures in excess of 120°C.

1.5 Nodular cast iron of the ferritic type

ar The following limitations are given for the use of nodular cast iron of ferritic type in piping systems:

- shall in general have specified minimum elongation 12% or more
- shall not be used for media having temperature exceeding 350°C
- shall be subject to special consideration for design temperature below 0°C
- shall be subject to special consideration for class I piping systems.

1.6 Nodular cast iron of the ferritic/pearlitic and pearlitic type

1.6.1 Nodular cast iron of the ferritic/pearlitic and pearlitic type shall be subject to the limitation of use as grey cast iron as specified in [1.4].

1.7 Plastic piping systems

1.7.1 Plastic pipes used in systems and locations according to Table 1 shall meet the fire endurance requirements specified therein. The permitted use and the requirements for the piping are in conformance with IMO Resolution A.753(18) *Guidelines for the Application of Plastic Pipes on Ships*, except for the requirements for smoke generation and toxicity.

All pipes shall have low surface flame spread characteristics not exceeding average values listed in IMO Resolution A.753(18) Appendix 3. Surface flame spread characteristics may also be determined using the test procedures given in ASTM D635, or in other national equivalent standards.

This is not applicable to those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, if separated from accommodation, permanent manned areas and escape ways by means of an A class bulkhead.

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

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

1.7.3 In addition to the use permitted by Table 1, plastic pipes may be used for pipes for pneumatic and hydraulic instrumentation systems within control cabinets located in control rooms or engine rooms with the following exceptions:

— systems for steering gear

— systems for remote control of:
  — seawater valves
  — valves on fuel oil service tanks
  — valves in bilge and fuel oil systems
  — fire extinguishing.

1.7.4 Plastic pipes used in refrigerated seawater (RSW) systems do not need to be type approved by the Society if used outside machinery spaces of category A.

Remote control capable of being operated from a location outside the machinery space, shall be installed for valves fitted on the ship's sides and leading through the shell, as well as at RSW-tank penetrations.

1.7.5 Plastic piping used in systems listed in Table 1 shall be type tested according to the design requirements, test standards and test condition specified in DNV-CP-0070 and DNV-CP-0072.

1.7.6 For non-essential piping systems which do not ensure:

- main functions as defined in Pt.1 Ch.1 Sec.1

- functions related to applied class notations or

- functions ensuring the safety of the ship, e.g. SOLAS II-2, Reg.8-1 or when penetrating watertight bulkheads.

The type approval may be based on recognized standards such as DIN, EN, ISO. When such plastic pipes penetrate a watertight bulkhead or deck the following applies at each penetration:

Pipes with a nominal external pressure rating of at least 1.0 bar may be permitted, provided:

— a type approved penetration according to EN IMO Res. MSC.429(98) Reg. 13.2.3 is fitted, or
— a steel spool piece of 900 mm in length, preferable 450 mm on each side, with thickness according to Sec.9 [1.2.1] is arranged at the watertight penetration. The pipe shall be flanged or similar to each side of the steel spool piece. No valve(s) are required at the penetration, unless required by the assumptions made in the damage stability calculations.

Pipes with nominal external pressure rating below 1.0 bar shall not be accepted for penetrating watertight subdivisions, unless:

a) a steel spool piece of 900 mm in length, preferable 450 mm on each side, with thickness according to Sec.9 [1.2.1] is arranged at the watertight penetration. A remote operated emergency shut off valve shall be arranged between the steel spool piece and the pipe on one side. This valve shall be of safe to close type, or else the control including hydraulic piping and electric cables shall be routed inboard of B/5, and preferably to centre line, before being routed longitudinally. On the opposite side should the pipe be flanged or similar to the steel spool piece, or
b) two manual valves, one on each side of the steel spool piece in a) are arranged, under the provision that these valves are easily accessible.

Table 1 Fire endurance requirements matrix

	Piping systems	*Location*										
		A	B	C	D	E	F	G	H	I	J	K
		Machinery spaces of category A	Other machinery spaces	Cargo pump rooms	Ro/Ro cargo holds	Other dry cargo holds	Cargo tanks	Fuel oil tanks	Ballast water tanks	Cofferdams, void spaces, pipe tunnel and ducts	Accommodation service and control spaces	Open decks
Flammable cargo (flash point ≤ 60°C)												
1	Cargo lines	NA	NA	L1	NA	NA	0	NA	0 [10)]	0	NA	L1 [2)]
2	Crude oil washing lines	NA	NA	L1	NA	NA	0	NA	0 [10)]	0	NA	L1 [2)]
3	Vent lines	NA	NA	NA	NA	NA	0	NA	0 [10)]	0	NA	X
Inert gas												
4	Water seal effluent line	NA	NA	0 [1)]	NA	NA	0 [1)]	0 [1)]	0 [1)]	0 [1)]	NA	0
5	Scrubber effluent line	0 [1)]	0 [1)]	NA	NA	NA	NA	NA	0 [1)]	0 [1)]	NA	0
6	Main line	0	0	L1	NA	NA	NA	NA	NA	0	NA	L1 [6)]
7	Distribution lines	NA	NA	L1	NA	NA	0	NA	NA	0	NA	L1 [2)]
Flammable liquids (flash point > 60°C)												
8	Cargo lines	X	X	L1	X	X	NA [3)]	0	0 [10)]	0	NA	L1
9	Fuel oil	X	X	L1	X	X	NA [3)]	0	0	0	L1	L1
10	Lubricating oil	X	X	L1	X	X	NA	NA	NA	0	L1	L1
11	Hydraulic oil	X	X	L1	X	X	0	0	0	0	L1	L1
Seawater[1)]												
12	Bilge main and branches	L1 [7)]	L1 [7)]	L1	X	X	NA	0	0	0	NA	L1
13	Fire main and water spray	L1	L1	L1	X	NA	NA	NA	0	0	X	L1
14	Foam system	L1W	L1W	L1W	NA	NA	NA	NA	NA	0	L1W	L1W
15	Sprinkler system	L1W	L1W	L3	X	NA	NA	NA	0	0	L3	L3
16	Ballast	L3	L3	L3	L3	X	0 [10)]	0	0	0	L2W	L2W

17	Cooling water, essential services	L3	L3	NA	NA	NA	NA	NA	0	0	NA	L2W
18	Tank cleaning services, fixed machines	NA	NA	L3	NA	NA	0	NA	0	0	NA	L3 [2)]
19	Non-essential systems	0	0	0	0	0	NA	0	0	0	0	0
Freshwater												
20	Cooling water, essential services	L3	L3	NA	NA	NA	NA	0	0	0	L3	L3
21	Condensate return	L3	L3	L3	0	0	NA	NA	NA	0	0	0
22	Non-essential systems	0	0	0	0	0	NA	0	0	0	0	0
Sanitary and drains and scuppers												
23	Deck drains (internal)	L1W [4)]	L1W [4)]	NA	L1W [4)]	0	NA	0	0	0	0	0
24	Sanitary drains (internal)	0	0	NA	0	0	NA	0	0	0	0	0
25	Scuppers and discharges (overboard)	0 [1)8)]	0 [1)8)]	0 [1)8)]	0 [1)8)]	0 [1)8)]	0	0	0	0	0 [1)8)]	0
Sounding and air												
26	Water tanks or dry spaces	0	0	0	0	0	0 [10)]	0	0	0	0	0
27	Oil tanks (flash point > 60°C)	X	X	X	X	X	X [3)]	0	0 [10)]	0	X	X
Miscellaneous												
28	Control air	L1 [5)]	L1 [5)]	L1 [5)]	L1 [5)]	L1 [5)]	NA	0	0	0	L1 [5)]	L1 [5)]
29	Service air (non-essential)	0	0	0	0	0	NA	0	0	0	0	0
30	Brine	0	0	NA	0	0	NA	NA	NA	0	0	0
31	Auxiliary low pressure steam (≤ 7 bar)	L2W	L2W	0 [9)]	0 [9)]	0 [9)]	0	0	0	0	0 [9)]	0 [9)]
32	Central vacuum cleaners	NA	NA	NA	0	NA	NA	NA	NA	0	0	0
33	Exhaust gas cleaning system effluent line	L3 [1)]	L3 [1)]	NA	NA	NA	NA	NA	NA	NA	L3 [1), 11)]	NA
34	Urea transfer/supply system	L1 [12)]	L1 [12)]	NA	NA	NA	NA	NA	NA	0	L3 [11), 12)]	0

Table 2 Abbreviations and footnotes in Table 1

Abbreviations

L1	=	fire endurance test in dry conditions, 60 minutes, Appendix 1 of IMO Res. A.753(18), as amended by IMO Res. MSC. 313(88) and IMO Res. MSC. 399(95)
L2	=	fire endurance test in dry conditions, 30 minutes, Appendix 1 of IMO Res. A.753(18), as amended by IMO Res. MSC. 313(88) and IMO Res. MSC. 399(95)
L3	=	fire endurance test in wet conditions, 30 minutes, Appendix 2 of IMO Res. A.753(18), as amended by IMO Res. MSC. 313(88) and IMO Res. MSC. 399(95)
0	=	no fire endurance test required
NA	=	not applicable
X	=	metallic materials having a melting point greater than 925°C
W	=	negligible leakage is accepted, i.e. not exceeding 5% flow loss.

Footnotes:

1) Where non-metallic piping is used, remotely controlled valves to be provided at ship's side (valve shall be controlled from outside space).
2) Remote closing valves to be provided at the cargo tanks.
3) When cargo tanks contain flammable liquids with flash point > 60°C, 0 may replace NA or X.
4) For drains serving only the space concerned, 0 may replace L1.
5) When controlling functions are not required by the rules, statutory requirements or guidelines, 0 may replace L1.
6) For pipe between machinery space and deck water seal, 0 may replace L1.
7) For passenger vessels, X shall 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, shall be X 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 ship's whistle, X shall replace 0.
10) For tankers where compliance with paragraph 3.6 of regulation 19 of Annex I of MARPOL 73/78 is required, NA shall replace 0.
11) L3 in service spaces, NA in accommodation- and control spaces.
12) Type approved plastic piping without fire endurance test (0) is acceptable downstream of the tank valve, provided this valve is metal seated and arranged as fail-to-closed or with quick closing from a safe position outside the space in the event of fire.
13) For passenger ships subject to SOLAS II-2, Reg.21.4 (Safe Return to Port), plastic pipes for services required to remain operative in the part of the ship not affected by the casualty thresholds, such as systems intended to support safe areas, shall be considered essential services. In accordance with MSC Circular MSC.1/Circ.1369, interpretation 12, for 'Safe Return to Port' purposes, plastic piping may be considered to remain operational after a fire casualty if the plastic pipes and fittings have been tested to L1 standard.

Location definitions

Location	Definition
A - Machinery spaces of category A	Machinery spaces of category A as defined in SOLAS 1974, as amended, regulation II-2/3.19.
B - Other machinery spaces and pump rooms	Spaces, other than category A machinery spaces and cargo pump rooms, containing propulsion machinery, boilers, steam and internal combustion engines, generators and major electrical machinery, pumps, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces, and trunks to such spaces.
C - Cargo pump rooms	Spaces containing cargo pumps and entrances and trunks to such spaces.

D - Ro-ro cargo holds	Ro-ro cargo holds are ro-ro cargo spaces and special category spaces as defined in SOLAS 1974, as amended, regulation II-2/3.14 and 3.18.
E - Other dry cargo holds	All spaces other than ro-ro cargo holds used for non-liquid cargo and trunks to such spaces.
F - Cargo tanks	All spaces used for liquid cargo and trunks to such spaces.
G - Fuel oil tanks	All spaces used for fuel oil (excluding cargo tanks) and trunks to such spaces.
H - Ballast water tanks	All spaces used for ballast water and trunks to such spaces.
I - Cofferdams, voids spaces, pipe tunnel and ducts	Cofferdams and voids are those empty spaces between two bulkheads separating two adjacent compartments.
J - Accommodation, service and control spaces	Accommodation spaces, service spaces and control stations as defined in SOLAS 1974, as amended, regulation II-2/3.10, 3.12, 3.22.
K - Open decks	Open deck spaces as defined in SOLAS 1974, as amended, regulation II-2/26.2.2(5).

1.8 Required compliance documentation

1.8.1 The materials used in piping systems shall be delivered with compliance documents and be documented according to Table 3. For definitions related to the various types of documentation of material certification, see DNV-CG-0550.

Regarding requirements for material compliance documentation and documentation concerning piping systems for chemical carriers and liquefied gas carriers. See Pt.5 Ch.6 Sec.1 [3] and Pt.5 Ch.7 Sec.1 [5], respectively.

Guidance note:

The control and monitoring system for valves and pumps for systems listed in Sec.1 [3.1.3] is not required to be delivered with a product certificate.

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Table 3 Material certificates

Component	*Material*	*Class of piping system*	*Nominal diameter [mm]*	*Design temperature [°C]*	*Compliance document type*		
					MC issued by Society	*MD issued by manufacturer*	*MTR issued by manufacturer*
Pipes [1)]		I	> 50		x		
		II, III	> 50			x	
		I, II, III	≤ 50				x
Flanges and bolts[3)]				> 400	x		
				≤ 400			x

Component	*Material*	*Class of piping system*	*Nominal diameter [mm]*	*Design temperature [°C]*	*Compliance document type*		
					MC issued by Society	*MD issued by manufacturer*	*MTR issued by manufacturer*
Bodies of valves and fittings [1], source materials of steel expansion bellows, other pressure containing components not considered as pressure vessels	Steel[2]	I	> 100	> 400	x		
			≤ 100	> 400		x	
	Steel or nodular cast iron	I, II	> 100	≤ 400		x	
			≤ 100	≤ 400			x
		III					x
	Cast iron	III					x
	Copper and titanium alloys[2]	I, II	> 50			x	
			≤ 50				x
		III					x
Pump housings		I				x	
		II, III					x

1) Pipes and bodies of valves fitted on ship's side and bottom and bodies of valves fitted on collision bulkhead shall be provided with documentation as required for class II piping systems.

2) When fittings are made from plates or pipes, the compliance document requirements for pipes shall be applied also for pipe fittings.

3) Not applicable for exhaust gas systems.

SECTION 3 DESIGN PRINCIPLES

1 Arrangement

1.1 Piping systems

1.1.1 Piping systems shall consist of permanently installed pipes and fittings supported in such a way that their weight is not taken by connected machinery or that heavy valves and fittings do not cause large additional stresses in adjacent pipes.

1.1.2 Axial forces due to internal pressure, change in direction or cross-sectional area and movement of the ship shall be taken into consideration when mounting the piping system.

1.1.3 The support of the piping system shall be such that detrimental vibrations shall not arise in the system.

1.1.4 Metallic pipes shall be connected by welding or brazing in accordance with Sec.10 [1] and Sec.10 [2] or by detachable connections in accordance with Sec.9 [5].

1.1.5 Plastic pipes shall be connected by welding, gluing, cementing, lamination or similar methods in accordance with Sec.10 [4] or by approved detachable connections in accordance with Sec.9 [5].

1.1.6 Installation of pipes for water, steam or oil behind or above electric switchboards shall be avoided as far as possible. If this is impracticable, all detachable pipe joints and valves shall be at a safe distance from the switchboard or well shielded from it.

1.1.7 Water pipes and air and sounding pipes through freezing chambers shall be avoided.

Guidance note:

For special requirements regarding air, sounding and water pipes penetrating insulated tank tops, see Pt.6 Ch.4 Sec.9 [4.4.3].

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.1.8 Piping systems shall be adequately identified according to their purpose. Valves shall be permanently and clearly marked.

1.1.9 The blowdown valve on the ship's side shall be fitted in a readily accessible position. It shall be located above the level of the floor in such a way that it is easy access to verify whether it is open or shut. The cock handle shall not be removable unless the cock is shut and, if a valve is fitted, the wheel shall be fixed to the spindle. See also Ch.7 Sec.5.

1.2 Operation of valves

1.2.1 Sea suction valves, discharge valves below the deepest water line, bilge valves and valves on the fuel oil and lubricating oil tanks which are situated higher than the double bottom tanks, shall be arranged for local manual operation. If such valves are arranged for remote operation, the changeover to manual operation shall be possible to perform without the need for additional tools to get access to operate the valve manually.

Guidance note:

Where hydraulically actuated sea suction and discharge valves are located in the engine room, a hand pump ready for use fitted to each actuator is considered acceptable as local manual operation.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.2.2 Where remotely operated valves are required by the rules to also be arranged for local manual operation, the changeover to manual operation shall be simple to execute. This implies that there shall be no need to use additional tools for removal of covers or similar to get access to operate the valve manually.

Means for local control of sea suction valves, discharge valves below the deepest water line and bilge valves in engine rooms shall extend above the floor plates or by other means be easily accessible and visible.

Such controls shall be located in a space entered without using tools and shall be protected from obstructions, moving equipment and hot surfaces that hinder operation or servicing.

1.2.3 For remotely operated valves, failure in valve control system shall not cause:

— opening of closed valves
— closing of valves that need to remain open to maintain propulsion and power generation.

1.2.4 All valves located in tanks or void spaces and therefore inaccessible, which are hydraulically or pneumatically controlled are also to be arranged for manual operation, e.g. with a hand pump connected to the control system.

1.2.5 Remotely controlled valves shall be provided with indications for open and closed valve positions at the control station.

In cases where local manual operation is required [1.2.1] in addition to the remote control, means of observing the valve position at the valve location shall be provided.

1.3 Valves on ship's sides and bottom

1.3.1 All sea inlet and overboard discharge pipes shall be fitted with valves or cocks secured direct to the shell or sea chest.

Scuppers and sanitary discharges shall be arranged in accordance with Pt.3 Ch.12 Sec.9, as applicable.

1.3.2 If it is impractical to fit the valves or cocks directly to the shell or sea chest, distance pieces of steel may be accepted. These shall be made as short, rigid constructions, and shall not be of a thickness less than given in Pt.3 Ch.12 Sec.9. The distance piece shall extend through the shell plating or sea chest, and shall be welded on both sides or with full penetration welding.

If valves are bolted to pads on the ship side, the pads shall be welded to the ship side as described for distance pieces above.

1.3.3 For vessels with double side and/or bottom, the following requirements apply:

a) The valve may be fitted to the inboard tank boundary.
b) The pipe wall thickness between side and bottom and inner boundary shall be minimum 11 mm, regardless of pipe diameter and regardless the shell plating thickness.
c) Due attention shall be paid to the detail design to avoid high stresses being introduced at pipe fixations, as e.g. where the outer and inner boundary are connected by a short and straight pipe.
d) Outlet- or inlet-pipes passing through heated fuel oil tanks or lubricating oil tanks shall be surrounded by cofferdams.

1.3.4 All outlets and sea inlet valves shall be fitted to the shell in such a way that piping inboard of the valves may be disconnected without interfering with the watertight integrity of the shell.

1.3.5 Valves and cocks for blow down of boilers shall have a protection ring fitted on the outside of the shell plating through which the spigot shall be carried. The spigot shall terminate flush with the outer side of the ring.

1.3.6 Suction and discharge valves of steel and sea chests and distance pieces shall be protected against corrosion by an efficient coating or equivalent.

1.3.7 All suction and discharge pipes shall be adequately protected where they are liable to be damaged by cargo.

1.3.8 Sea inlets shall be so designed and arranged as to limit turbulence and to avoid entry of air due to the ship's movements.

1.3.9 Sea suctions and discharge valves for ships having additional class notation for navigation in ice see Pt.6 Ch.6.

1.3.10 Sea inlets and discharge valves for systems where plastic piping is used shall be arranged with approved remote closing arrangement.

1.4 Fittings on watertight bulkheads

1.4.1 Drain cocks shall not be fitted to collision bulkhead, nor are other openings to be cut in same.

1.4.2 The collision bulkhead may be penetrated below the bulkhead deck by one pipe for pumping fluid in the forepeak tank, and where the forepeak is divided into two tanks, two pipe penetrations may be accepted for same purpose on following conditions:

- A valve which is operable from above the bulkhead deck is fitted directly on the collision bulkhead inside the forepeak. A manually operable valve may be fitted at the after side of the collision bulkhead provided that the valve is readily accessible under all service conditions and the space in which it is located is not a cargo space.
- The valve shall be of a screw-down type valve. Alternatively, for cargo ships, the valve may be a butterfly valve suitable supported by a seat or flanges . The valve shall be manufactured of steel, bronze, nodular cast iron of ferritic type or other approved ductile material. Valves of grey cast iron or similar materials are not acceptable.
- Butterfly wafer types shall not be used.

1.4.3 No drain valve or cock shall be fitted to watertight bulkheads unless it is accessible at all times and capable of being closed from above the deep load line. Alternatively the valve shall be of the self-closing type. Indication of open and closed position of the valves and cocks shall be provided.

1.4.4 The fastening of fittings, pipes, etc. to bulkheads or tunnel plating by using bolts passing through clearing holes in the plating shall not be accepted.

1.4.5 Pipe penetrations through watertight bulkheads or decks as well as through fire divisions shall be Type Approved unless the pipe is welded into the bulkhead/deck.

1.4.6 When a plastic pipe penetrates a bulkhead or deck which is also a fire division and a fire may cause flooding of watertight compartments, a metallic shut-off valve shall be fitted at the bulkhead or deck. The operation of this valve shall be provided for from above the freeboard deck.

Guidance note:

This is related to e.g. tanks with plastic pipes without a remotely operated valve located at the tank.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.4.7 If pipes with wall thicknesses approved according to Sec.9 [1.2.2] are penetrating a watertight bulkhead, there shall be a remotely operated valve located at the bulkhead. The operation of this valve shall be provided for from above the freeboard deck.

SECTION 4 SHIP PIPING SYSTEMS

1 General

1.1 Application

1.1.1 The rules in this section apply to ship piping systems for all ships to be assigned main class.

Vessels arranged with spaces as mentioned in the notation for fishing vessels in Pt.5 Ch.12 shall also comply with the bilge system requirements in Pt.5 Ch.12.

2 Basic requirements for drainage of compartments and tanks

2.1 General

2.1.1 An efficient drainage system shall be provided for all tanks and watertight compartments.

Void spaces without piping installations may be drained by portable equipment.

2.1.2 For dry compartments the drainage system shall be so arranged that effective drainage through at least one suction is achieved even if the ship has a list of 5° when otherwise on an even keel.

For this purpose, wing suctions shall be necessary, except in short, narrow compartments where one suction can provide effective drainage under the above conditions.

2.1.3 Where screw-down non-return valves are required in these rules, a non return valve and a closable valve in series is regarded as equivalent.

2.2 Prevention of unintentional ingress of water into compartments or between compartments

2.2.1 Two non-return valves in series shall be installed between sea or ballast system and bilge suctions in compartments.

2.2.2 For direct and emergency bilge suctions in the machinery space one non-return valve between sea or ballast system and these suctions may be acceptable.

2.2.3 Bilge distribution chest valves shall be screw-down non-return valves.

2.2.4 All direct bilge suctions, and branch suctions not leading to a bilge distribution chest shall be fitted with screw-down non-return valves.

2.2.5 If ejectors are used for drainage of cargo holds the requirement in [2.2.1] may be dispensed with provided the arrangement gives equivalent safety against ingress of water.

2.2.6 The arrangement of the drainage system shall be so that no sea water can unintentionally enter dry compartments or pass from one compartment to another.

3 Drainage of cargo holds

3.1 General

3.1.1 One bilge suction shall be fitted to each side of each cargo hold. Where the rise of the cargo hold floor is more than 5° one suction near the centre line may be accepted.

3.1.2 Ships with one cargo hold shall have suctions as required in [3.1.1] both in fore and after ends of the cargo hold. This also applies to ships having two or more cargo holds with length greater than 0.2 *L* if these are longer than 35 m.

3.1.3 For cargo holds with double bottom the bilge suctions shall be led from bilge wells with a capacity of at least 0.15 m^3 each. Wells of less capacity may be accepted for small compartments.

3.1.4 Cargo holds for dry cargo in bulk shall be provided with arrangement giving satisfactory drainage when bulk cargoes are carried.

Drainage arrangement for fishing vessels built for carrying fish in bulk, see Pt.5 Ch.12.

3.1.5 Drainage from refrigerated cargo spaces shall comply with the requirements for vessels with additional class notation **RM**, see Pt.6 Ch.4 Sec.9.

3.2 Cargo holds carrying alternately liquid cargo, ballast and dry cargo

3.2.1 One centre suction may be accepted and the wing suctions may be omitted, if the inner bottom is sloping towards the centre line with an angle of slope of minimum 1.5°.

3.2.2 For such tanks, the filling and suction pipes for liquid cargo and ballast shall be arranged for blank flanging. Bilge suction pipes are also to be arranged for blank flanging at the tank bulkhead.

Guidance note:

An instruction for transfer between liquid cargo and dry cargo service should be made in the appendix to the classification certificate.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4 Drainage of cargo deck spaces

4.1 General

4.1.1 All cargo decks shall have an appropriate number of drainage openings on each side of the vessel, for the drainage of small leaks.

4.1.2 Cargo decks with a length of less than 70 m shall have minimum one drainage on each side in the forward and aft end. For cargo decks with length above 70 m one additional drainage on each side within the middle 50% of the length shall be arranged.

4.1.3 The total drainage capacity of each part of the deck as defined in [4.2] shall have a capacity greater than the quantity of water supplied from two nozzles (four nozzles from cargo spaces intended for carriage of dangerous goods).

4.1.4 The cross sectional area of each drainage opening shall not be less than that corresponding to a pipe diameter of 125 mm. Each opening shall have a strain off grating with total area of openings not less than 4 times that of the drainage opening.

4.1.5 The outlets may be led overboard if the drainage openings in the deck are not lower than the waterline when the vessel is loaded to the summer load waterline and has a list of 5°. If the drainage openings in the deck are lower than the waterline at a list of 5°, the outlets shall be led down to bilge wells in the inner bottom or to a separate bilge water tank.

4.1.6 Drainage pipes from different watertight subdivisions leading to a common bilge water tank shall have automatic non-return valves.

4.1.7 The bilge water tank shall be connected to the vessel's bilge system. The suction pipe from the tank shall have a diameter not less than that of the main bilge line.

4.1.8 The bilge tank volume shall correspond to not less than 1/3 of the total drainage capacity per hour of each part of the deck(s).

4.1.9 Bilge water tanks and bilge wells collecting drainage water from cargo spaces as specified in [4.1] and [4.2] shall be arranged with alarm to the bridge indicating ingress of water.

4.1.10 Drainage from a cargo deck for dangerous goods into bilge wells in a lower space is only permitted if that space satisfies the same requirements as the cargo deck above.

4.1.11 From vehicle, special category and ro-ro spaces, scuppers shall not be led to machinery spaces or other spaces where sources of ignition may be present.

4.2 Additional requirements for cargo spaces with fixed water-spraying system or high-expansion foam system

4.2.1 Where cargo spaces are protected against fire by a pressure water-spraying system or a high-expansion foam system, drainage openings shall be arranged as follows:

The cargo deck area shall be divided into four areas, two on each side of the ship. One area shall cover the forward half of the deck length, and the other shall cover the aft half of the deck length. Each of the four cargo deck areas shall have two or more drainage openings with a combined capacity at least equal to the total capacity of the water-spraying system or the high-expansion foam system. For the latter, the total capacity of the drainage openings shall be determined considering the water content of the high-expansion foam only.

However, the drainage capacity shall in no case be less than that given in [4.1.3].

4.2.2 The diameter d of each drainage pipe shall not be less than calculated by the following formula:

$$d = 12\sqrt{\frac{Q}{n\sqrt{h - 0.6}}} \ [\text{mm}]$$

where:

n = number of drains in the deck area on each side of the compartment, where drainage capacity Q is required

h = the lesser of the vertical distance in m from the drained deck to outlet of the drain pipe or to the waterline

Q = total capacity in m^3/hour of the combined capacity of both the water-spraying system pumps and the required number of fire hose nozzles.

4.2.3 Where the water is discharged by means of pumps pumping directly from bilge wells or bilge tanks, the capacity of the bilge pumps shall be at least 125% of the combined capacity of both the water-spraying system pumps and the required number of fire hose nozzles.

4.2.4 The drainage system valves shall be operable from outside the protected space at a position in the vicinity of the extinguishing system controls.

4.2.5 An easily removable grating, screen or other means shall be installed over each drain opening in the protected spaces to prevent debris from blocking the drain. The total open area ratio of the grating to the attached drain pipe shall be at least 6:1 for spaces protected by the fire water system. The grating shall be raised above the deck or installed at an angle to prevent large objects from blocking the drain. No dimension of the individual openings in the grating shall be more than 25 mm.

5 Drainage of dry compartments other than machinery spaces of category A and cargo holds

5.1 General

5.1.1 Dry compartments shall be connected to the bilge system or to be drained by separate bilge pumps. For small compartments hand pumps may be accepted.

5.1.2 Alternatively, the compartments may be arranged with drain pipes leading to a bilge well in the main bilge system.

5.1.3 Where an open drain pipe is carried through a watertight bulkhead or deck, it shall be fitted with an easily accessible self-closing valve at the bulkhead or deck, or a valve that can be closed from above the deep load line. The valve shall have an indication for the open and the closed position.

5.1.4 Pipe and shaft tunnels of length greater than 35 m shall have suctions in fore and after ends.

5.1.5 Exhaust lines and silencers shall be provided with suitable drains of adequate size.

5.2 Spaces other than cargo spaces fitted with automatic water sprinkler systems

5.2.1 Spaces fitted with automatic sprinkler systems shall be provided with drainage arrangements with a capacity at least equal to the sprinkler system assuming all nozzles in the space are in operation.

5.2.2 The requirement in [5.2.1] may be exempted from upon considerations of stability.

6 Drainage of machinery spaces of category A

6.1 General

6.1.1 It shall be possible to pump out any water entering the compartment through at least two bilge suctions when the ship is on an even keel, and is either upright or has a list of not more than 5°. One of these suctions shall be a branch bilge suction, i.e. a suction connected to the main bilge line, and the other shall be a direct bilge suction, i.e. a suction led directly to an independent power pump.

To obtain this the bilge suctions shall be arranged as specified in [6.2], [6.3] and [6.4].

6.2 Branch bilge suctions

6.2.1 At least three branch bilge suctions shall be fitted. The suctions shall be arranged forward and aft at both sides of the engine room.

6.2.2 Where the rise of the bottom of the room is more than 5° one branch suction near the centre line may be acceptable.

6.2.3 In ships propelled by electrical machinery, special means shall be provided to prevent the accumulation of bilge water under the main propulsion generators and motors.

6.3 Direct bilge suctions

6.3.1 Separate bilge suctions shall be lead directly to the bilge pumps from each side of the engine room in addition to the branch bilge suctions.

6.3.2 If an emergency bilge suction is arranged to a self-priming pump on a cargo vessel (as required by SOLAS for passenger vessels), the direct bilge suction may be omitted on the side where the emergency suction is fitted.

6.3.3 Where the rise of the bottom of the room is more than 5°, one direct suction from near the centre line may be accepted.

6.4 Divided and specially formed machinery spaces

6.4.1 Where the machinery space is divided into compartments separated by watertight bulkheads, boiler rooms, auxiliary engine rooms etc shall have one bilge suction fitted to each side of the space. Where the rise of the floor is more than 5°, one suction near the centre line may be accepted. In addition one direct bilge suction shall be arranged for each compartment to an independent pump.

6.4.2 Specially formed parts of the machinery space, e.g. flywheel wells and hot well of main condensers shall be fitted with branch suctions, with internal diameter not less than 50 mm.

7 Drainage of barges and pontoons

7.1 General

7.1.1 Barges and pontoons shall be provided with means for drainage of cargo holds, engine rooms and watertight compartments and tanks giving major contribution to the vessel's buoyancy and floatability.

7.1.2 As far as applicable and with the exemptions specified in the following, the rules and principles for drainage of ship with propulsion machinery shall be complied with.

7.2 Barges

7.2.1 Manned barges shall be provided with a permanently installed bilge system with power bilge pumps.

The bilge system shall have suctions in rooms mentioned in [7.1.1].

An additional emergency bilge suction shall be provided in engine rooms.

Dry compartments in fore- and after peaks may be drained by effective hand pumps.

Rooms situated on deck may be drained directly overboard.

7.2.2 Manned barges for unlimited service shall be equipped with two permanently installed bilge pumps.

Manned barges with restricted service shall have minimum one bilge pump.

Ballast pumps may be used as bilge pumps. Where only one permanently installed bilge pump is installed, this pump shall not serve as fire pump.

7.2.3 Ballast systems shall comply with the requirements for ballast systems in ships. However, one ballast pump may be accepted.

Alternative methods for emptying ballast tanks, e.g. by means of compressed air and bottom valves, may be accepted upon consideration in each case.

7.2.4 Unmanned barges shall be provided with drainage facilities for rooms mentioned in [7.1.1].

For cargo holds the facilities shall be so arranged that drainage can be performed in loaded conditions, for instance by arranging ducts for portable pumps to bilge wells or piping from the connection point of the bilge pump to the bilge wells.

Other rooms which shall be drained by portable equipment, shall be provided with suitable access openings for such equipment.

Any engine room or pump room shall have bilge suctions to available pumps.

7.2.5 Unmanned barges may have portable bilge pumping equipment only, arranged with their own power supply.

For barges for unlimited service such equipment shall be delivered with the barge.

For barges for restricted service the rules are based on the assumption that suitable bilge pumping equipment is carried on board the barge or on board the tug.

This assumption shall be included in the appendix to the classification certificate for the barge.

7.3 Pontoons

7.3.1 Manned pontoons shall be provided with bilge or ballast system as specified for manned barges in [7.2].

7.3.2 Unmanned pontoons may be drained by portable bilge pumping equipment carried on board the tug.

Suitable access hatches for the pumping equipment shall be provided for each tank or compartment.

The assumption that suitable bilge pumping equipment is carried on board the tug, shall be included in the appendix to the classification certificate for the pontoon.

Where an engine room or pump room is arranged below deck, bilge suctions shall be provided to an available pump.

7.3.3 Ballast connections to closed compartments which are assumed to be empty in loaded condition, shall be fitted with means to prevent unintentional ingress of water to the compartments, e.g. blank flanges, etc.

8 Bilge pumping and piping

8.1 General

8.1.1 At least two bilge pumping units shall be provided. For ships with length 90 m and less, one of these may be driven by the main engine. In larger ships, both units shall be independently driven.

8.1.2 Each pumping unit may consist of one or more pumps connected to the main bilge line, provided their combined capacity is sufficiently large.

8.1.3 One of the bilge pumps may be a bilge ejector if there is a separate pump delivering sufficient water for operating the ejector.

8.1.4 The bilge pumping units may be connected to other systems for service duties of an intermittent nature provided a redundancy type 2 according to Ch.1 is established.

8.1.5 In vessels arranged with inboard drainage of cargo deck spaces which have access openings in the shell plating or which have fixed water-spraying fire fighting systems, one of the bilge pumping units shall not be connected to more than one additional system in which the number and capacity of pumping units already satisfy the rules.

8.1.6 For ships intended exclusively for the carriage of containers in cargo holds with non-weathertight hatch covers additional requirements to bilge pumping arrangement is given in Pt.6 Ch.5 Sec.2.

For ships carrying dangerous goods, requirements to bilge pumping arrangement in Pt.6 Ch.5 Sec.10 may be applicable.

8.2 Capacity and types of bilge pumping units

8.2.1 Each bilge-pumping unit shall be capable of giving a water velocity of at least 2 m/s through a rule size main bilge pipe.

8.2.2 Where the capacity of one bilge pumping unit is somewhat less than required, the deficiency may be made up for by the other bilge pumping unit. However, the capacity of the smaller bilge-pumping unit shall not be less than one third of the combined pumping capacity.

8.2.3 Pumping unit capacity determined from pipe diameter given in [8.4] is specified in Table 1.

The pump capacity Q in m^3/hour may also be determined from the formula:

$$Q = \frac{5.75d^2}{10^3}$$

where:

d = bore of bilge pipe in mm according to [8.4.1] or [8.4.2].

For ships with spaces protected by water sprinkler systems see also [4.2.3].

8.2.4 Bilge pumps of centrifugal type are either to be of the self-priming type or connected to a central priming system.

Guidance note:

It is advised that at least one of the bilge pumps be of the reciprocating type.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Table 1 Pipe diameter and corresponding bilge pump capacity

Bore of bilge pipe [mm]	*Capacity of each pump [m^3/hour]*	*Bore of bilge pipe [mm]*	*Capacity of each pump [m^3/hour]*

50	15	130	97
55	18	135	105
60	21	140	113
65	25	145	121
70	29	150	130
75	33	155	138
80	37	160	147
85	42	165	157
90	47	170	166
95	52	175	176
100	58	180	186
105	64	185	197
110	70	190	208
115	76	195	219
120	83	200	230
125	90	205	246
		210	254

8.2.5 Where large centrifugal pumps are being used for bilge drainage, the pump characteristics together with calculations of the pressure losses in the pipe system shall be submitted for approval in those cases where the water velocity in the main bilge line may exceed 5 m/s. Arrangement plans of systems for air evacuation, cooling of bearings, etc. shall be submitted for approval.

Guidance note:

Centrifugal pumps much larger than specified by Table 1 (for a given bilge main diameter) should preferably not be used as bilge pumps.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

8.3 Bilge pumping arrangement

8.3.1 All bilge pump connections to the main bilge line shall be fitted with stop valves.

8.3.2 The bilge pumps shall be so arranged that either can be used while the other is being overhauled.

8.3.3 The direct bilge suctions from machinery spaces shall be so arranged that they can be used at the same time as the other bilge pumping unit is drawing from the main bilge line.

8.3.4 Centrifugal bilge pumps shall be located as low as possible in the ship.

8.3.5 Centrifugal bilge pumps shall be arranged in such a way that any suction line is not led through more than two non-return valves, preferably not more than one.

8.4 Sizes of bilge suctions

8.4.1 The internal diameter of the main bilge suction line shall not be less than given by the following formula, to the nearest 5 mm:

$$d = 1.68\sqrt{L(B+D)} + 25 \quad [\text{mm}]$$

where:

L = rule length of ship [m]
B = breadth of ship [m]
D = depth of ship to bulkhead deck [m].

as defined in Pt.3 Ch.1 Sec.4 [3.1.1].

8.4.2 For ships where the pumps in the machinery space are not used for bilge drainage outside the machinery space, the size of the main bilge suction line may be less than stipulated in [8.4.1]. In no case, however, is the cross-sectional area of the pipe to be less than twice the area required for branch bilge suction pipes in engine rooms, see [8.4.3].

8.4.3 The internal diameter of branch bilge suctions shall not be less than stipulated by the following formula, to the nearest 5 mm:

$$d_1 = 2.15\sqrt{l(B+D)} + 25 \quad [\text{mm}]$$

where:

l = length of compartment [m].

B and D as given in [8.4.1].

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

8.4.4 Direct bilge suctions shall have an internal diameter of not less than 1.4 d_1 but need not exceed the diameter given in [8.4.1].

For SPS and passenger vessels, the direct suctions shall not be taken less than what is required for the bilge main.

If an emergency suction is fitted, the diameter shall be taken equal to that of the suction side of the pump, but need not exceed 400 mm.

8.4.5 The sizes of direct bilge suctions in smaller separated machinery spaces shall be considered in each case.

8.4.6 The sectional area of a suction pipe from a bilge distribution chest shall not be less than the combined area of the two largest branch bilge suctions connected to that chest, but it need not exceed that required above for the main bilge line.

8.4.7 The internal diameter of the bilge suction pipes to the fore and after peaks and to the tunnel well shall not be less than 63 mm for ships exceeding 61 m in length.

8.5 Bilge pipes through tanks and holds

8.5.1 Bilge suction pipes are, as far as practicable, not to be carried through double bottom tanks. If bilge pipes are led through tanks containing water ballast or fuel oil, their open ends shall be provided with non-return valves preventing draining of the tank content in case of failure of the bilge pipe inside the tank.

8.5.2 If a main bilge line for the cargo holds is arranged, this shall be placed in a pipe tunnel or duct, and the branch bilge suctions from the main shall be fitted with remotely controlled valves. The main line shall be dimensioned as the machinery space main bilge line, and it shall be placed as high as possible in the pipe tunnel/duct.

8.5.3 As alternatives for locating the main bilge line in a pipe tunnel or pipe duct, the following alternatives may be accepted:

1) Main bilge line through double bottom ballast tanks with the branch valves located in accessible dry compartments.
2) Two main bilge lines with branch line valves located in double bottom ballast tanks. Each cargo hold has branch suctions connected to main lines, i.e. two bilge suctions per hold.

8.5.4 The main bilge line for cargo holds shall be fitted with a shut-off valve in the machinery space.

8.5.5 Where bilge pipes are led through cargo holds, they shall be efficiently protected by covers or to be built in.

8.5.6 Remotely controlled bilge and ballast pumps shall be provided with operating indications at the location of where the operation is controlled. .

8.6 Bilge wells, mud boxes, valves, etc.

8.6.1 The bilge wells shall have a capacity of at least 0.15 m^3.

8.6.2 Branch bilge pipes for drainage of machinery spaces and shaft tunnels shall be led to mud boxes. The mud boxes shall have straight tail pipes to the bilges and shall be arranged for easy inspection and cleaning. Strums or rose boxes shall not be fitted to the lower end of these pipes or to direct or emergency bilge suctions.

8.6.3 Strums or rose boxes shall be fitted to the ends of bilge suction pipes in cargo holds, and arranged for easy inspection and cleaning. The open area shall be at least twice the internal sectional area of the pipe. The diameter of the holes shall be approximately 10 mm.

8.6.4 The distance between the open ends of the bilge suction pipes and the bottom of the bilge or wells shall be adequate to allow a full flow of water and to facilitate cleaning.

8.6.5 Valves, cocks and mud boxes shall be located in readily accessible positions above or on the same level as the floor plates. Where this is not practicable, they may be placed immediately below, provided that the floor plates in question can easily be removed and are fitted with a name plate which indicates the presence of these fittings.

9 Ballast system and drainage of tanks

9.1 Drainage of ballast tanks

9.1.1 All ballast tanks shall be connected to at least two drainage pumps. For drainage of top wing tanks see Pt.3 Ch.12 Sec.9.

9.1.2 For ballast tanks with flat bottoms and width exceeding half of the vessels beam wing suctions are required.

9.1.3 The dimensions of pipes are at least to be as specified for branch bilge pipes in [8.4.3].

9.2 Ballast water management systems

9.2.1 Ships with ballast water treatment systems installed in order for ships to meet the requirements of the ballast water management convention shall follow the requirements of Pt.6 Ch.7 Sec.1.

9.3 Anti-heeling arrangements

9.3.1 Anti-heeling arrangements, which may counteract heeling angles of more than 10°, shall be designed as follows:

- A shut-off device shall be provided in the cross channel between the tanks destined for this purpose before and after the anti-heeling pump.
- These shut-off devices and the pump shall be remotely operated. The control devices shall be arranged in one control stand.
- At least one of the arranged remote controlled shut-off devices shall automatically shut-down in the case of power supply failure.
- The position closed on the shut-off devices shall be indicated on the control stand by end position indicators.

10 Air, overflow and sounding pipes

10.1 Air pipes

10.1.1 Air pipes shall be fitted to all tanks, voids, cofferdams, shaft tunnels and pipe tunnels. For small dry compartments without piping installations the requirement for fitting air pipes may be waived.

10.1.2 Air pipes shall not be fitted with valves that may impair the venting function.

10.1.3 Tank air pipes shall be placed at the highest part of the tank and as far away as possible from the filling pipes.

Where the tank top is unusual or of irregular profile or of great length, the number and positions of the air pipes shall be decided in each case. For tanks and voids with width exceeding half of the vessel's beam, air pipes on each side shall be required.

10.1.4 Pipe ducts of great length shall be fitted with air pipes in the fore and after ends. The shaft ducts shall be provided with an air pipe at the after end.

10.1.5 Tanks with anodes for cathodic protection shall have air pipes fitted forward and aft, alternatively a single air pipe provided with a flame screen may be accepted.

10.1.6 Air pipes from tanks which can be filled from the sea, air pipes from double bottom tanks, shaft tunnels, pipe ducts and air pipes from sea chests shall be carried up to above the bulkhead deck.

10.1.7 Air pipes from fuel oil tanks, heated lubrication oil tanks, cofferdams and all tanks which can be pumped up, shall be carried above the bulkhead deck up to the open air.

10.1.8 Air pipes from lubricating oil and hydraulic oil storage tanks may terminate in the machinery space, provided that the open ends are so located that issuing oil cannot come into contact with electrical equipment or heated surfaces.

10.1.9 Air pipes from fuel oil daily service tanks and settling tanks shall be so arranged that possible ingress of seawater or rainwater through a broken pipe does not reach the fuel oil service tanks. If lubrication oil service tanks have air pipes extending to the open deck, the same requirements as for fuel oil apply.

Guidance note:

Arrangements utilising common venting through an overflow tank, or a drain pot in the air pipe with automatic drainage to a suitable tank should comply with the above.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

10.1.10 Air pipes from fuel oil draining tanks with a volume less than 2 m^3 and which cannot be pumped up, may terminate in the engine room.

10.1.11 For height and wall thickness of air pipes above deck, see Pt.3 Ch.12 Sec.7 [3].

10.1.12 The ends of the air pipes shall be so designed or so located that ingress of water is prevented. Where automatic vent heads with ball floats or similar devices are fitted, they shall be type approved.

10.1.13 Air pipes for tanks containing heated fuel shall comply with Sec.5 [4.1].

10.1.14 Where only one air pipe is fitted, it shall not be used as a filling pipe.

10.1.15 All air pipes shall be clearly marked at the upper end.

10.1.16 Air pipes shall be self-draining under normal conditions of trim.

10.1.17 Air pipes for tanks shall not be used as primary means for sounding.

10.1.18 Air pipes from the bilge tank required in [4.1] shall be led to open air above the bulkhead deck.

10.1.19 Air pipes from thermal oil tanks shall be led to open deck. For tanks without drainage possibilities, e.g. double bottom tanks, air pipes shall be arranged with drainable water traps at the lowest practicable points.

10.2 Sectional area of air pipes

10.2.1 For tanks which can be pumped up and for which overflow pipes are not arranged, the sectional area of air pipes shall be dimensioned such that the structure is able to withstand the pressure if the tank is over-pumped with the largest available pump.

Documentation of calculated pressure drops in air pipes for water overflow is required in cases where the capacity of the ballast pump is large compared to the cross-sectional area of the air pipes. The calculations shall verify that the dynamic pressure increase during water overflow does not exceed 25 kN/m^2. Alternatively, arrangements for prevention of over-pumping of tanks may be accepted.

The sectional area of the air pipes shall in no case be taken less than 125% of the sectional area of the filling pipe.

Guidance note:

Automatic stop of ballast pumps or automatic closing of valve in the ballast filling line may be accepted as arrangement for prevention of over-pumping of tanks. Such means should be activated by a remote level gauging system or equivalent. In addition an independent visual and audible high level or high-pressure alarm should be required. The alarm should be activated prior to stop of pumps or closing of valve. Arrangements for functional testing of the automatic stop or closing and alarm systems should be provided.

For short air pipes of the gooseneck type a maximum water velocity of 4 m/s may be acceptable. If an automatic type airvent head is fitted, the flow resistance is increased and the water velocity should be lower.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

10.2.2 For tanks that are filled from installations outside the vessel (e.g. bunker fuel tanks) and not fitted with overflow pipes, the sectional area of air pipes shall not be less than 125% of the sectional area of the filling pipe.

10.2.3 Air pipes shall have an internal diameter not less than 50 mm. However, for tanks of volume less than 0.5 m^3 smaller diameters may be considered for air pipes of short length.

10.2.4 Shaft ducts and pipe ducts shall be fitted with an air pipe with an internal diameter not less than 75 mm.

Guidance note:

Damage stability considerations may require significantly larger sectional areas than the minimum required by these rules.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

10.3 Overflow pipes

10.3.1 The requirements in [10.3.2] to [10.4.1] are applicable to any overflow system when fitted.

10.3.2 The overflow system shall be fitted with an alarm device or a sight glass, easily visible from the place where the transfer pump can be stopped.

10.3.3 The overflow system shall be so arranged that water from the sea cannot enter through the overflow main line into other tanks in case of any tanks being damaged.

Guidance note:

This requirement applies if any fuel tank or overflow tank connected to a common overflow line or air vent tank is bounded by bottom shell plating or ship's side plating below the waterline.

In such cases the common overflow line or air vent tank should be located higher than the deepest waterline, alternatively individual tank overflow lines should be arranged with loops extending above the waterline.

Ships subject to damage stability requirements:

Routing of the pipe lines in the overflow system should take account of the deepest waterline derived from the damage stability calculations. The deepest waterline in this context should be taken from the cases where any tank connected to the system are damaged and should correspond to the equilibrium angle after damage + the required range of positive stability (residual stability).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

10.3.4 The overflow pipes shall be self-draining under normal conditions of trim and ambient temperature.

10.4 Sectional area of overflow pipes

10.4.1 The sectional area of overflow pipes shall in no case be taken less than 125% of the sectional area of the filling pipe.

10.5 Sounding pipes

10.5.1 All tanks, cofferdams, pipe tunnels and ducts shall be provided with sounding pipes or other approved means for ascertaining the level of liquid in the tanks. Spaces which are not always accessible, shall be provided with sounding pipes. In cargo holds, sounding pipes shall be fitted to the bilges on each side and as near the suction pipe rose boxes as practicable.

10.5.2 Sounding pipes shall be readily accessible at any time and clearly marked.

10.5.3 Sounding pipes shall be led to the bulkhead deck. Sounding pipes from tanks that can be pumped up and contains flammable liquids shall be carried to the open air (except as provided for in [10.5.5]).

Sounding pipes to tanks containing liquids which have a flash point below 60°C (closed cup), are always to be carried up to the open air. The sounding rod of these tanks shall be of spark proof material and no gauge glasses shall be fitted to these tanks if located in machinery spaces.

The sounding pipes shall be fitted with efficient closing appliances.

10.5.4 Sounding pipes on tanks shall be provided with holes for equalising the pressure close to the top of the tank.

10.5.5 Readily accessible short sounding pipes may be fitted to the top of tanks in machinery spaces and shaft tunnels. If the tanks contain fuel oil or other flammable liquids the following conditions shall be met:

a) A closed type level gauging system is fitted for all passenger ships and cargo ships of 500 gross tonnage and above.
b) The sounding pipes terminate in safe distance from ignition hazards. If not, other arrangements shall be made to prevent oil from coming into contact with a source of ignition.
c) The terminations of sounding pipes shall be fitted with self-closing cocks having cylindrical plugs with weight-loaded levers permanently attached.
d) Small self closing test cocks are fitted below the self-closing cocks mentioned in c).

For fuel oil tanks above double bottom short sounding pipes may be permitted on the same conditions provided that in addition the tanks are fitted with an approved oil level gauge.

10.5.6 Short sounding pipes to tanks not intended for oil may be fitted with a screw cap attached by chain to the pipe or with shut-off cocks.

Such arrangement may also be accepted for lubrication oil tanks and hydraulic oil tanks which cannot be pumped up and for fuel oil drain tanks less than 2 m^3 which cannot be pumped up.

10.6 Other level indicating devices

10.6.1 Oil level indicating devices of approved type may be installed in lieu of sounding pipes, provided adequate means to prevent release of oil in case of failure or overfilling are fitted.

10.6.2 Flat glass type gauge glasses or magnetic level indicators can be installed as a means of level indication for tanks containing flammable fluids. They shall be fitted with a self-closing valve at each end, and shall be protected against mechanical damage.

10.6.3 Other oil level indicating devices and level switches, which penetrate below the tank top, may be used, provided they are contained in a steel enclosure or other enclosures not being capable of being destroyed by fire.

10.6.4 In passenger ships, no oil level indicating devices requiring penetrations below the top of the tank are permitted.

10.6.5 Open sounding system shall not be allowed for oil fuel tanks which can be heated up to above 50°C.

10.6.6 Remote sounding system may replace ordinary sounding pipes or gauges as follows:

a) For tanks easily accessible for checking of level through for example manholes, one remote sounding system may be accepted.
b) For tanks not always accessible for checking of level, two remote sounding systems are required inside the tanks. In the case of remote- or local sounding based on the air-bubble principle, two air bubble lines per tank is accepted as sufficient redundancy. In cases where pressure sensors are utilized, 2 sensors with individual cables will be accepted.

10.7 Sectional area of sounding pipes

10.7.1 The internal diameter of sounding pipes shall not be less than 32 mm. For heavy fuel oil tanks the internal diameter shall not be less than 50 mm.

10.8 Air and sounding pipes through refrigerated spaces

10.8.1 Air and sounding pipes through refrigerated cargo spaces, see Pt.6 Ch.4 Sec.9.

10.9 Air and sounding pipes for barges and pontoons

10.9.1 Closed compartments and tanks shall be provided with air and sounding pipes.

Air and sounding pipes may not be required for dedicated dry voids which are permanently preserved and closed, and do not contain piping.

Access shall be arranged for detecting possible water ingress and enable use of portable bilge pumps.

10.9.2 Air pipes for unmanned barges and pontoons shall be fitted with automatic operating closing appliances.

10.9.3 Manned barges and barges for unlimited service shall be provided with sounding pipes to the cargo holds.

10.9.4 Where air pipes of full height may cause difficulties in operation of the vessel, a lower height may be approved, provided the national maritime authorities in question are satisfied that the closing arrangements and other circumstances justify a lower height.

10.9.5 Where the presence of air pipes may cause particular difficulties in operation of the vessel, the requirement to air pipes may be dispensed with after consideration in each case.

Such compartments and tanks are, however, to have alternative means for expansion.

10.9.6 Ballast tanks which have been approved without air pipes according to [10.9.5], shall be arranged with suitable hatch arrangement for opening during pumping of ballast.

11 Tanks for liquid cargoes other than mineral oils with flash point above 60°C (closed cup)

11.1 General

11.1.1 Air and sounding pipes shall satisfy the requirements for fuel oil tanks, see [10].

11.1.2 On tanks carrying latex, air pipes fitted with pressure vacuum valves shall be provided if the remaining air and filling pipes are kept closed.

11.1.3 Pipes for vegetable oils and other liquid cargoes shall not be led through fuel oil tanks. In addition, fuel oil pipes shall not be led through tanks for vegetable oil or other liquid cargoes.

11.1.4 It shall be possible to blank flange bilge and ballast piping terminating in tanks which can be used for vegetable oils or other liquid cargoes. See also [3.2.2].

11.1.5 For hydraulic testing of pipes in tanks, see Sec.10 [5].

11.1.6 Requirements for transport of mineral oils with flash point below 60°C, see Pt.5 Ch.5.

SECTION 5 MACHINERY PIPING SYSTEMS

1 General

1.1 Redundancy and capacity

1.1.1 For definition of redundancy, see Ch.1.

1.1.2 Redundancy shall be arranged as specified in Ch.1, and capacity of redundant components shall be as specified in the requirements for the different systems.

Applied to piping systems this implies that more than one pump unit shall be installed when failure of such a unit will result in loss of a main function specified in Pt.1 Ch.1 Sec.1 [1.2].

The capacity shall cover demands at maximum continuous load on the component served when any pump unit is out of service.

1.1.3 For propulsion plants with one engine with output less than 400 kW and with pumps driven directly by the unit it serves, redundancy type 3 may be accepted. I.e. an easily removable pump of each type may be approved as a standby pump.

1.2 Drip trays

1.2.1 All oil tanks in machinery spaces over double bottom tanks shall be equipped with drip trays of sufficient capacity and height for collecting any leakage of oil that may occur from valves, fittings etc. Drip trays shall be fitted under those parts of the oil systems which are often opened up for cleaning such as burners, purifiers, filters, pumps, etc.

1.2.2 Precautions shall be taken against overflow of oil from the lowest situated drip trays. Drainpipes led to double bottom tanks shall be provided with means for prevention of backflow.

1.2.3 The drip trays shall be drained to a closed waste tank not forming part of an overflow system. For drip trays intended for small leakages and located far away from the nearest drain tank, other solutions may be considered.

2 Cooling systems

2.1 General

2.1.1 Centrifugal sea-water cooling pumps shall be installed as low as possible in the ship or other means shall be provided to prevent, as far as practicable, that the pumps lose water in a seaway.

2.1.2 For systems using fuel oil as a cooling agent, requirements in [4] are also applicable.

2.1.3 Shut-off valves shall be provided at the inlet and outlet of all heat exchangers.

2.1.4 Every heat exchanger and cooler shall be provided with a vent and a drain.

2.1.5 For heat exchangers attached to smaller engines (or other small installations), the requirements of [2.1.3] and [2.1.4] may be dispensed with, provided that the engine is fitted with such shutoff valves and drains.

2.2 Cooling water supply

2.2.1 For propulsion systems with an output of 400 kW or less, engine-driven bilge pumps can be used as standby cooling water pumps.

2.2.2 For auxiliary engines with engine-driven sea water cooling pumps a complete spare pump ready for mounting shall be delivered with the ship. If at least 3 auxiliary engines are installed, each with sufficient output for normal operation at sea, the requirement regarding a spare pump is waived.

2.2.3 For steam-driven propulsion plants the cooling water pumps for the main condenser shall be arranged with built in redundancy, to at least 30% capacity.

2.2.4 For condenser installations with scoop cooling, a standby cooling water pump with at least 30% capacity shall be installed. In addition the largest of the remaining sea water pumps in the machinery shall be arranged for emergency supply of cooling water to the main condenser.

2.2.5 If cooling water is used for heating of oil, the system shall be arranged to avoid contamination of the cooling water. For this purpose the heating coils shall be located on the pressure side of the cooling pumps.

Alternatively a primary and secondary system arrangement may be used. In the case of direct heating the heating coils shall be all welded with no detachable connections where mixing of oil and water may occur.

2.3 Sea inlets for cooling water pumps

2.3.1 Sea-water cooling systems for the main and auxiliary machinery shall be connected to at least two cooling water inlets, preferably on opposite sides of the ship.

Guidance note:

The inlets may be arranged as high and low suctions.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.3.2 Strums shall be fitted to all sea chest openings in the shell plating. The total area of the strum holes shall be at least twice the total flow area in the sea water inlet valves.

2.3.3 Where sea water is used for cooling the main engines or auxiliary engines, the cooling water, suction lines shall be provided with strainers which can be cleaned without interrupting the cooling water supply.

2.3.4 Regarding sea inlets see Sec.3 [1.3].

2.3.5 Regarding sea chest arrangements for ships having additional class notations for navigation in ice, see Pt.6 Ch.6.

3 Lubricating oil system

3.1 General

3.1.1 Lubricating oil systems shall be separated from other systems. This requirement does not apply to hydraulic governing and manoeuvring systems for main and auxiliary engines.

3.1.2 For ships where a double bottom is required, the minimum distance between shell and circulating lubricating oil tank shall not be less than 500 mm. See also SOLAS Ch. II-1, Reg. 9.3.

3.1.3 Lubricating oil drain pipes from the engine sump to the drain tank shall be submerged at their outlet ends.

3.2 Lubricating oil pre-treatment and filter arrangement

3.2.1 In systems where the lubricating oil circulates under pressure, efficient filtering shall be arranged.

3.2.2 For non-redundant units it shall be possible to clean the filters without interrupting the filtered oil supply.

Guidance note:

This may be achieved by installing two such filters or strainers in parallel or installing the duplex type, with a changeover facility that will enable cleaning without interrupting the filtered oil supply. An auto-backwash filter satisfying the same intent may also be accepted. Single lubricating oil filters are accepted for engines used for emergency generator duty.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.2.3 Back-flushing intervals of automatic back-flushing filters provided for intermittent back-flushing shall be monitored and frequent flushing shall be alarmed.

3.2.4 Where blocking lubrication oil filters may lead to loss of propulsion or power generation, they shall be fitted with differential pressure monitoring. On engines provided for operation with gas oil only, differential pressure monitoring is not required.

3.2.5 Duplex filters shall be arranged with means for preventing opening of a filter under pressure and for venting when put into operation. It shall be clearly visible, which chamber is in and which is out of operation.

3.2.6 For diesel engines burning residual oil fuel, cleaning of the lubrication oil by means of purifiers shall be arranged. These means are additional to the filters required in [3.2.1].

3.3 Lubricating oil supply

3.3.1 Each auxiliary engine or turbine shall be supplied with at least one lubricating oil pump of sufficient capacity for the maximum output of the engine.

3.4 Emergency supply of lubricating oil to main machinery

3.4.1 Main machinery installations with long roll-out times such as steam turbines shall be provided with a satisfactory emergency supply of lubricating oil in case of low oil pressure. This emergency supply shall be independent of power from the main switchboard. The emergency supply may be taken from a gravity tank containing sufficient oil to maintain adequate lubrication until the engines come to rest.

3.5 Remote shut-off arrangement for lubricating oil tanks

3.5.1 Valves on lubricating oil tanks shall be arranged with quick-acting shut-off valves as outlined in [4.5.1] if all conditions below are in place:

— the tanks are situated in machinery spaces above the double bottom
— the valves are open during normal service
— the valves are located below top of the tank or overflow outlet.

This requirement may be exempted from upon consideration in each case, for small tanks with volume less than 0.5 m^3 and tanks, for which an unintended closing of the valves may result in loss of main function specified in Pt.1 Ch.1 Sec.1 [1.2].

4 Fuel oil systems

4.1 Flash point of fuel oil

4.1.1 Oil fuels with a flash point of less than 60°C (closed cup) are not permitted, except for the following:

— ships certified for restricted service within areas having climate ensuring that ambient temperatures of spaces where such fuel oil is stored shall not rise to temperatures within 10°C below the flash point of the fuel, may use fuel oil with flash point below 60°C but not less than 43°C.
— installation specially approved for the use of crude oil as fuel.

The use of gas as fuel is permitted in gas carriers as given in Pt.5 Ch.7 Sec.16 and in other ships as given in Pt.6 Ch.2.

4.1.2 Heating of oil fuel in storage tanks shall be limited to a temperature 10°C below the flash point of the fuel except that for heated tanks in the supply system when arranged in compliance with the following:

— temperature of the vapour at the outlet of the air pipes shall be below 60°C when the outlet is within 3 m from a source of ignition
— the air pipes shall be fitted with flame screens
— no openings from the vapour space of the fuel tanks shall have outlet into machinery spaces
— enclosed spaces shall not be located directly over such fuel tanks, except for well-ventilated cofferdams
— electrical equipment shall not be fitted in the vapour space of the tanks, unless it is certified intrinsically safe.

4.2 Fuel oil tanks

4.2.1 Two fuel oil service tanks for each type of fuel used on board necessary for propulsion and vital systems or equivalent arrangements shall be provided. Each tank shall have a capacity sufficient for continuous rating of the propulsion plant and normal operating load at sea of the generator plant for a period of not less than 8 hours.

Guidance note:

For guidance, see also IACS UI SC123.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.2 Settling tanks for heavy fuel oil shall be provided. Settling tanks shall have sufficiently dimensioned heating systems and be provided with drains, emptying arrangements and temperature measuring instruments.

4.2.3 Where fuel oil tanks are situated near to boilers or other hot surfaces, the tanks shall be well insulated. In order to keep the oil temperature well below the flash point, care shall be taken that the free air circulation is not impeded.

4.2.4 The plate thickness in free standing fuel oil tanks shall not be less than 5 mm. For very small tanks, however, the plate thickness may be reduced to 3 mm. Sides and bottom of the tanks shall be well stiffened. Large tanks shall be fitted with wash bulkheads.

4.2.5 Outlets for fuel oil centrifuges, if fitted, shall be taken from the lowest point of the tank bottom.

4.2.6 The use of free standing fuel tanks is prohibited for passenger vessels.

4.3 Fuel oil piping

4.3.1 Piping conveying flammable liquids under pressure in the engine room and boiler room shall be laid in well-lit places, in order that the piping may be kept under observation.

4.3.2 All detachable pipe connections and valves in oil fuel pressure piping shall be at a safe distance from boilers, exhaust pipes or other heated surfaces and electrical appliances.

4.3.3 The number of detachable pipe connections shall be limited to those which are necessary for mounting and dismantling.

4.3.4 Fuel lines shall not pass through tanks containing feed water, drinking water, urea, lubricating oil or thermal oil.

4.3.5 For tanks that can be used for both fuel oil and water ballast (allowable in special cases only) separate valve chests shall be provided for fuel oil and water ballast. The piping arrangement shall be such that the same tank cannot be connected to both valve chests at the same time.

4.3.6 Piping arrangements for deep tanks carrying alternately dry cargo, fuel oil and water ballast, see Sec.4 [3.2.2].

4.3.7 The arrangement of piping and valves shall be such that oil cannot enter tanks not intended for this purpose.

4.3.8 The design pressure for fuel oil systems with a working pressure above 7 bar and a working temperature above 60°C shall be minimum 14 bar. Other fuel oil systems shall have a minimum design pressure of 3 bar.

(IACS UR P1.2.7)

4.4 Arrangement of valves, cocks and fittings

4.4.1 Every fuel oil inlet or outlet pipe from any fuel oil tank, that would allow fuel oil to escape from the tank if damaged, shall be provided with a shut-off valve directly on the tank.

For a tank situated above the double bottom, the valve shall be secured to the tank itself. Short distance pieces of rigid construction are acceptable in places where valves are required to be fitted directly on tanks.

4.4.2 All valves and cocks on oil tanks shall be mounted and protected in such a way that they cannot be damaged as the result of an accident. The positioning of valves shall be such that any possible leakage shall not lead to oil spray on boilers, exhaust pipes or other hot surfaces of the machinery, or on electric motors and appliances.

4.4.3 In multi-engine installations, which are supplied from the same fuel source, means of isolating the fuel supply and spill piping to individual engines shall be provided. The means of isolation shall not affect the operation of the other engines, and shall be operable from a position not rendered inaccessible by a fire on any of the engines.

Guidance note:

A manual, closable valve located at least 5 metres from the engine is considered acceptable as means for isolation. See MSC. Circ. 1321

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.4.4 All valves in the fuel oil system shall be controllable from positions above the floor plates.

4.4.5 Sampling points shall be arranged for measurement of sulphur content in fuel.

Guidance note:

Arrangement of sampling points in accordance to IMO MEPC.1/Circ.864/Rev.1 is considered acceptable.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.5 Shut-off arrangement for fuel oil tanks

4.5.1 Oil fuel pipes, which, if damaged, would allow oil to escape from a storage, settling or daily service tank having a capacity of 500 l and above and situated above the double bottom, shall be fitted with a cock or valve directly on the tank capable of being closed from a safe position outside the space concerned.

4.5.2 In machinery spaces, fuel oil valves on tanks shall be arranged as quick-acting shut-off valves with remote operation. This remote operation shall be carried out from a central position outside the space itself, and at a safe distance from openings to the engine and boiler rooms.

4.5.3 Oil fuel pipes, which are led into the engine room from tanks situated above the double bottom outside this space, are also to be fitted with quick-acting shut-off valves in the engine room close to the bulkhead. This is not applicable where the valve on the tank is arranged for quick acting shut-off.

4.5.4 The requirement for remote quick acting shut-off is not applicable for valves closed during normal service, valves on double bottom tanks or valves on tanks less than 0.5 m^3. For valves on filling lines connected below the liquid level, remote shut-off may be omitted if non-return valves are used.

4.5.5 The means used to operate the quick acting shut-off valves shall be independent of any power sources located in the same space as the valves. For a pneumatically operated system, the air supply may be from a source located within the same space as the valves provided that an air receiver complying with the following is located outside the space:

— sufficient capacity to close all connected valves twice
— fitted with low air pressure alarm
— fitted with a non-return valve adjacent to the air receiver in the air supply line.

Materials readily rendered ineffective by heat shall not be used in the construction of the valves or the closure mechanism.

4.5.6 The controls for remote shut-off for emergency generator and emergency fire pump shall be located separately from the controls of the other valves in order to avoid erroneous operation.

4.5.7 The arrangement shall be such that paint, corrosion, etc., shall not impair the efficiency of the remote operation of the valves.

4.5.8 The use of hydraulic or pneumatic systems for keeping quick-acting shut-off valves in open position shall not be accepted.

4.5.9 Pressurized mixing tanks shall be designed as pressure vessels and shall be fitted with the following equipment:

— a non-return valve in the recirculating lines from the engines
— an automatic degasser or a gas blanket monitor with manual degasser
— a drain/emptying device, which shall be locked in the closed position.

4.6 Fuel oil pre-treatment and filter arrangement

4.6.1 Filters shall be fitted in the supply lines to the main and auxiliary machinery. These shall be arranged in such a way that they can be cleaned without interrupting the supply of filtered fuel oil.

Guidance note:

This may be achieved by installing two such filters or strainers in parallel or installing the duplex type, with a changeover facility that will enable cleaning without interrupting the filtered oil supply. An auto-backwash filter satisfying the same intent may also be accepted.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.6.2 For auxiliary and emergency generator engines one single fuel oil filter for each engine is acceptable.

4.6.3 Back-flushing intervals of automatic back-flushing filters provided for intermittent back-flushing shall be monitored and frequent flushing shall be alarmed.

4.6.4 Differential pressure monitoring shall be fitted where blocking of fuel oil filters may lead to loss of propulsion or power generation. On engines provided for operation with gas oil only, differential pressure monitoring is not required.

4.6.5 Duplex filters shall be arranged with means for preventing opening of a filter under pressure and for venting when put into operation. It shall be clearly visible, which chamber is in and which is out of operation.

4.6.6 Fuel supply for diesel engines burning residual oil fuel (heavy fuel) or mixtures containing such oils shall be provided with suitable means for removal of harmful contaminants. These means are additional to the filters required in [4.6.1].

If centrifuges are used for the above purpose the arrangement shall have adequate built in redundancy.

4.7 Fuel oil pre-heaters

4.7.1 If pre-heating of the fuel in the fuel oil service system is required, two pre-heaters shall be provided. The arrangement of only one pre-heater may be accepted where temporary operation with fuel oil that does not need pre-heating can be ensured.

4.7.2 A by-pass of the fuel heaters with shut-off valve shall be provided.

4.8 Viscosity control

4.8.1 Where main and auxiliary engines are operated on heavy fuel oil, automatic viscosity control shall be provided.

4.8.2 Viscosity regulators shall be fitted with a local temperature indicator.

4.8.3 The following local control devices shall be fitted directly before the engine

— a gauge for operating pressure
— an indicator for the operating temperature.

4.9 Various requirements

4.9.1 Settling tanks and daily service tanks shall be fitted with means for draining of water from the bottom of the tanks.

4.9.2 Open drains for removing water from oil tanks shall be fitted with self-closing valves or cocks, and means shall be provided for collecting all waste oil in closed tanks.

4.9.3 The inlet connections of suction lines for service and settling tanks shall be arranged sufficiently high above the tank bottom to avoid that water and impurities which have settled out are entering the fuel supply system.

Where the overflow pipe of a heavy fuel oil service tank is terminated in the settling tanks, arrangements to prevent back-flow of untreated fuel to the service tanks shall be provided.

4.9.4 Fuel oil booster units shall be protected against pressure peaks, e.g. by using adequate dampers.

Guidance note:

Dampers may be dispensed with if adequate damping is confirmed by the engine manufacturer or engine licenser.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.9.5 For propulsion plants less than 400 kW a hand pump can be accepted as second means for pumping up the daily service tank.

4.9.6 Flow-meters of positive displacement type shall be fitted with means preventing immediate loss of fuel supply in case of blockage if this will lead to loss of propulsion plant or auxiliary power. For vessels with unmanned machinery spaces, there shall be an automatic bypass installed.

4.10 Fuel oil supply to burners and firing equipment

4.10.1 The oil burners shall be so arranged that they cannot be withdrawn unless the oil supply to the burners is cut off.

4.10.2 For auxiliary boilers where the installation of two separate burner units is impossible, the use of one unit may be accepted on the condition that necessary spare parts are provided.

4.10.3 The fuel supply to the burners shall be fitted with hand-operated, quick-closing shut-off device on the fuel oil manifold. Depending on the design and method of operation, a quick-closing shut-off device may be required fitted directly before each burner.

4.10.4 In case only steam operated pre-heaters are installed, the burner shall be equipped with supply of fuel oil not requiring pre-heating.

4.10.5 Any controllable heat source may be used to preheat the fuel oil. Preheating with open flame is not permitted.

4.10.6 Temperature or viscosity control of the fuel shall be done automatically. For monitoring purposes, a thermometer or viscosimeter shall be fitted to the fuel oil pressure line in front of the burners.

4.10.7 The fuel oil supply temperature shall be selected so as to avoid excessive foaming, the formation of vapour or gas, and the formation of deposits on the heating surface.

4.10.8 Fuel oil circulating lines shall be provided to enable the preheating of the fuel oil prior to the start-up of the heat generators.

4.10.9 When performing change over from heavy to light fuel, arrangements shall be installed to prevent excessive heating of the fuel, e.g. by-pass or heater temperature control.

4.10.10 Ignition of burners shall take place at reduced fuel oil supply. Fuel oil shall not be supplied before ignition device produces sufficient energy for safe ignition.

4.10.11 For steam-atomising burners and when steam blowing is used for cleaning of the burners, effective precautions shall be taken to prevent fuel oil from penetrating into the steam system.

5 Thermal-oil installations

5.1 Installation of thermal oil plants

5.1.1 If oil fired thermal-oil heaters are not located in separate rooms, they shall be surrounded by coamings of height not less than 150 mm and with drainage to a closed tank.

5.1.2 If oil fired thermal oil heaters are installed in a separate room, the room shall have mechanical ventilation, automatic fire detection and an approved fixed fire-extinguishing system, operated from an easily accessible place outside the room. Stop of ventilation, oil-burner and oil-booster pumps shall be placed outside the room. Ventilating ducts shall have closing flaps.

5.1.3 Oil piping in the exhaust fired thermal-oil heater area shall be so arranged that spray or drip from detachable pipe and valve connections can neither reach the heater and exhaust ducts nor flow to the engine room below.

5.1.4 Thermal-oil piping shall be installed to provide sufficient flexibility to accommodate thermal expansion. Expansion bellows shall not be used. Type approved flexible hoses may be accepted.

5.1.5 Thermal-oil pipes shall have welded connections, with the exception of flange connections required for servicing system components. The requirements for non-destructive testing (NDT) of welded joints for thermal oil piping can be found in Sec.10 [1.5].

5.1.6 Pipe penetrations through bulkheads and decks shall be insulated against heat conduction to the bulkhead.

5.2 Thermal oil tanks

5.2.1 An expansion vessel shall be placed at a high level in the system. The space provided for expansion shall be such that volume increase of the thermal oil at the maximum thermal oil temperature can be safely accommodated.

The following shall be regarded as minimum requirements: 1.5 times the increase in volume for volumes up to 1000 litres, and 1.3 times the increase for volumes over 1000 litres. The volume is the total quantity of thermal oil contained in the system up to the lowest liquid level in the expansion vessel.

5.2.2 A drainage tank shall be located at the lowest point of the system. The capacity shall be sufficient to hold the volume of the largest isolatable system section.

5.2.3 System tanks and vessels where water may accumulate shall be arranged with drain cocks.

5.2.4 Valves on the thermal oil tanks shall be arranged in accordance to [4.5.1] and [4.5.5].

5.3 Thermal oil expansion tank arrangement

5.3.1 The alarms required for the expansion tanks shall create optical and acoustic fault signals at the thermal oil system control panel. The following alarms and indication equipment are required:

— Liquid level gauge with a mark indicating the lowest allowable liquid level.

— A level switch with alarm shall be fitted which shuts down and interlocks the oil burner and switches off the circulating pumps if the liquid level in the expansion tank falls below the allowable minimum.
— An alarm shall be provided for the maximum liquid level.
— Level gauges made from glass or plastic are not permitted.
— Alarm for high temperature.

5.4 Quick drainage valves and emergency shut-off valves

5.4.1 A quick drainage valve shall be fitted directly to the expansion tank with remote control from outside the space in which the equipment is installed.

5.4.2 Automatic means shall be provided to ensure sufficient air supply to the expansion vessel when the quick drainage valve is operated.

5.4.3 Where the expansion tank is installed outside the engine room, the quick drainage valve may be replaced by an emergency shut-off device (quick closing valve).

5.4.4 The opening of the quick drainage valve or the actuation of the emergency shut-off device shall activate an alarm. At the same time the oil fired heater shall automatically be shut-down.

5.4.5 The dimensions of the drainage and air pipes shall be applied according to Table 1.

Table 1 Dimension of drainage and air pipes

Heater output [kW]	*Expansion and overflow pipes Nominal diameter DN*	*Drainage and venting pipes Nominal diameter DN*
≤ 600	25	32
≤ 900	32	40
≤ 1200	40	50
≤ 2400	50	65
≤ 6000	65	80

5.5 Expansion tank connection lines

5.5.1 A safety expansion line shall connect the system to the expansion vessel. It shall be installed with a continuous positive gradient and be dimensioned such that a pressure increase of more than 10% above the maximum allowable working pressure in the system is avoided.

5.5.2 The expansion vessel shall be provided with an overflow line leading to the drainage tank.

5.5.3 All parts of the system in which thermal oil can expand due to the absorption of heat from outside, shall be safeguarded against excessive pressure. Any thermal oil emitted shall be safely drained off.

5.5.4 The dimensions of the expansion and overflow pipes shall be applied according to Table 1.

5.6 Pre-pressurised thermal oil systems

5.6.1 Pre-pressurised systems shall be equipped with an expansion vessel.

5.6.2 The pressure in the expansion vessel shall be locally indicated and safeguarded against overpressure.

5.6.3 A high pressure alarm and a shutdown of the oil burner, at set pressures below the set-pressure of the safety valve, shall be provided for the expansion vessel.

5.7 Thermal oil circulation system

5.7.1 Arrangements shall be made to ensure a minimum circulation through the heater in case consumers are shut-off. Such arrangements shall be automatically operated.

5.7.2 Each circulation system shall have a minimum of two circulation pumps. One pump shall be in continuous operation, the other in auto stand-by. Starting of the stand-by pump shall be initiated by the dropping out of the contactor for the pump in operation.

5.7.3 A transfer pump shall be installed for filling the expansion vessel and for draining the system.

5.8 Valves in thermal oil systems

5.8.1 Valves shall be designed for a minimum nominal pressure of PN 16.

5.8.2 Valves shall be mounted in accessible positions.

5.8.3 Non-return valves shall be fitted in the pressure lines of the pumps.

5.8.4 Valves in return pipes shall be secured in the open position.

Guidance note:

Bellow sealed valves should be used.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.9 Equipment

5.9.1 The discharge side of the circulating pumps shall be equipped with pressure gauges.

5.9.2 Emergency stop of the system shall be capable of being performed from outside the space of the thermal oil installation. For steam heated thermal oil systems, other arrangements may be considered.

5.9.3 Devices for safe sampling shall be provided in the thermal oil circuit.

5.9.4 Means of de-aeration of the system shall be provided at the highest points of isolatable sections of the thermal oil system and drainage devices at the lowest points. Open venting and drainage is not permitted.

5.9.5 Drip trays with drains to a waste oil tank shall be arranged under all equipment where leakage may occur.

5.10 Insulation and shielding

5.10.1 All insulation shall be covered with an outer barrier which shall be impervious to liquid. In areas and locations where pipes are exposed to mechanical impact, the outer barrier shall be made of galvanised steel plates or aluminium plates of sufficient impact strength to resist deformations from normal wear and strain.

5.10.2 The arrangement of pipes and components shall provide sufficient space for satisfactory insulation installations. Flanged pipe connections shall have installed effective detachable shielding, which shall prevent oil leakage from reaching potential danger areas.

6 Feed water and condensate systems

6.1 Feed water pumps

6.1.1 Feed water pumps installed to meet the rule requirements to redundancy shall be independently driven.

6.2 Feed water piping

6.2.1 If feed water preheaters are fitted in feed water lines by-pass arrangements shall be provided enabling repair of a heater without interrupting the feed water supply.

6.3 Feed water heating

6.3.1 For steam boilers with design pressure above 7 bar arrangements for preheating and deaeration of the feed water before entering the boiler shall be provided.

The preheating arrangement shall be capable of maintaining the temperature above 80°C when boilers are operated at maximum load during normal seagoing service.

6.4 Feed water tanks

6.4.1 Reserve feed water tanks shall be provided, with a capacity corresponding to at least twice the hourly evaporation rate of the main boilers.

6.4.2 Feed water tanks shall be separated from oil tanks by cofferdams.

6.4.3 Piping for feed tanks shall not be arranged through tanks containing oil.

6.5 Condensate from steam heating of tanks

6.5.1 Where fuel or lubricating oil tanks, heaters or purifiers are heated by steam in pipe coils, the condensate shall be led into an observation tank. This tank shall be placed in an easily accessible, well ventilated and well illuminated position where it can easily be observed whether the condensate is free from oil or not.

6.6 Evaporators

6.6.1 For main boilers, evaporators shall be installed with a capacity sufficient to cover normal loss in the system even when one of the evaporators is out of order.

Guidance note:

Normal loss in the system is expected to be in the range of 1 to 2% of the boiler evaporation. The upper part of the range applies for smaller plants.

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7 Steam systems

7.1 Steam piping

7.1.1 Water pockets in the steam flow lines shall be avoided as far as practicable in order to prevent water hammer in the system. If this cannot be avoided, drain cocks or valves shall be fitted in such places so that the pipes may be efficiently drained while in operation.

7.1.2 Steam pipes shall not be led through cargo holds unless the arrangement is specially approved. Where the pipes are led through shaft tunnels they shall be insulated in such a way that the lagging surface temperature does not exceed 60°C.

Uninsulated steam pipes shall not be led through spaces or tanks without satisfactory possibilities for removal of the heat.

Guidance note:

Regarding steam heating of double bottom fuel oil tanks below insulated reefer cargo chambers, see Pt.6 Ch.4 Sec.9.

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7.1.3 For pipes conveying steam at temperatures exceeding 450°C an arrangement may be required (calibrated gauge lengths) for checking of creep in highly stressed areas.

7.2 Steam supply to auxiliary machinery

7.2.1 Steam supply to the steering gear, feed water pumps and machines operating electrical generators shall not be interrupted if steam supply to the propulsion machinery or cargo oil pumps is shut off.

7.3 Shut-off valves

7.3.1 If two or more boilers are connected to a common header or steam manifold the steam connection to each boiler shall be provided with two shut-off valves with a free blowing drain in between.

This requirement does not apply to exhaust gas economisers with forced circulation.

7.3.2 Where blow-downs from two or more boilers are connected to a common discharge, two valves shall be fitted to each discharge.

7.3.3 Heating coils in tanks containing oil residues or fuel, e.g. sludge tanks, leak oil tanks and bilge water tanks, shall be provided with shut-off valves at the inlet and outlet of the tank. In addition, a testing device shall be fitted at the outlet of the tank.

7.4 Safety valves

7.4.1 The discharge from safety valves shall be to a point where hazard is not created.

7.5 Blow down valves on ship's side

7.5.1 The blowdown valve on the ship's side shall be fitted in a readily accessible position. It shall be located above the level of the floor in such a way that it is easy to verify whether it is open or shut. The cock handle shall not be removable unless the cock is shut, and if a valve is fitted, the wheel shall be fixed to the spindle.

8 Hydraulic systems

8.1 General

8.1.1 The redundancy requirement in [1.1.2] applies to pumps, filters and pressure reduction units.

8.1.2 Hydraulic systems shall be separated from other piping systems except lubricating oil systems as specified in [3.1.1].

8.1.3 The hydraulic fluid shall not corrode or attack chemically the components in the system. It shall have a flash point not lower than 150°C and shall be suitable for operation at all temperatures to which the system may be subjected.

8.1.4 Means for filtration and cooling of the fluid and for deflation of entrapped gases shall be incorporated in the system where found necessary.

8.1.5 Detachable pipe connections and valves in hydraulic pressure piping shall be at a safe distance from electrical appliances, boilers, exhaust pipes and other sources of ignition.

8.1.6 Air pipes from hydraulic oil circulation tanks and expansion tanks shall be lead to safe locations so that any escaping oil does not reach possible sources of ignition.

8.1.7 Oil circulation tanks or expansion tanks in engine rooms shall be provided with arrangements preventing overflow of oil (e.g. from generation of vapour due to moisture in the hydraulic oil).

The following alternative arrangements may be accepted:

a) The free volume of the circulation tanks is sufficient for accumulating all the hydraulic oil in the system. A high level alarm is fitted in the tank at a level leaving sufficient free volume for containing the oil in the system.
b) The circulation tank or expansion tank is provided with an overflow pipe leading to a collecting tank. The cross sectional area of the overflow pipe is twice that of the return oil pipe.
c) The air pipe from the tank is lead to a safe position outside machinery space. The cross sectional area of the air pipe is twice that of the return oil pipe.

8.2 Hydraulic power supply

8.2.1 Anchor windlasses may be approved with one power unit provided the anchor(s) can be lowered independent of the hydraulic system.

8.2.2 Anchor windlasses arranged for remote control are in addition to be arranged for local manual control.

8.3 Hydraulic cylinders

8.3.1 Hydraulic cylinders shall be certified as specified in Sec.1 Table 3.

8.4 Accumulators

8.4.1 Hydraulic accumulators of the gas or hydraulic fluid type having

$$pV > 1.5$$

where:

p = design pressure in bar
V = volume in m^3

shall comply with Ch.7, while requirements to smaller accumulators are as for piping.

8.4.2 For hydraulic accumulators of the gas or hydraulic fluid type the two media shall be suitably separated if their mixture would be dangerous or would result in the contamination of the hydraulic fluid and/or loss of gas through absorption.

8.4.3 Each accumulator shall be protected on both gas and hydraulic fluid side by a safety device such as relief valve, fuse plug or rupture disc to prevent excess pressure if overheated. When the accumulator is an integral part of a system with such a safety device, the accumulator itself need not be supplied with a safety device.

8.4.4 Cast accumulators shall have an inside coating.

8.5 Hydraulic equipment

8.5.1 Piping and tubing to actuators and between actuators and local accumulators shall be hydrostatically tested to 1.5 times the system design pressure for 15 minutes.

Guidance note:

This requirement may be waived by the surveyor on a case-by-case basis. Aspects to be considered are maximum operating pressure compared to design pressure. Experience with workmanship may also influence the decision.

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8.5.2 Local accumulators used as backup power supply for essential systems shall be designed and located or protected to minimise the possibility of inadvertent isolation or mechanical damage which could prevent correct operation on demand.

8.5.3 Piping, tubing and components in systems required to operate in a fire scenario shall have adequate fire resistance properties to ensure correct system operation. This is particularly important for systems where hydraulic energy is required to activate or maintain control over the system. The Society may request fire test certificates for such system components.

8.5.4 Piping and tubing shall be flushed and cleaned before being connected to control systems.

8.5.5 Hydraulic oil return lines shall be designed with capacity to allow the maximum return flow during extreme conditions without reducing overall system performance. Care shall be taken to avoid the possibility of blockages at filters, vents or by mechanical damage or inadvertent operation of valves.

9 Pneumatic systems

9.1 General

9.1.1 The redundancy requirement in [1.1.2] applies for compressors, filters, pressure reduction units, when supplying more than one important consumer, and air treatment units (lubricator or oil mist injector and dehumidifier).

9.1.2 Air intakes for the compressors shall be so located as to minimise the intake of oil or water contaminated air.

9.1.3 Pipes between the compressors and pressure vessels shall not have connections to other machinery.

9.1.4 Pressure lines connected to air compressors shall be fitted with non-return valves at the compressor outlet.

9.1.5 Valves on the air receivers shall be designed such that detrimental pressure shock does not arise in the pipes when the valves are opened.

9.1.6 Pipes from air compressors with automatic start shall be fitted with a separator or similar device to prevent condensate from draining into the compressors.

9.1.7 If the ship has a pneumatic auxiliary steering gear, two starting air compressors with a total capacity sufficient for normal operation of the auxiliary steering gear shall be provided.

9.1.8 Air driven whistles shall be supplied from at least two compressed air receivers.

9.1.9 If the service air system is connected to control- or starting air system, there shall be a closable isolation valve installed between the systems.

9.1.10 Where an air ejector is used for pump priming, a non-return valve shall be installed in the air delivery line, to prevent ingress of liquid into the system.

9.2 Pneumatic equipment

9.2.1 Main pipes shall be inclined relative to the horizontal as far as possible, and drainage shall be arranged at the lowest point.

9.2.2 Air to instrumentation equipment shall be free from oil, moisture and other contamination. Condensation shall not be permitted to occur at relevant operational design pressures and temperatures.

For air flowing in pipes which are located entirely inside the machinery space and accommodation, the dew point shall be more than 10°C below ambient temperature, but need not be lower than 5°C.

The dew point of air flowing in pipes on open deck shall be below -25°C.

9.3 Air lubrication systems

9.3.1 For air lubrication systems, the air delivery pipes shall be equipped with a non-return valve and a remotely operated valve in series downstream of the compressors. The remotely operated valve shall be operable from outside the space of the compressors. In addition, a level switch able to detect water ingress in the air delivery pipes shall be installed.

9.4 Pneumatic starting arrangements

9.4.1 Starting systems for internal combustion engines and gas turbines shall have capacity for a number of starts specified in Table 2 without reloading of air receivers.

The capacity shall be divided between at least two air receivers of approximately same size.

Table 2 Capacity for number of starts

Duty of engines	*Number of starts*
Propulsion engines, reversible	12 starts
Propulsion engines, non-reversible	6 starts
Engines for driving electric generators and emergency generators, and engines for other purposes	3 starts each

9.4.2 If a starting system serves two or more of the above specified purposes, the capacity of the system shall be the sum of the capacity requirements.

9.4.3 For multi-engine propulsion plants the capacity of the starting air receivers shall be sufficient for three (3) starts per engine. However, the total capacity shall not be less than 12 starts and need not exceed 18 starts.

9.4.4 Two or more compressors shall be installed with a total capacity sufficient for charging the air receivers from atmospheric to full pressure in the course of one (1) hour.

The capacity shall be approximately equally shared between the compressors. At least one of the compressors shall be independently driven.

9.4.5 If the emergency generator is arranged for pneumatic starting, the air supply shall be from a separate air receiver.

9.4.6 The emergency starting air receiver shall not be connected to other pneumatic systems, except for the starting system in the engine room. If such a connection is arranged, then the pipeline shall be provided with a screw-down non-return valve in the emergency generator room.

SECTION 6 REFRIGERATION SYSTEMS

1 General

1.1 Application

1.1.1 The rules in this section apply to refrigerating plants using group 2 refrigerants and R744 (CO_2). For other group 1 refrigerants the rules apply for plants with a total prime mover effect of 100 kW and above.

1.2 References

1.2.1 For ships with additional class notation **RM** see Pt.6 Ch.4 Sec.9.

1.2.2 For ships with class notation **Tanker for liquefied gas** see Pt.5 Ch.7.

1.2.3 For ships with class notation **Fishing vessel** with refrigerated spaces see Pt.5 Ch.12.

2 Materials

2.1 Materials

2.1.1 The materials shall comply with the requirements specified in Pt.2 Ch.2 and Ch.7 Sec.2.

Other suitable material specifications shall be considered for approval in each individual case. The materials shall be tested in accordance with the regulations for material testing given in Pt.2.

For a closed refrigerating circuit using refrigerants of group 1, or R717 and with a lowest design evaporating temperature of -41°C or warmer:

— rolled steel plates shall be accepted in accordance with Pt.2 Ch.2 Sec.3 [2]. A grade impact tested at 0°C (or colder) shall be selected
— steel pipes and fittings shall be accepted in accordance with Pt.2 Ch.2 Sec.5 [2].

For closed refrigerating systems with design evaporating temperature below -41°C and group 2 refrigerants other than R717 rolled steel plates and steel pipes and fittings shall comply with Pt.5 Ch.7.

Possible sub-cooling of the liquid in connection with accidental blow down need not be taken into account when deciding the design temperature.

2.1.2 The materials shall be corrosion-resistant to the refrigerant and the compressor oil and to the combination of the two.

Piping located in areas where exposure to high humidity or water splashing is expected, e.g. fish processing spaces, shall be of corrosion resistant material, e.g. stainless steel.

2.1.3 The following materials and refrigerants shall not be combined:

1) copper with ammonia
2) magnesium with fluorinated hydrocarbons
3) zinc with ammonia and fluorinated hydrocarbons.

2.1.4 Thermal insulation of organic foams shall be of a flame-retarding quality, i.e. low ignitability and low flame-spread properties. Testing shall be carried out in accordance with a recognized standard, e.g. DIN 4102-1 B1, or equivalent. The test method chosen shall be suitable for the type of foam in question.

3 Design criteria

3.1 Refrigerants

Group 1:

Refrigerants in this group are normally nonpoisonous, but all of them, except R744, can be poisonous when decomposed by a flame or by a hot surface. These refrigerants are heavier than air, give no odour warning and will give a dangerous atmosphere by displacement of air. The lack of odour and the high density make these refrigerants particularly dangerous with regard to suffocation.

Table 1 Group 1 refrigerants

Refrigerant	*Description*
R22 (monochlorodifluoromethane)	CHF_2Cl
R134a (1,1,1,2-tetrafluoroethan)	$CH_2F\text{-}CF_3$
R404A	hydrofluorocarbon mix
R407A	hydrofluorocarbon mix
R407B	hydrofluorocarbon mix
R407C	hydrofluorocarbon mix
R410	hydrofluorocarbon mix
R507	hydrofluorocarbon mix
R744 (carbon dioxide)	CO_2

Group 2:

Refrigerants in this group are particularly poisonous. R717 is lighter than air and is flammable in very high mixing ratios with air. A very high ignition energy is then required to start a fire.

Group 2 refrigerants shall not be used in air conditioning systems with direct expansion.

Table 2 Group 2 refrigerants

Refrigerant	*Description*
R717 (ammonia)	NH_3

The use of other refrigerants shall be given special consideration.

3.2 Design pressures

The scantlings of the various parts of the refrigerating plant shall be based on the pressures specified in Table 3.

Table 3 Design pressures for refrigerating plant

Refrigerant	*Minimum design pressure bar*	
	HP side of system	*LP side of system*
R22	21	17
R134a	14	11
R717	22	17
R404A	25	20
R407A	25	20
R407B	27	21
R407C	24	19
R410	34	27
R507	26	20
R744 (CO2)	1)	1)

1) Design pressure shall be specified by the designer.

If refrigerants other than those specified in Table 3 are used, the design pressure shall be subject to approval in each individual case. It may be assumed to be equal to the vapour saturation pressure of the refrigerant at 55°C and 45°C on the HP and LP sides, respectively. Low pressure side shall be considered as all parts of the refrigerating plant subjected to evaporation pressure of the refrigerant, however parts of the low pressure side that can be exposed to high pressure (e.g. during hot gas defrosting) shall be considered as high pressure side with regards to design pressure.

4 Design

4.1 Refrigeration machinery

4.1.1 Except as permitted in [4.1.12] and [4.2.1], refrigeration systems using refrigerant R717 or R744 shall have the complete refrigerant circuit located within a separate machinery room surrounded by steel decks and bulkheads and fitted with self-closing doors opening outwards and with a sill height of at least 300 mm but not less than sufficient to prevent overflow of refrigerant in case 80% of the total refrigerant quantity of the largest unit is released while the ship is within normal range of trim and with a list not exceeding 15°. Decks and bulkheads shall be without openings and pipe and cable penetrations etc. shall be sufficiently tight to prevent leaked refrigerant from entering other rooms and spaces. Special glands of approved type need, however, not be used.

4.1.2 The refrigerating machinery room shall be located as high as reasonable within the ship. The refrigerating machinery room is subject to approval with regard to its location and arrangement within the ship and with regard to accesses and emergency escapes. Except for small refrigerating machinery rooms, at least two access doors shall be provided.

4.1.3 On ships of less than 65 m of length (as defined in Pt.3 Ch.1 Sec.4) R717 or R744 refrigerating systems with less than 25 kg filling may be located within the engine room or another suitable space not including accommodation spaces. All parts of such refrigerating systems shall be located together. A secondary refrigerant or a heat transfer fluid shall be used in the air coolers in provision stores, air conditioning systems etc. connected to such refrigerating systems. The area where the refrigerating system is installed shall be fitted with a hood with a negative ventilation system and with a water spray system. The outlet from the ventilation system shall be arranged in accordance with [4.1.1].

R744 systems may be accepted with more than 25 kg filling if it can be proven that leakage of the complete refrigerant charge from the system will not result in oxygen concentration below 19% by volume.

4.1.4 For refrigerating machinery utilizing R717, the ventilation inlets and outlets to such rooms shall be located sufficiently high above deck to not require closing appliances according to the international load line convention.

4.1.5 Thin plate ventilation ducts for other spaces shall not be led through the refrigerating machinery room. Air coolers for air conditioning plants shall not be located within the refrigerating machinery room.

4.1.6 The ventilation system for the refrigerating machinery room shall be separated from other ventilation systems, shall be of the exhaust type, and to give minimum 30 air changes per hour. If the refrigerant is lighter than air, the ventilation exhaust shall be from the top of the refrigerating machinery room.

4.1.7 All ventilation outlets from the refrigerating machinery room shall be at safe locations with regard to:

- the hazards of possibly leaked refrigerant in the ventilation air
- intake of ventilation air into other ventilation systems on the ship
- recycling between the ventilation outlets and intakes for the refrigerating machinery room.

Guidance note:

In case of R744, refrigerating machinery rooms surrounded by decks and bulkheads constructed of other materials than steel may be accepted upon special considerations.

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4.1.8 For refrigerants of group 2 the refrigerating machinery room shall additionally be equipped with effective mechanical catastrophe ventilation. For R717 the capacity shall be the larger of the values calculated by:

- 7.2 m^3/h for each kg refrigerant up to 500 kg plus 3.0 m^3/h for each kg refrigerant above 500 kg. In case the refrigerant is contained in completely separated refrigerant circuits, only the circuit with the largest quantity need be considered; or
- 300 m^3/h for each m^2 deck area of the refrigerating machinery room. Special considerations shall be made in case the deck is thermally insulated to reduce evaporation of leaked refrigerant or the wet area is minimised by the deck shape or construction. If the refrigeration compressor/condenser skid is provided with spill coamings of min. 100 mm height, the area inside the coamings may be taken as the deck area for the purpose of capacity calculations.

4.1.9 For other refrigerants of group 2, the required capacity shall be corrected according to the evaporating heat of the refrigerant at atmospheric pressure and the acceptable concentration in the ventilation exhaust air.

4.1.10 To avoid under-pressure in the room, making opening of doors difficult, a push button for temporary stop of ventilation shall be located close to the door(s) inside the room.

4.1.11 Both the normal and the catastrophe ventilation shall be arranged such that a single failure cannot cause a complete ventilation failure for the refrigerating machinery room.

4.1.12 Areas on open deck within a distance of 1 m from inlet ventilation openings, and within a distance of 3 m from outlet ventilation openings of refrigerating machinery rooms with R717 (both normal and catastrophe ventilation) shall be classified as hazardous zone 2.

4.1.13 If R717 is used as refrigerant the required separate refrigerating machinery room shall comply with the following:

- bilge wells shall be as small as practicable, e.g. not more than 25 litres

— the deck plating shall be arranged for easy cleaning and drying. Separate floor plating above the deck plating of the refrigerating machinery room shall not be fitted
— bilge drainage system shall be separate for the room. Drain piping to bilge systems/bilge wells/bilges in other parts of the ship shall not be arranged unless they are fitted with self-closing valves
— all non-Ex protected electrical equipment within the refrigerating machinery room shall be automatically de-energised in case an R717 concentration above 5 000 PPM is detected. Additionally, all non-EX protected electrical equipment shall be capable of being de-energised independently by a central switch located outside of the room. The normal and catastrophe ventilation systems shall be arranged with Ex protected motors and non-sparking fans
— ex protected (emergency) lighting fixtures shall be fitted in the refrigerating machinery room
— access doors and emergency escapes shall be provided with external water screens and eye washes with constantly available water supply.

Separate refrigerating machinery rooms for R717 systems with less than 25 kg filling shall be specially considered.

4.1.14 Access doors and -hatches to refrigerated chambers shall either be operable from both sides or be fitted with catches to prevent inadvertent closing. All chambers and air cooler rooms shall each be fitted with at least one conveniently located alarm call button.

4.2 Refrigerant circuit

4.2.1 R717 or R744 may be used for direct expansion in cooling/freezing equipment located outside the refrigerating machinery room and within normally manned spaces such as production areas and cooled/ frozen product cargo chambers on fishing vessels and fish factory ships. The refrigerant piping shall not be located within the crew accommodation spaces, the navigating bridge and the main engine room or such that all accesses to the main engine room will be blocked in case of pipe rupture.

4.2.2 The requirements in Pt.5 Ch.12 Sec.3 [4] shall be fulfilled, even if the notations **Fishing vessel** or **Stern trawler** is not assigned.

4.2.3 Where R717 or R744 is used as refrigerant for direct expansion within production areas and cargo chambers, quick closing valves shall be fitted in the delivery lines (liquid and hot gas) and return within the refrigerating machinery room. The return lines shall be fitted with a valve arrangement providing a non-return function allowing flow towards the low pressure side within the refrigerating machinery room. Activation shall be possible from the refrigerating machinery room, the production area and from a suitably located emergency station outside these rooms.

4.2.4 Safety valves shall be located on the high-pressure side of the compressor ahead of the shutoff valve. The outlet may lead back to the suction side of the compressor.

4.2.5 Bottles containing spare refrigerant should be stored in well ventilated spaces specially prepared for that purpose. Storage in refrigerating machinery spaces may be accepted on a case-by-case basis considering the quantity of stored refrigerant and the location of the refrigerating machinery space.

5 Refrigeration system components

5.1 Pipes and tubes

5.1.1 The complete refrigerant circuit, including both low- and high pressure sides, shall be considered as pertaining to class II piping systems except R744 (CO2) with design pressure above 40 bar and R717 (ammonia), regardless of design pressure, which shall pertain to class I.

5.1.2 Soldered connections shall be able to withstand a temperature of at least 425°C if refrigerants of group 2 are used.

5.1.3 When tin soldering, the solder shall be of a type which does not decompose.

5.1.4 Any insulation of refrigerant and brine pipes shall be efficiently protected against the diffusion of moisture.

Guidance note:

Insulation and water vapour barriers should preferably be led continuously through the fastening arrangements.

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5.2 Pressure vessels and heat exchangers

5.2.1 Pressure vessels, heat exchangers and coolers shall be constructed in accordance with Ch.7. Pressure vessels for refrigerant of group 2 shall comply with the requirements for class I pressure vessels and shall be delivered with compliance documents according to requirements in Pt.6 Ch.4 Sec.9 [1.4.2]. Requirements for thermal stress relief of pressure vessels with fluids liable to cause stress corrosion cracking (e.g. ammonia, R717) are given in Ch.7 Sec.7 [3.1.1].

5.2.2 Pressure vessels in closed refrigerating circuits may be accepted without inspection openings.

5.2.3 Condenser cooling water tubes shall be made of materials with high resistance to corrosion and erosion.

Guidance note:

The water velocity should not exceed:

- 2.5 m/s for aluminium brass pipes
- 2.5 m/s for 90/10 copper/nickel pipes
- 1.5 m/s for steel pipes.

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For sea water cooled R717 condensers the condenser tubes and tube-plates shall be made of materials resistant to both sea water and ammonia corrosion. Use of coating or lining systems shall not be accepted in lieu of corrosion resistant materials.

5.2.4 Liquid level indicators constructed of glass tubes are not permitted.

Liquid level indicators with long glass plates shall be fitted with self closing valves in lower and upper connections.

5.3 Safety valves and discharge system

5.3.1 The refrigerant circuit(s) shall be protected against excessive pressure by safety relief valves, or equivalent arrangements.

5.3.2 If a shut-off valve is located between the pressure vessel and the safety valve, it shall be sealed in open position, and shall be closed only during repairs. A signboard stating this requirement shall be fitted.

5.3.3 Vessels with shut-off valves which contain liquid refrigerant shall be protected by a safety valve. For refrigerants of group 1, a safety disc which is corrosion-resistant, may be substituted for the safety valve.

5.3.4 The safety valve and safety disc shall be located above the surface of the liquid. They shall open at a pressure not less than the design pressure and shall be fully effective at a pressure which is maximum 10% higher.

5.3.5 The safety valve shall have a minimum capacity determined from the following formula (Ref. EN 13136:2013):

$$Q_{md} = \frac{\varphi x A_{surf}}{h_{vap}} \ [\mathrm{kg/s}]$$

where:

A_{surf} = surface area of the vessel
Q_{md} = minimum required discharge capacity
h_{vap} = heat of vaporization at the relieving conditions [kJ/kg]
φ = density of heat flow rate, assumed to be 10 kW/m^2 for normal cases.

If the pressure vessel has a thermal insulation with thickness more than 0.04 m and the insulation material is fire retardant e.g. class D or better acc. To EN 13501-1, a reduced density of heat flow rate may be used as follows:

$$\varphi_{red} = \varphi x \frac{0.04}{s} \ \left[\mathrm{kW/m^2}\right]$$

where:

s = thickness of insulation [m].

5.3.6 The discharge piping system from the relief devices shall have sufficient capacity to ensure critical flow through the relief devices.

5.3.7 The safety valve outlet shall be routed to a safe position on open deck, not in the vicinity of personnel.

5.3.8 When R717 is used as refrigerant the outlet shall be at a safe location as high as possible on the ship e.g. top of funnel or top of mast. The outlet shall be directed upwards.

6 Secondary refrigerating circuit

6.1 Brine piping system and vessels

6.1.1 Special consideration shall be given to corrosion resistance of materials.

Guidance note:

A corrosion-reducing agent consisting of 2.0 kg sodium dichromate + 0.54 kg caustic soda for each m^3 of the solution should be added to calcium chloride. The pH value should be about 8. It is advised that a closed brine system be installed.

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6.1.2 If internally galvanized vessels or pipes are used with a closed system, and if the brine attacks zink, the vessels shall be vented to a safe place in open air. At the outlet, the pipes shall be equipped with safety equipment against back flaming.

6.1.3 With an open system, the rooms where internally galvanized brine tanks are located shall be effectively ventilated, and brine, which generates gases with flash point lower than 30°C, shall not be used.

6.1.4 The thickness of the brine pipes from the bottom of the threads shall not be less than 2.5 mm.

7 Refrigeration system instrumentation

7.1 Instrumentation

7.1.1 A refrigerant leakage detection system with alarm, shall cover the following:

— spaces with refrigerating machinery
— the outlet piping from safety relief devices if R717 is the refrigerant
— in case of direct expansion, all refrigerated chambers
  — for R744 alarm shall be given if the concentration exceeds 1500 ppm.

For plants using group 1 refrigerants except R744, monitoring for oxygen deficiency is an acceptable alternative to refrigerant gas detection.

The sensors shall be located with due regard to the relative density of the refrigerant in gas form as well as to the ventilation flow.

7.1.2 The acoustic and optical alarm signals shall be given at such locations that crew members attending to an alarm shall not be led to entering a space possibly filled with refrigerant.

7.1.3 For provision and air condition refrigeration plants using group 1 refrigerants located in the engine room, leakage detection systems need not be fitted if the ventilation arrangement is considered sufficient to eliminate the risk of suffocation.

7.1.4 When R717 is used leakage detectors covering compartments with refrigerating machinery (including process vessels) shall give audible alarm within the compartment.

7.1.5 When R717 is used, refrigerant leakage in the refrigerating machinery room shall be detected at three (3) different consecutive levels with set points not higher than:

a) 150 PPM Initial detection of leakage
b) 350 PPM Access dangerous. Automatic shutdown of refrigerant circulation pump

Guidance note:

One processing unit for both levels may be accepted if sensor for level a) is separate from sensor for level b).

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7.1.6 For plants using R744, a low pressure alarm with set point well above the triple point pressure (abt. 5.2 bar) shall be fitted in the low pressure liquid part of the system.

8 Personnel protective equipment

8.1 Personnel protection equipment

8.1.1 At least two sets of air breathing apparatuses with spare air bottles shall be available onboard. The breathing apparatuses may be the same as those required for other purposes, e.g. SOLAS, provided the ship is equipped with an air compressor for recharging the air bottles.

8.1.2 In case R717 is the refrigerant, refrigerant gas masks and hermetically sealed filters shall be available in a permanently marked transparent door case located immediately outside each entrance to the space where the refrigerating machinery is located. Additionally at least two sets of suitable protective clothing including also gloves and boots shall be available onboard and located in the vicinity of the space for the refrigerating machinery. In case any one refrigerant circuit contains more than 25 kg refrigerant the two sets

of protective clothing shall be gas tight suits with permanently attached boots and gloves and suitable for use in combination with the air breathing apparatuses.

SECTION 7 OZONE SHIP INSTALLATIONS

1 General

1.1 Application

The rules are applicable for ozone systems and oxygen piping used for creation of ozone on ships where the worst case leakage in an enclosed space may result in ozone concentrations of above 0.1 ppm.

Other safety measures that provide an equivalent level of safety may be accepted upon special consideration.

1.2 Definitions

Term	*Description*
ozone and oxygen leakage sources	ozone- and oxygen generator, flanges, valves, welds etc.
secondary containment	space containing ozone- and oxygen piping, e.g. an ozone- and oxygen production room or the annular space in double walled piping

1.3 Signboards

1.3.1 A signboard shall be permanently fitted on doors or other access points to spaces containing ozone- and oxygen warning that such systems are installed.

1.3.2 A signboard shall be permanently fitted in the space containing ozone- and oxygen piping stating that heavy lifting, implying danger of damage to the ozone pipes, shall not be done during operation.

1.4 Protective and medical equipment

1.4.1 At least two sets of air breathing apparatuses with spare air bottles shall be available onboard. The breathing apparatuses may be the same as those required for other purposes, provided the ship is equipped with an air compressor for recharging the air bottles.

1.4.2 At least one resuscitator shall be kept on board for medical treatment.

1.4.3 Personal protective equipment shall be stored outside entrances to spaces containing ozone- and oxygen piping.

2 Requirements

2.1 Materials

2.1.1 Ozone and oxygen piping shall be of austenitic stainless steel or of a material with similar corrosion resistant properties. Special consideration shall be given to connections between stainless steel ozone and oxygen piping and mild steel piping.

Guidance note:

Elastomers are not compatible with ozone.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.2 Arrangement and system design

2.2.1 Leakage from the ozone generating system shall not directly lead to intoxication of personnel or to an oxygen rich atmosphere.

2.2.2 The ozone generator shall be installed in a dedicated space with access only through self-closing gas tight doors. For small ozone generators, located in other spaces, this is subject to cases-by-case consideration by the Society.

Guidance note:

Ozone generators with production capacity of less than 150 g/h and less than 10% of O_3 mass fraction need not be located in dedicated room. Ozone generators with production capacity up to 1500 g/h of O_3 are accepted in separate rooms which are not dedicated only for ozone systems.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.2.3 The ozone piping shall be designed with a dedicated secondary containment, i.e double pipe.

For piping with underpressure, single walled, butt welded pipes may be accepted. In such case, loss of underpressure shall lead to automatic shut down of ozone system.

2.2.4 The ventilation system for the secondary containment space shall be separated from other ventilation systems.

2.2.5 All ventilation outlets from the secondary containment space shall be at safe locations with regard to air intakes for other ventilation systems on the ship.

2.2.6 Ventilation openings in the secondary containment space shall be located to ensure an efficient air flow in the space.

2.2.7 Capacity of ventilation of secondary containment shall be sufficient to prevent leakage of ozone to reach 0.1 ppm concentration, but not less than 30 changes of air per hour.

2.3 Piping and generation system

2.3.1 Ozone- and oxygen pipes shall not pass through accommodation or service spaces.

2.3.2 Ozone- and oxygen piping systems shall be located in safe locations with regards to mechanical damage from dropped or rolling objects.

2.3.3 Ozone- and oxygen pipes shall be marked to visually separate them from other piping systems.

2.3.4 The extent of ozone- and oxygen piping shall be minimized as far as possible in order to reduce the possible leakage points.

2.3.5 Flange connections on ozone- and oxygen piping shall be minimized as far as possible in order to reduce the possible leakage points.

2.3.6 It shall be possible to safely gas-free the ozone and oxygen system prior to opening the containment.

2.3.7 Outlets for purging of the ozone- and oxygen system shall be at safe locations with regard to air intakes for other ventilation systems on the ship.

2.3.8 Purging or venting of the ozone- and oxygen piping systems shall not lead to hazardous ozone concentrations on deck or in enclosed spaces.

Guidance note:

Hazardous concentrations may be avoided by diluting the ozone or installing an ozone destructor.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.3.9 Safety measures shall be in place to prevent supply of ozone to empty water systems.

2.3.10 Nitrogen rich waste stream shall be vented to open air. Disposal of nitrogen to an enclosed space may be accepted if it can be shown by calculation that the amount of disposed nitrogen does not affect the health of present personnel.

2.4 Instrumentation and control systems

2.4.1 All possible leakage sources in the ozone piping system shall be covered by a minimum of two independent means of ozone leakage detection.

Guidance note:

Fixed ozone gas detectors close to possible leakage sources and pressure monitoring are accepted methods for leakage detection. A combination of the two methods is accepted.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.2 Fixed gas detectors shall cover all possible leakage sources. Gas detectors shall as a minimum be placed close to the generators and the ozone injection point.

2.4.3 The sensors or sampling suction points for ozone gas detectors shall be located where leakage is most likely to be sensed first.

Due regard shall be taken to the relative density of the gas as well as to the ventilation flow.

2.4.4 If double walled ozone piping is installed, fixed ozone gas detectors shall be located at the ventilation outlet from the annular space in the double walled piping.

2.4.5 Ozone gas detectors shall have a set point of 0.1 ppm ozone.

2.4.6 Piping systems shall be fitted with automatic shut-off and purging functions.

2.4.7 An emergency stop button shall be located where an ozone or oxygen system is operated as well as locally within and outside the accessible spaces containing such piping.

2.4.8 The alarm shall be both acoustic and optical and the signals shall be given within the accessible spaces containing ozone piping and at such locations that crew members attending to an alarm shall not be led to entering a space possibly containing leaked ozone.

2.4.9 The following signals shall lead to alarm, automatic shutdown and purging of the ozone system:

a) ozone leakage detection
b) emergency stop buttons
c) failure of ventilation system
d) failure of connected water system to which the ozone is injected.

2.4.10 Portable ozone and oxygen gas detection shall be provided. Oxygen gas detection is not required on systems where worst case leakage of oxygen, nitrogen or ozone cannot lead to hazardous concentrations with regards to suffocation.

2.5 Operational instructions

2.5.1 An operational manual for the ozone- and oxygen system shall be prepared and is subject to approval. The manual shall be kept on board the ship and shall as a minimum contain the following:

a) general description of the system
b) generation and supply system piping and instrumentation diagram
c) procedures for starting up the system
d) procedures for shutting down and gas freeing the system
e) procedures for opening of containment
f) entry and evacuation procedures for the spaces containing piping systems
g) procedures for calibration or changing of sensors
h) procedures for periodic inspections and tightness testing
i) use of personal protective equipment
j) medical treatment procedures for intoxication and suffocation.

2.6 Manufacture and testing

2.6.1 The piping systems shall be tightness tested in the presence of the surveyor after installation on board.

2.6.2 All required functions of the safety and control system shall be tested in the presence of the surveyor after installation on board.

SECTION 8 POLLUTION PREVENTION

1 Oil Pollution prevention

1.1 Application

1.1.1 The following requirements apply to arrangements and equipment for handling and disposal of oily water and oil residues except when originating from cargo handling on tankers.

1.2 Ships of 400 gross tonnage and above

1.2.1 Forepeak tanks and other tanks forward of the collision bulkhead shall not be arranged for carriage of oil.

1.2.2 Combined fuel oil and ballast water tanks shall not be permitted, except for special cases as referred to in Sec.5 [4.3.5].

1.2.3 Collecting tank(s) for oil residues including sludge, waste oil, drain oil, etc. shall be arranged with a minimum aggregate capacity of:

$$V = K\,C\,D\ [\mathrm{m}^3]$$

K = 0.015 for ships where heavy fuel oil is purified for main engine use, or
= 0.005 for ships using diesel oil or heavy fuel oil which does not require purification before use

C = daily fuel oil consumption [m^3]

D = length of voyage in days, but not less than 30 days unless restricted service notation.

1.2.4 Where heavy fuel oil is purified onboard, at least 80% of the capacity given in [1.2.3] shall be in tank(s) suitable for sludge from the fuel oil purifiers.

1.2.5 Tanks for oil residues shall be arranged with suitable access possibilities to facilitate cleaning.

1.2.6 Tanks for sludge from heavy fuel oil purifiers shall be fitted with heating arrangements.

1.2.7 Arrangements for transferring oil residues and oily bilge water to reception facilities shall be provided. The reception facility connection flange(s) shall be suitably located and with dimensions as given in Table 1. The oil residue handling system shall have no connections to the bilge water system except for:

— a possible common line leading to a common reception facility connection flange fitted with a screw-down non-return valve, and
— connections for draining settled water from sludge tanks to bilge water holding tanks or bilge wells provided fitted with manually operated self-closing valves or equivalent arrangements.

Table 1 Standard dimensions of flanges for discharge connections

Description	*Dimension*
Outside diameter	215 mm
Inner diameter	According to pipe outside diameter
Bolt circle diameter	183 mm

Description	*Dimension*
Slots in flange	6 holes 22 mm in diameter equidistantly placed on a bolt circle of the above diameter, slotted to the flange periphery. The slot width to be 22 mm
Flange thickness	20 mm
Bolts and nuts quantity, diameter:	6, each of 20 mm in diameter and of suitable length
The flange is designed to accept pipes up to a maximum internal diameter of 125 mm and shall be of steel or other equivalent material having a flat face. This flange, together with a gasket of oilproof material, shall be suitable for a service pressure of 6 bar.	

1.2.8 The oil residue handling system shall have no direct overboard connection other than the reception facility connection flange.

1.2.9 An oily-water separating/oil filtering equipment capable of producing an effluent with oil content of less than 15 ppm shall be installed for the purpose of processing oil contaminated discharges.

Guidance note:

Excessive oil content in the water fed to the oily-water separating or filtering equipment could frequently cause malfunction of this equipment. It is recommended that a bilge water holding tank is arranged for pre-separation of oily water and with facilities for transfer of the oil-on-top in this tank to the oil sludge or waste oil tanks. Unless used for discharge to shore, bilge water holding tanks should not be connected to the suction side of the bilge pumps. The holding thank should be emptied through the bilge water separator.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.2.10 For ships above 10 000 gross tonnage an oil content detecting device which shall sound an alarm if the oil content of the effluent exceeds 15 ppm shall be fitted. In addition to activating acoustic and visual alarm, the oil content detecting device shall automatically stop the discharge of oily water overboard, and instead direct it to bilge holding tank or bilge well.

Ships having combined fuel oil tanks and ballast tanks are required to comply with these requirements regardless of tonnage.

Guidance note:

In order to permit discharge of bilge water within special areas as defined in MARPOL 73/78 Annex I Reg. 10(1) (Baltic Sea, Mediterranean Sea, Black Sea, Red Sea, Gulfs, Gulf of Aden and Antarctic areas), alarm and automatic stop of the overboard discharge when oil content in the effluent exceeds 15 ppm, is required also for vessels less than 10 000 gross tonnage.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.2.11 Where the bilge separator pump is arranged for automatic start, the oil content detecting device shall initiate automatic stop of the overboard discharge when the oil content in the effluent exceeds 15 ppm.

1.2.12 Oily-water separating/oil filtering equipment and oil content detecting device, if fitted, shall comply with MARPOL 73/78 Annex I.

1.2.13 The discharge lines of oily-water separators shall be fitted with a reverse flow protecting valve at the ship's side.

1.2.14 For vessels in dedicated trades the requirements in [1.2.9] and [1.2.10] may be dispensed with subject to acceptance of the flag administration and port state administrations, involved.

1.3 Ships below 400 gross tonnage

1.3.1 Suitable arrangements for collecting, handling and transfer to reception facilities of oily water and oil residues shall be available.

SECTION 9 PIPES, PUMPS, VALVES, FLEXIBLE HOSES AND DETACHABLE PIPE CONNECTIONS

1 Pipes

1.1 General

1.1.1 The wall thicknesses of pipes shall comply with the requirements in this section.

1.1.2 For special applications and in cases where the pipes may be subject to excessive external loads or are inaccessible during service, greater wall thicknesses than given in the following may be required.

1.2 Minimum wall thickness

1.2.1 The minimum wall thickness shall not be less than given in Table 1, Table 2 and Table 3 for pipes of copper or copper alloy, steel and stainless steel, respectively.

1.2.2 The outer diameters and wall thicknesses given in the tables are in accordance with ISO-standards. For pipes covered by other standards or approved on a case-by case basis, thicknesses slightly less may be accepted.

1.2.3 Bilge and ballast pipes and fittings of nodular cast iron shall have minimum wall thickness not less than:

$$t = K\left(0.5 + 0.001D_N\right) \quad [\text{mm}]$$

where:

D_N = nominal diameter in mm
K = 9 for pipes
= 12 for fittings other than tees
= 14 for tees.

1.3 Calculation of wall thickness of pipes being subject to internal pressure

1.3.1 The wall thickness of pipes subjected to internal pressure shall be calculated as specified in this subsection. The nominal wall thickness is, however, not to be less than specified in [1.2].

1.3.2 Symbols used in calculation of wall thickness of pipes:

t_1 = nominal wall thickness [mm]
t_0 = strength thickness [mm]
t = minimum required wall thickness [mm]
c = corrosion allowance [mm]
b = bending allowance [mm]
σ_t = permissible stress [N/mm^2]
σ_b = specified minimum tensile strength of the material at 20°C [N/mm^2]

σ_{ft}	=	specified minimum yield stress or 0.2% proof stress of the material at design material temperature [N/mm^2]
p	=	design pressure [bar]
D	=	outer diameter of pipe [mm]
$\sigma_{b\ 100\ 000}$	=	average value for stress to rupture after 100 000 hours at design material temperature [N/mm^2]
a	=	percentage negative manufacturing tolerance
e	=	strength ratio.

1.3.3 The design pressure p to be used in the formula in [1.3.6], is defined as the maximum working pressure, and shall not be less than the highest set pressure of the safety valve or relief device. For special cases, the design pressure shall be specially considered.

For pipes which are connected to pumps, p shall be taken equal to the maximum pump pressure, i.e. the safety valve set pressure for displacement pumps, and for centrifugal pumps the maximum pressure on the head-capacity characteristic together with the static head at suction side.

When determining the maximum working pressure p, consideration shall be given to possible pressure surges in the piping.

For steam pipes between boiler and superheater, and for steam pipes leading from the superheater, where the superheater safety valve is controlled by a pilot valve operated by the steam pressure in the saturated steam drum, the design pressure shall be taken equal to the set pressure of this safety valve.

For pipes without safety valves and pressure gauges on the low-pressure side of pressure-reducing valves, p shall be taken equal to the pressure on the high-pressure side of the pressure-reducing valve.

For feed pipes, p shall be taken equal to 1.25 times the boiler design pressure.

Table 1 Minimum wall thickness for pipes of copper and copper alloys

External pipe diameter D [mm]	*Minimum wall thickness [mm]*	
	Copper	*Copper alloy*
$D \leq 10$	1	0.8
$10 < D \leq 20$	1.2	1
$20 < D \leq 44.5$	1.5	1.2
$44.5 < D \leq 76.1$	2	1.5
$76.1 < D \leq 108$	2.5	2
$108 < D \leq 159$	3	2.5
$159 < D \leq 267$	3.5	3
$267 < D \leq 470$	4	3.5
$470 < D \leq 508$	4.5	4

Table 2 Minimum wall thickness for steel pipes

External diameter D [mm]	*Pipes in general 3) 4) 5) 6) 7) 8)*	*Air, overflow and sounding pipes for structural tanks 1) 2) 3) 5) 8) 9)*	*Bilge, ballast and general seawater pipes 1) 3) 4) 5) 7) 8)*	*Bilge, air, overflow and sounding pipes through ballast or oil tanks, ballast lines through oil tanks and oil lines through ballast tanks 1) 2) 3) 4) 5) 7) 8) 9)*
10.2 to 12 13.5 to 17.2 20	1.6 1.8 2			
21.3 to 25 26.9 to 33.7 38 to 44.5	2 2 2	4.5	3.2 3.2 3.6	6.3
48.3 51 to 63.5 70	2.3 2.3 2.6	4.5 4.5 4.5	3.6 4 4	6.3 6.3 6.3
76.1 to 82.5 88.9 to 108 114.3 to 127	2.6 2.9 3.2	4.5 4.5 4.5	4.5 4.5 4.5	6.3 7.1 8
133 to 139.7 152.4 to 168.3 177.8	3.6 4 4.5	4.5 4.5 5	4.5 4.5 5	8 8.8 8.8
193.7 219.1 244.5 to 273	4.5 4.5 5	5.4 5.9 6.3	5.4 5.9 6.3	8.8 8.8 8.8
298.5 to 368 406 to 457	5.6 6.3	6.3 6.3	6.3 6.3	8.8 8.8

1) For pipes efficiently protected against corrosion, the thickness may be reduced by 20% of the required wall thickness but not more than 1 mm.
2) For sounding pipes, except those for cargo tanks with cargo having a flash point less than 60°C, the minimum wall thickness is intended to apply to the part outside the tank.
3) For threaded pipes, where allowed, the minimum wall thickness shall be measured at the bottom of the thread.
4) The minimum wall thickness for bilge lines and ballast lines through deep tanks and for cargo lines is subject to special consideration.
5) For larger diameters the minimum wall thickness is subject to special consideration.
6) The wall thickness of pipes within cargo oil and ballast tanks in systems for remote control of valves shall be no less than 4 mm.
7) For inlets and sanitary discharges, see Pt.3 Ch.12 Sec.9.
8) For stainless steel pipes, the minimum wall thickness shall be specially considered, but it shall not be less than given in Table 3.
9) For air pipes on exposed decks, see Pt.3 Ch.12 Sec.7 [3].

Table 3 Minimum wall thickness for stainless steel pipes

External diameter D [mm]	*Minimum wall thickness [mm]*
10.2 to 17.2	1.0
21.3 to 48.3	1.6
60.3 to 88.9	2.0
114.3 to 168.3	2.3
219.1	2.6
273.0	2.9
323.9 to 406.4	3.6
over 406.4	4.0
Note: The external diameters and thickness have been selected from ISO-Standard 1127. For pipes covered by other standards, thickness slightly less may be accepted.	

1.3.4 The design temperature to be considered for determining the permissible stresses, may be the maximum temperature of the medium inside the pipe. For special cases, the design temperature shall be specially considered.

For steel pipes and pipes of copper and copper alloys, whose working temperature is lower than 50°C, the design temperature shall be taken equal to 50°C.

For saturated steam, the design temperature shall be equal to the saturation temperature.

For superheated steam with manual steam temperature regulation, the design temperature shall be taken at least equal to the steam temperature +15°C. For installations with automatic temperature control of the superheated steam, the design temperature may be equal to the steam temperature +5°C. It is assumed that any temperature fluctuations greater than 15°C or 5°C, respectively, above the normal working temperature shall be of short duration.

1.3.5 The minimum wall thickness of a straight or bent pipe shall not be less than:

$$t = t_0 + c$$

If to be bent, the minimum wall thickness before bending shall not be less than: $t + b$.

1.3.6 The strength thickness, t_0, shall not be less than calculated by the following formula:

$$t_0 = \frac{pD}{20\sigma_t e + p}$$

The formula is valid for pipes having a ratio of wall thickness to outside diameter of 0.17 or less. For higher ratios the calculation of wall thickness shall be given special consideration.

1.3.7 For steel pipes the permissible stress, σ_t, shall be based on the lower value of the following criteria:

$$\frac{\sigma_b}{2.7} \text{ and } \frac{\sigma_{ft}}{1.6} \text{ (for austenitic) or}$$

$$\frac{\sigma_{ft}}{1.8} \text{ and } \frac{\sigma_{b100\,000}}{1.8} \text{ (for other materials)}$$

Values for specified minimum yield or proof stress shall be in accordance with recognised standards given in Pt.2 Ch.2 Sec.4.

Table 4 Tensile strength and permissible stress in pipes of copper and copper alloys

Pipe material		*Copper*	*Aluminium brass*	*Copper nickel Cu Ni 5 Fe 1 Mn Cu Ni 10 Fe 1 Mn*	*Copper nickel Cu Ni 30*
Material condition		Annealed	Annealed	Annealed	Annealed
Minimum tensile strength [N/mm^2]		215	325	275	365
Permissible stress [N/mm^2]	50°C	41	78	68	81
	75°C	41	78	68	79
	100°C	40	78	67	77
	125°C	40	78	65.5	75
	150°C	34	78	64	73
	175°C	27.5	51	62	71
	200°C	18.5	24.5	59	69
	225°C	-	-	56	67
	250°C	-	-	52	65.5
	275°C	-	-	48	64
	300°C	-	-	44	62
	Notes: 1) Intermediate values may be determined by linear interpolation. 2) For materials not included in the table, the permissible stress shall be specially considered by the Society.				

Table 5 Corrosion allowance c for steel pipes

Piping service	*c [mm]*
Superheated steam	0.3
Saturated steam	0.8
Steam coils in cargo tanks	2
Feed water for boilers in open circuit systems	1.5
Feed water for boilers in closed circuit systems	0.5
Blowdown pipes (for boilers)	1.5
Compressed air	1
Hydraulic oil	0.3
Lubricating oil	0.3
Fuel oil	1
Cargo oil	2
LPG	0.3
Refrigerants	0.3
Fresh water	0.8
Sea water in general	3

1)	For pipes passing through tanks, an additional allowance for external corrosion shall be considered according to the figures given in the table, depending on the external medium.
2)	For pipes efficiently protected against corrosion, the corrosion allowance upon approval may be reduced up to 50%.
3)	For stainless steels the corrosion allowance may be omitted.

1.3.8 For pipes made of copper and copper alloys the permissible stresses are given in Table 4 which refers to copper and copper alloys specified in Pt.2 Ch.2 Sec.11.

1.3.9 For pipes made of materials other than steel, copper and copper alloys the permissible stresses shall be especially considered.

1.3.10 When the allowance for bending b is not determined by a more accurate procedure, or when the bending is not carried out by a bending procedure ensuring a control of the wall thickness, the allowance shall not be less than:

$$b = \frac{1}{2.5}\frac{D}{R}t_0 \qquad (1)$$

where:

R = mean radius of the bend [mm].

In case the bending ratio:

$$\frac{D}{R}$$

is not given, this ratio shall be taken equal to 1:3.

1.3.11 For steel pipes the corrosion allowance c shall be as specified in Table 5.

For pipes of copper, brasses, copper-tin alloys and Cu—Ni alloys with Ni-content < 10% the corrosion allowance is 0.8 mm. For pipes of Cu—Ni alloys with Ni-content ≥ 10% the corrosion allowance is 0.5 mm. For media with small corrosive action in respect of the material employed, the corrosion allowance may upon approval be reduced to zero.

For pipes where there is a risk of heavy corrosion and/or erosion, a greater corrosion allowance may be required.

1.3.12 For seamless pipes and for welded pipes delivered by manufacturer approved for making welded pipes which are considered equivalent to seamless pipes, the strength ratio e = 1.

For welded pipes from other approved pipe manufacturers, e = 0.9.

1.3.13 The value of t does not account for any negative manufacturing tolerance, therefore the nominal wall thickness, t_1, shall not be less than:

$$t_1 = \frac{t}{1 - \frac{a}{100}}$$

1.3.14 The minimum wall thickness of branch pipe and main pipe in way of branch connections shall be determined according to a recognised standard and using permissible stresses in accordance with [1.3.7]. Alternatively, the thicknesses may be calculated according to [1.3.15]. However, the validity of [1.3.15] is limited by a maximum ratio for main line wall thickness/branch lines wall thickness of 2.

1.3.15 The minimum pipe wall thickness of main pipes at a branch connection shall not be less than:

$$t = t_0 + c \text{ [mm]}$$

$$t_0 = \frac{pD}{20\sigma_t e + p} \text{ [mm]}$$

e, the strength ratio, is expressed by the formula:

$$e = e_1 \sin\gamma \frac{1.25}{1.25 + \frac{d_{\max} - d_{\min}}{2d_{\min}}}$$

e_1 = basic strength ratio. Its variation with the parameter

$$\frac{D_b}{\sqrt{Dt_b}}$$

is shown in Figure 1.

γ = angle between centre lines of main pipe and branch. γ shall not be less than 45°

d_{max}, d_{min} = maximum and minimum diameter, respectively, of extruded opening in the main pipe, see Figure 1.

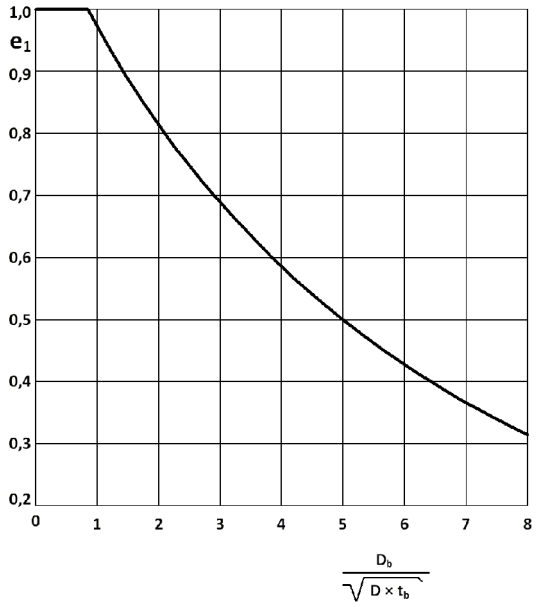


Figure 1 Basic strength ratio

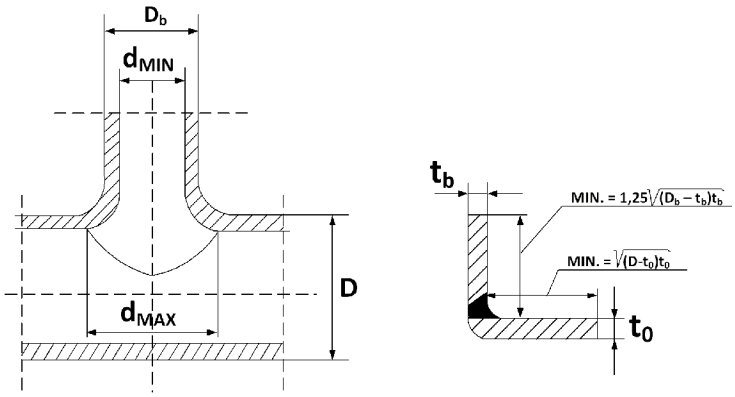


Figure 2 Details of main pipe and branch pipe

The wall thickness t_0 of the main pipe shall have an extension not less than:

$$\sqrt{(D - t_0)t_0}$$

from the branch, see Figure 1.

The branch thickness t_b shall have an extension not less than:

$$1.25\sqrt{(D_b - t_b)t_b}$$

from the main pipe, see Figure 1.

Examples of acceptable branch connections for use in piping systems for steam temperature above 400°C and for liquefied gases with temperature below -110°C are shown in Figure 2.

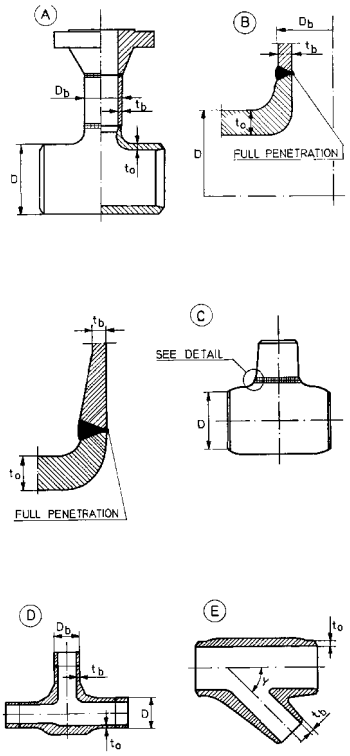


Figure 3 Examples of acceptable branch connections for steam at temperatures above 400°C and for liquefied gases with temperature below -110°C

1.4 Thermal expansion stresses

1.4.1 For piping systems for steam at temperatures above 400°C, an analysis of thermal stresses shall be performed. In the following special cases, the analysis is not considered to be necessary:

— when the proposed piping system is considered equivalent to a successfully operating and approved installation

— when the proposed piping system, on being closely examined, may be regarded as being in no way inferior to a previously approved installation.

1.5 Documentation of thermal stress calculation

1.5.1 When an analysis of the piping system is necessary, full details of the thermal stress calculations shall be submitted for approval. All assumptions and approximations which are made, shall be stated clearly.

1.5.2 Plans or diagrams of the proposed piping system, including specifications of coordinate axes, pipe lengths, bend radius in pipe bends, together with information on suspension details shall be submitted. When the piping system has been subject to initial pre-stressing, the degree and location of the same shall be stated.

1.6 Stress calculation

1.6.1 When a thermal stress analysis of a piping system between two or more anchor points is carried out, the system shall be treated as a whole. The significance of all parts of the line, of restraints such as solid hangers, sway braces and guides and of intermediate restraints built in for the purpose of reducing loads on equipment or small branch lines, shall be duly considered. The stress analysis shall be carried out on the assumption that the piping system expands from 20°C to the highest operating temperature. The modulus of elasticity to be used for the pipe material, is the value of same at 20°C.

1.6.2 In carrying out a thermal stress analysis, stress concentration factors found to exist in components other than straight pipes, shall be taken into account. In cases where it is known that such components possess extra flexibility, this may be incorporated in the stress calculations. Stress concentration factors and flexibility factors given in Table 6 may be accepted for use in the calculations when other substantiated factors may be lacking.

1.6.3 The thermal expansion resultant stress σ_r is defined as:

$$\sigma_r = \sqrt{\sigma_b^2 + 4\tau^2} \text{ ... [N/mm}^2\text{]}$$

where:

σ_b = $\frac{\sqrt{(i_1 M_1)^2 + (i_0 M_0)^2}}{Z}$

= total bending stress [N/mm^2]

τ = $\frac{M_T}{2Z}$

= torsional stress in [N/mm^2]

M_T = torsional moment [Nm]

M_1 = bending moment in plane of member [Nm]

M_0 = bending moment transverse to plane of member [Nm]

i_1 = stress concentration factor for in-plane bending moments

i_0 = stress concentration factor for out-of-plane bending moments

Z = section modulus in bending of member [mm^3].

When the member cross-section is non-uniform, the section modulus of the matching pipe shall be used.

For branched systems, where the branch diameter is less than the header diameter, the branch section modulus may be taken as the smaller value of:

$$\pi\, r_b^2\, t_h \text{ and } \pi\, r_b^2\, i_{ib}\, t_b$$

where:

r_b = mean cross-sectional radius of branch [mm]

t_h = thickness of pipe which matches header [mm]

t_b = thickness of pipe which matches branch [mm]

r_b = mean cross-sectional radius of branch [mm]

i_{ib} = in-plane stress concentration factor for branch.

1.6.4 The resultant stress σ_r is at no point of the piping system to exceed the corresponding stress range σ_{int}:

$$\sigma_{\text{int}} = 0.75\sigma_{tk} + 0.25\sigma_{tv}$$

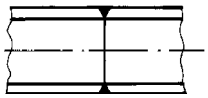
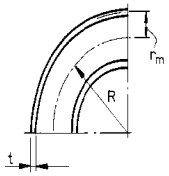
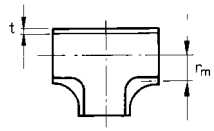
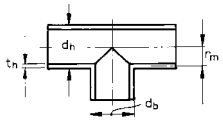
where:

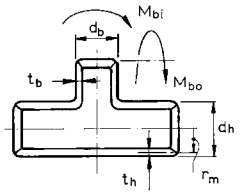
σ_{tk} = permissible pipe wall stress at 100°C or lower [N/mm^2]
σ_{tv} = permissible pipe wall stress at maximum working temperature of system [N/mm^2].

For low temperature piping σ_{int} shall be determined upon special consideration.

1.6.5 The sum of axial bending stress in the pipe wall due to static loading (pipe weight) and axial tensile stress due to internal pressure, is at no point in the system to exceed the permissible stress σ_{tv}.

Table 6 Stress concentration factors and flexibility factors for metallic pipe-line elements

Type of element	*Sketch*	*Flexibility parameter* γ	*Flexibility factor k*	*In-plane stress concen- tration factor* i_0 [1)]	*Out-of -plane stress concen- tration factor* i_0 [1)]
Straight buttwelded pipe			1.0	1.0	1.0
Curved pipe		$\frac{tR}{r_m^2}$	$\frac{1.65}{\gamma}\left[\frac{1}{1+6\frac{p}{E_k}\left(\frac{r_m}{t}\right)^{\frac{7}{3}}\left(\frac{R}{r_m}\right)^{\frac{1}{3}}}\right]$	$\frac{0.9}{\gamma^{\frac{2}{3}}}$	$\frac{0.75}{\gamma^{\frac{2}{3}}}$
Welding tee		$4.4\frac{t}{r_m}$	1.0	$\frac{3}{4}i_0 + 0.25$	$\frac{0.9}{\gamma^{\frac{2}{3}}}$
Fabricated tee $\frac{d_b}{d_h} > 0.3$		$\frac{t_h}{r_m}$	1.0	$\frac{3}{4}i_0 + 0.25$	$\frac{0.9}{\gamma^{\frac{2}{3}}}$

Type of element	*Sketch*	*Flexibility parameter* γ	*Flexibility factor k*	*In-plane stress concen- tration factor* i_0 [1)]	*Out-of -plane stress concen- tration factor* i_0 [1)]
Branch-connection with $\frac{d_b}{d_h} \leq 0.3$ If $\frac{d_b}{d_h} > 0.3$ as for fabricated tee		$\frac{t_h}{r_m}$	$0.9\left(\frac{d_h}{t_h}\right)^{\frac{3}{2}} \frac{t_b}{t_h} \frac{d_b}{d_h}$ for M_{bi} $0.27\left(\frac{d_h}{t_h}\right)^{\frac{3}{2}} \frac{t_b}{t_h} \frac{d_b}{d_h}$ for M_{bo}	$\frac{3}{4} i_0 + 0.25$	$\frac{0.9}{\gamma^{\frac{2}{3}}}$
1) i_0 and i_i shall be taken less than 1.0.					

Guidance note:

If the piping system is fitted with pre-stress (cold spring), allowance for this is given in evaluating the pipe reaction forces on connected machinery. The following formulae for estimating pipe reaction forces may be applied whenever an effective method of obtaining the designed pre-stress is specified and used, and may be used for calculating the hot and cold reaction forces, respectively:

$$R_V = \left(1 - \frac{2}{3}C\right)\frac{E_V}{E_K}R$$

$$R_K = C_R \quad \text{or} \quad R_K = \left(1 - \frac{\sigma_{tv}}{\sigma_r}\frac{E_K}{E_V}\right)R$$

whichever is the greater.

R = reaction force at 20°C with no pre-stress [N]

C = amount of pre-stress; with no pre-stress C = 0.0; with 100% pre-stress C = 1.0

E_V = modulus of elasticity for pipe material in hot condition [N/mm^2]

E_K = modulus of elasticity for pipe material at 20°C [N/mm^2].

The quantity:

$$\frac{\sigma_{tv}}{\sigma_r}\frac{E_K}{E_V}$$

shall in all cases be less than 1.0.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.7 Plastic pipes

1.7.1 If thermoplastic pipes shall be installed in external areas, the pipes shall either be particularly approved for external use or be protected against ultraviolet radiation.

1.7.2 Plastic pipes are normally made of electrically insulating materials and are as such not acceptable for service in gas hazardous areas. Special conductive qualities can be permitted if in accordance with the following principles:

- piping systems in or through gas hazardous areas carrying conductive fluids shall be electrically conductive on the outside
- piping systems in or through gas hazardous areas carrying non-conductive fluids, e.g. refined oil products and distillates, shall be electrically conductive on the inside and outside.

Where conductive piping is required, the resistance per unit length of pipe, fitting, etc. shall not exceed 10^5 ohm/m, and the resistance to earth from any point in the piping system shall not exceed 10^6 ohm.

1.7.3 The need for expansion elements shall be specially considered with respect to the large thermal expansion coefficient of the plastic materials.

1.7.4 In cases where the design load components /service conditions include any cyclic or fluctuating nature, the fatigue shall be considered in selection of the plastic piping system and installation method.

1.7.5 Piping materials' compatibility with the fluid to be carried or in which it will be immersed, shall be ensured (e.g. for other liquids/gases than the normal such as water and common hydrocarbons).

2 Pumps, fans and blowers

2.1 General

2.1.1 Pumps listed in Sec.1 Table 3 shall be delivered with the Society's product certificate.

2.1.2 Fans listed in Sec.1 Table 3 shall be delivered with the Society's product certificate.

2.2 Relief valves

2.2.1 Displacement pumps shall be fitted with relief valves. For pumps transporting flammable liquids, the discharge from the relief valve may be led back to suction side of the pump.

2.3 Hydrostatic tests

2.3.1 Pump housings, except those for cargo oil pumps, shall be hydrostatically tested at a pressure of 1.5 times the design pressure. However, the test pressure need not exceed the design pressure by more than 70 bar.

Cargo oil pumps shall be tested to 1.3 times the design pressure, with a minimum of 14 bar. For centrifugal pumps the design pressure shall be the design pressure head on the head-capacity curve. For displacement pumps the design pressure shall not be taken less than the relief valve opening pressure.

The steamside of steam-driven pumps shall be hydraulically tested to 1.5 times the steam pressure.

Hydrostatic testing of pump housings on submerged pumps may not be required.

2.4 Capacity tests

2.4.1 Pump capacities shall be checked with the pump running at design condition (rated speed and pressure head, viscosity, etc.).

Capacity test may be dispensed with for pumps produced in series when previous satisfactory tests have been carried out on similar pumps.

For centrifugal pumps having capacities less than 1 000 m^3/h, the pump characteristic (head-capacity curve) shall be determined for each type of pump. For centrifugal pumps having capacities equal to or greater than 1 000 m^3/h, the pump characteristic shall be determined over a suitable range on each side of the design point, for each pump.

2.4.2 Special survey arrangement for testing of pumps may be agreed upon.

2.5 Fans or blowers

2.5.1 Fans serving gas hazardous spaces shall comply with the requirements Pt.5 Ch.5 Sec.6 [1.2].

2.5.2 For inert gas fans, see Pt.6 Ch.5 Sec.8.

3 Valves

3.1 Valve design

3.1.1 Drawings and specifications shall be submitted for approval for valves of new type or unconventional design and for valves of welded construction fitted on ship's side and bottom.

3.1.2 Pressure-temperature ratings for valves shall be in accordance with a recognised standard.

Guidance note:

Pressure-temperature ratings according to DIN, EN, JIS, ASME and ANSI may be accepted.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.1.3 Screwed-on valve bonnets shall not be used for valves with nominal diameter exceeding 40 mm in class I piping systems, for valves on ship's side and bottom and for valves in systems for flammable fluids. Bolted bonnets having bonnet secured to body by less than four bolts and/or having secured bonnet by U-bolts shall only be accepted for class III service. Valves with bodies that are assembled by bolts, are only allowed in class III piping systems, and shall not be fitted on ship's side or bottom.

3.1.4 Screwed-on valve bonnets shall be secured against loosening when the valve is operated.

3.1.5 Valves shall be closed by turning the handwheel clockwise.

3.1.6 Indicators shall be provided to show the open and closed position of the valve.

3.1.7 Handles on cocks shall be removable only when the cocks are in closed position.

3.1.8 Welded necks of valve bodies shall be sufficiently long to ensure that the valves are not distorted as result of welding and subsequent heat treatment of the joints.

3.1.9 When the valves are designed for one way flow, the direction of flow shall be clearly and legible marked on the valve. The direction may be cast into the valve housing.

3.1.10 Suitable mechanical stops shall be provided on valves where the spindle is turned a part of a 360° turn between open and closed position. Manually operated butterfly valves, which are designed for throttling service, shall be equipped with a locking arrangement that holds the disc in any relevant position.

3.1.11 Non-integral seats or seat linings shall be locked in such a manner that they cannot become loose in service.

3.1.12 Valves with threaded end flanges or piping connections are subject for the restrictions given in [5].

3.2 Hydrostatic tests

3.2.1 All valve bodies shall be subjected by the manufacturer to a hydrostatic test at a pressure equal to 1.5 times the nominal pressure (The nominal pressure is the maximum allowable working pressure at room temperature). The test pressure need not be more than 70 bar in excess of the nominal pressure.

For valves fitted on ship's side and bottom the test pressure shall not be less than 5 bar.

3.2.2 Butterfly valves fitted on ship's side and bottom shall also be hydrostatically tested at a pressure equal to 5 bar applied independently on each side of the closed disc.

Guidance note:

Compliance with this requirement will be stated in the product certificates.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4 Flexible hoses

4.1 General

4.1.1 A flexible hose assembly is a short length of metallic or non-metallic hose normally with prefabricated end fittings ready for installation.

Guidance note:

Short lengths are no more than 1.5 m. See MSC Circ. 1321.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.1.2 Flexible hose assemblies may be accepted for use in fuel systems, lubricating, hydraulic and thermal oil systems, fresh water and sea water cooling systems, compressed air systems, CO_2 systems, bilge and ballast systems, refrigeration systems and class III steam systems. Flexible hoses in high pressure fuel oil injection systems are not accepted. For double walled hoses used in gas fuel systems where the secondary enclosure is required, the hose arrangement is subject to case-by-case approval..

4.1.3 Flexible hoses may only be used when necessary to admit relative movements between machinery and fixed piping systems. The hoses with couplings shall be type approved.

Flexible hoses intended for installation in piping systems for flammable media and sea water system where failure may result in flooding shall be of fire-resistant type. This is not applicable in cases where such hoses are installed on open decks, as defined in SOLAS II-2/Reg. 9.2.3.3.2.2(10) and not used for fuel oil lines.

4.1.4 In fresh cooling water lines for diesel engines and compressors, flexible hoses without type approved couplings may be used provided each engine or compressor is arranged with an independent cooling system. Rubber hoses with internal textile reinforcement fitted by means of hose clamps may be accepted provided the hose is a short and reasonably straight length fitted between two metallic pipes with double hose clamps on each side.

4.1.5 For hoses of non-metallic materials documentation, showing the suitability of the hose for its intended use, shall be submitted for approval.

4.1.6 Flexible hoses constructed of rubber materials and intended for use in bilge, ballast, compressed air, oil fuel, lubricating, hydraulic and thermal oil systems shall 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, shall have suitable material reinforcement as far as practicable.

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

4.1.7 Every hose assembly shall be hydrostatically tested at a hydrostatic pressure of 1.5 times the maximum working pressure.

4.2 Installation

4.2.1 Flexible hoses shall be accessible for inspection.

4.2.2 Flexible hoses shall be limited to a length necessary to provide for relative movement between fixed and flexibly mounted items of machinery/equipment or systems.

4.2.3 Means shall be provided to isolate flexible hoses used in systems for fuel oil, lubricating oil, sea-water cooling and compressed air.

4.2.4 When used in systems conveying flammable fluids flexible hoses shall be shielded from hot surfaces and other sources of ignition.

5 Detachable pipe connections

5.1 Flange connections

5.1.1 Flanges with their pressure-temperature ratings in accordance with a recognised national standard may be accepted.

5.1.2 Examples of accepted flange connections for steel piping are shown in Figure 4.

Typical applications of these types of connections are given in Table 7 depending upon the class of piping, media, size, pressure and temperature.

Other types of flange connections may be considered in each particular case.

For type D the pipe and flange shall be screwed with a tapered thread and the diameter of the screw portion of the pipe over the thread shall not be appreciably less than the outside diameter of the unthreaded pipe. For certain types of thread after the flange has been screwed hard home, the pipe shall be expanded into the flange.

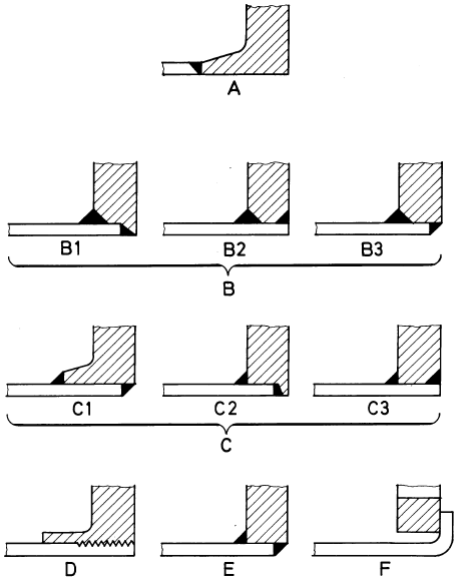


Figure 4 Types of pipe flanges

Table 7 Type of flange connections

Class of piping	*Steam and thermal oil*		*Lubricating oil, fuel oil and flammable hydraulic oil*	*Other media*	
	t [°C]	Typical flange application	Typical flange application	t [°C]	Typical flange application
I	> 400 ≤ 400	A A - B [1)]	A - B A - B	> 400 ≤ 400	A A - B
II	> 250 ≤ 250	A - B - C A - B - C - D - E	A - B - C	> 250 ≤ 250	A - B - C A - B - C - D - E - F
III		A - B - C - D - E	A - B - C - E		A - B - C - D - E - F

1) Type B for outer diameter < 150 mm only.

5.2 Pipe couplings other than flanges

5.2.1 Mechanical joints including pipe unions, compression couplings, slip-on joints and similar joints shall be type approved for the service conditions and the intended application.

Examples of mechanical joints are shown in Table 8.

5.2.2 Slip-on joints shall not be used in pipelines in cargo holds, tanks, and other spaces which are not easily accessible. Application of these joints inside tanks may be permitted only for the same media that is in the tanks.

Mechanical joints, which in the event of damage could cause fire or flooding, shall not be used in piping sections directly connected to the ship's side below the bulkhead deck of passenger ships and freeboard deck of cargo ships or tanks containing flammable fluids.

The number of mechanical joints in flammable fluid systems shall be kept to a minimum. Flanged joints conforming to recognised standards shall be used.

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

5.2.4 The use of slip type slip-on joints as a means of pipe connection is not permitted except for cases where compensation of axial pipe deformation is necessary.

5.2.5 Application of mechanical joints and their acceptable use for each service is indicated in Table 9.

Dependence upon the class of piping and pipe dimensions is indicated in Table 10. Grip type couplings shall not be used in refrigeration systems.

5.2.6 Slip-on threaded joints having pipe threads where pressure-tight joints are made on the threads with parallel or tapered threads, shall comply with requirements of a recognized national or international standard.

Slip-on threaded joints may be used for outside diameters as stated below except for piping systems conveying toxic or flammable media or services where fatigue, severe erosion or crevice corrosion is expected to occur.

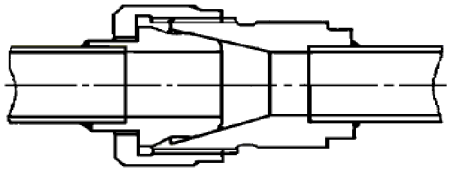
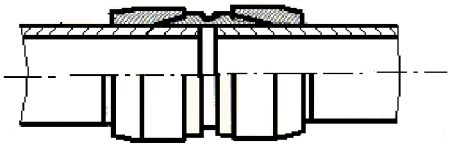
Threaded joints in CO_2 systems shall be allowed only inside protected spaces and in CO_2 cylinder rooms.

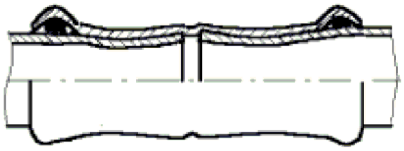
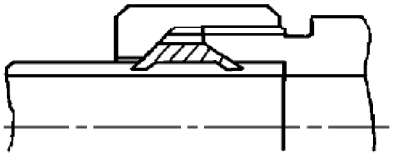
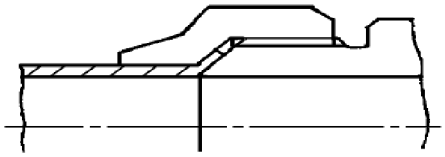
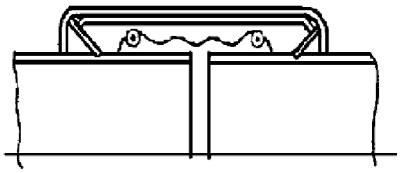
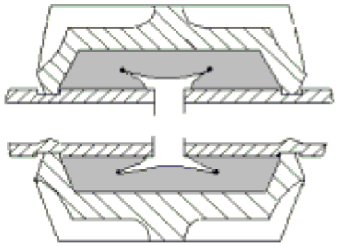
Threaded joints for direct connectors of pipe lengths with tapered thread shall be allowed for:

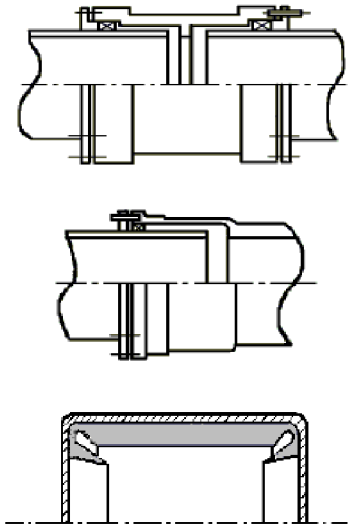
— class I, outside diameter not more than 33.7 mm
— class II and class III, outside diameter not more than 60.3 mm.

Threaded joints with parallel thread shall be allowed for class III, outside diameter not more than 60.3 mm.

Table 8 Examples of mechanical joints

Pipe unions	
Welded and brazed types	
Compression coupling	
Swage type	

Press type	
Bite type	
Flared type	
Slip-on joints	
Grip type	
Machined grooved type	

Slip type	

The following table indicates systems where the various kinds of joints may be accepted. However, in all cases, acceptance of the joint type shall be subject to approval for the intended application, and subject to conditions of the approval and applicable rules.

Table 9 Application of mechanical joints

Systems		*Kind of connections*		
		Pipe unions	*Compression couplings*	*Slip-on joints*
Flammable fluids (flash point ≤ 60°C)				
1	Cargo oil lines[4)]	+	+	+
2	Crude oil washing lines[4)]	+	+	+
3	Vent lines[3)]	+	+	+
Inert gas				
4	Water seal effluent lines	+	+	+
5	Scrubber effluent lines	+	+	+
6	Main lines[2),4)]	+	+	+
7	Distributions lines[4)]	+	+	+
Flammable fluids (flash point > 60°C)				
8	Cargo oil lines[4)]	+	+	+
9	Fuel oil lines[2),3)]	+	+	+
10	Lubricating oil lines[2),3)]	+	+	+
11	Hydraulic oil[2),3)]	+	+	+

Systems		Kind of connections		
		Pipe unions	*Compression couplings*	*Slip-on joints*
12	Thermal oil[2),3)]	+	+	+
Sea water				
13	Bilge lines[1)]	+	+	+
14	Water filled fire extinguishing systems, e.g. sprinkler systems[3)]	+	+	+
15	Non water filled fire extinguishing systems, e.g. foam, drencher systems[3)]	+	+	+
16	Fire main (not permanently filled)[3)]	+	+	+
17	Ballast system[1)]	+	+	+
18	Cooling water system[1)]	+	+	+
19	Tank cleaning services	+	+	+
20	Non-essential systems	+	+	+
Fresh water				
21	Cooling water system[1)]	+	+	+
22	Condensate return[1)]	+	+	+
23	Non-essential system	+	+	+
Sanitary/drains/scuppers				
24	Deck drains (internal)[6)]	+	+	+
25	Sanitary drains	+	+	+
26	Scuppers and discharge (overboard)	+	+	-
Sounding/vent				
27	Water tanks/dry spaces	+	+	+
28	Oil tanks (f.p. > 60°C)[2),3)]	+	+	+
Miscellaneous				
29	Starting/control air [1)]	+	+	-
30	Service air (non-essential)	+	+	+
31	Brine	+	+	+
32	CO_2 system [1)]	+	+	-
33	Steam	+	+	+[5)]

Systems	*Kind of connections*		
	Pipe unions	*Compression couplings*	*Slip-on joints*
Abbreviations: + = application is allowed – = application is not allowed. Footnotes - Fire resistance capability If mechanical joints include any components which may readily deteriorate in case of fire, they shall be of an approved fire resistant type under consideration of the following footnotes: 1) Inside machinery spaces of category A - only approved fire resistant types. 2) Valid for slip-on joints only: Not inside machinery spaces of category A or accommodation spaces. May be accepted in other machinery spaces provided the joints are located in easily visible and accessible positions. 3) Approved fire resistant types except in cases where such mechanical joints are installed on exposed open decks, as defined in SOLAS II-2/Reg. 9.2.3.3.2.2(10) and not used for fuel oil lines. 4) Only in pump rooms and open decks - only approved fire resistant types. Footnotes - General: 5) Slip type slip-on joints as shown in Table 8. May be used for pipes on deck with a design pressure of 10 bar or less. 6) Only above bulkhead deck of passenger ships and freeboard deck of cargo ships.			

Table 10 Application of mechanical joints depending upon the class of piping

Types of joints	*Classes of piping systems*		
	Class I	*Class II*	*Class III*
Pipe unions			
Welded and brazed type	+ (OD ≤ 60.3 mm)	+ (OD ≤ 60.3 mm)	+
Compression couplings			
Swage type	+	+	+
Bite type Flared type	+ (OD ≤ 60.3 mm) + (OD ≤ 60.3 mm)	+ (OD ≤ 60.3 mm) + (OD ≤ 60.3 mm)	+ +
Press type	–	–	+
Slip-on joints			
Machine grooved type	+	+	+
Grip type	–	+	+
Slip type	–	+	+
Abbreviations: + = application is allowed – = application is not allowed.			

5.3 Expansion bellows

5.3.1 The use of expansion bellows shall be restricted as far as practicable.

5.3.2 Expansion bellows are subject to approval for their intended use and shall be delivered with the Society's type approval certificate. The bellows shall be so designed and installed that pulling or blowing out is prevented.

The pipeline in which an expansion bellow shall be fitted, shall be adequately adjusted, aligned and clamped. When found necessary, protection against mechanical damage of the expansion bellows may be required.

5.3.3 Design review of metallic expansion bellows shall be carried out according to an internationally recognized standard such as EJMA or EN14917.

5.3.4 Welding of metallic expansion bellows shall fulfill requirements in Pt.2 Ch.4.

5.3.5 The positions of expansion bellows shall be clearly shown in the drawing of the piping systems.

6 Socket welded joints and slip-on sleeve welded joints

6.1 General

6.1.1 Socket welded joints and slip-on sleeve welded joints may be used for class I and II pipes with an outer diameter of 88.9 mm and less.

6.1.2 Socket welded joints and slip-on sleeve welded joints may be used for class III pipes.

6.1.3 Socket welded joints and slip-on sleeve welded joints shall not be used in overboard pipes where substantial thickness is required, see Pt.3 Ch.12 Sec.9.

6.1.4 Joint designs and socket dimensions in accordance with a recognised national standard may be accepted.

6.1.5 Socket welded joints and slip-on sleeve welded joints in stainless steel pipes shall be subject to the Society's consideration in each case.

7 Overboard pipes and scuppers

7.1

Inlet and overboard discharge pipes as described in Sec.3 [1.3.2] and Sec.3 [1.3.3] and scuppers where substantial thickness is required by Pt.3 Ch.12 Sec.9 Table 2, shall be joined by butt welding.

7.2

Exceptions from [7.1] may be made for scuppers routed through ballast tanks or voids above the deepest water line.

Flange types A, B or C as described in Figure 4 may then be utilized in lieu of butt welding. The use of such flanges shall be kept to a minimum.

SECTION 10 MANUFACTURE, WORKMANSHIP, INSPECTION AND TESTING

1 Welding

1.1 General

1.1.1 The welding of joints shall be carried out by qualified welders using approved welding procedure specifications and type approved welding consumables, see Pt.2 Ch.4. Welding of joints belonging to class I and class II piping systems, requires approval based on a welding procedure qualification test (WPQT).

For welding of titanium alloys, a WPQT is required regardless of piping class.

1.1.2 Oxy-acetylene welding shall not be used for steel pipes in class I and II with outer diameter greater than 100 mm or wall thickness exceeding 10 mm.

1.1.3 Welding of pipes of copper and copper-nickel may be carried out by gas tungsten arc welding (GTAW) and for greater wall thicknesses by gas metal arc welding (GMAW) or by other approved welding processes.

1.1.4 Welding of pipes of aluminium-brass is subject to special consideration and requires approval based on a WPQT. Testing shall be performed in accordance with Pt.2 Ch.4 and a recognised standard.

1.1.5 Welding of a material grade where the welding shops have limited experience, requires the welding procedures to be based on a WPQT.

1.2 Welded connections

1.2.1 Welded butt joints shall be of the full penetration type. For class I pipes special provisions shall be taken to ensure a high quality of the root side.

1.2.2 Branches shall be welded to the main pipe by means of full penetration welds. For reinforcement in way of branches, see Sec.9 [1].

1.2.3 Joint preparation and alignment shall be in accordance with a recognised standard.

1.2.4 If the parts to be joined differ in wall thickness, the thicker wall shall be gradually tapered to that of the thinner of the butt joint with a slope not steeper than 1:4.

1.2.5 Assembling for welding shall be appropriate and within prescribed tolerances. Tack welds shall be made with welding consumables suitable for the base material. Tack welds that form part of the finished weld shall be made using approved welding procedure specifications. When welding materials require preheating, the same preheating shall be applied during tack welding.

1.2.6 For pipe-flange connections, see Sec.9 [5].

1.3 Preheating of steel pipes

1.3.1 Preheating of the different types of steel shall be dependent upon their thickness and chemical composition as indicated in Table 1. In any case, dryness shall be ensured using, if necessary, suitable preheating.

1.3.2 The values in Table 1 are based on use of low hydrogen processes; consideration should be given to using higher preheating temperatures when low hydrogen processes are not used.

Table 1 Preheating prior to welding of steel pipes

Type of steel	*Thickness of thicker part [mm]*	*Minimum preheating temperature [°C]*
C and C/Mn Steel, $C + \frac{Mn}{6} \leq 0.40$	≥ 20 [2]	50
C and C/Mn Steel, $C + \frac{Mn}{6} > 0.40$	≥ 20 [2]	100
0.3Mo	> 13 [2]	100
1Cr 0.5Mo	< 13 ≥ 13	100 150
2.25Cr 1Mo and 0.5Cr 0.5Mo 0.25V [1]	< 13 ≥ 13	150 200

1) For these materials, preheating may be omitted for thicknesses up to 6 mm if the results of hardness tests carried out during the welding procedure qualification test are considered acceptable.

2) For welding in ambient temperature below 0°C, the minimum preheating temperature is required independent of the thickness unless specially approved by the Society.

1.3.3 Austenitic stainless steel shall not be preheated.

1.3.4 Preheating shall be applied in accordance with agreed procedures. Special attention shall be paid to temperature control during the welding process such that the preheat temperature is kept uniformly in affected part of the welded object.

1.4 Heat treatment after welding of steel pipes

1.4.1 The heat treatments shall not impair the specified properties of the material.

The heat treatments shall preferably be carried out in suitable furnaces provided with temperature recording equipment. However, also localised heat treatments on a sufficient portion of the length in way of the welded joint, carried out with approved procedures, can be accepted. The width of the heated circumferential band shall be at least 75 mm on both sides of the weld.

1.4.2 For austenitic stainless steel heat treatment after welding may not be required.

1.4.3 For other alloy steel grades the necessary heat treatment after welding shall be considered in each case.

1.4.4 Stress relieving heat treatment after welding is required as indicated in Table 2 depending on the type of steel and thickness. For oxy-acetylene welding the heat treatment given in Table 3 is required unless otherwise specified.

The stress relieving heat treatment shall consist of heating the piping slowly and uniformly to a temperature within the given range, soaking at this temperature for a suitable period, one hour per 25 mm of thickness with minimum half an hour, cooling slowly and uniformly in the furnace to a temperature not exceeding 400°C and subsequently cooling in still air.

For quenched and tempered steel, the heat treatment temperature shall not be higher than t_T -20°C where t_T is the temperature of the final tempering treatment of the material.

Table 2 Stress relieving heat treatment after forming and welding

Type of steel	*Thickness of thicker part [mm]*	*Stress relief heat treatment temperature [°C]*
C and C/Mn Steel	≥ 15 [1)3)]	550 to 620
0.3Mo	≥ 15 [1)]	580 to 640
1Cr 0.5Mo	> 8	620 to 680
2.25Cr 1Mo and 0.5Cr 0.5Mo 0.25V	any [2)]	650 to 720

1) When steel with specified Charpy V-notch impact properties at low temperature is used, the thickness above which post-weld heat treatment shall be applied may be increased by special agreement.
2) Heat treatment may be omitted for pipes having thickness ≤ 8 mm, diameter ≤ 100 mm and minimum service temperature above 450°C.
3) For C and C-Mn steel, stress relieving heat treatment may be omitted up to 30 mm thickness by special agreement.

Table 3 Full heat treatment after forming and welding

Type of steel	*Heat treatment and temperature [°C]*
C and C/Mn Steel	Normalising 880 to 940
0.3Mo	Normalising 900 to 940
1Cr 0.5Mo	Normalising 900 to 960 Tempering 640 to 720
2.25Cr 1Mo	Normalising 900 to 960 Tempering 650 to 780
0.5Cr 0.5Mo 0.25V	Normalising 930 to 980 Tempering 670 to 720

1.5 Non-destructive testing

1.5.1 The welded joints including the inside wherever possible shall be visually examined. Non-destructive tests may be required depending on the class of pipes and type of joints as hereunder indicated:

Butt welded joints:

— for class I pipes with an outer diameter greater than 75 mm, 100% radiographic testing (RT) is required
— for class II pipes with an outer diameter greater than 100 mm and for class I pipes with an outer diameter ≤ 75 mm, at least 10% random radiographic testing is required. More stringent requirements may be applied at the Society's discretion depending on the kind of materials, welding procedure and controls during the fabrication.

Fillet welds:

— for fillet welds of flange type connections in class I pipes with an outer diameter greater than 75 mm, 100% magnetic particle testing (MT) is required
— for class II pipes with an outer diameter greater than 100 mm and for class I pipes with an outer diameter ≤ 75 mm, 10% random magnetic particle testing at the discretion of the Society is required.

In addition welded joints in pipes for thermal oil shall be subject to at least 10% random radiographic testing.

1.5.2 Titanium alloys

For titanium alloys, the requirements in [1.5.1] applies. In addition, spot check NDT for class III pipes will also be required.

1.5.3 Heating coils in cargo tanks shall be subject to NDT in accordance with Table 4.

Table 4 Non-destructive testing of heating coils

Material in coils	*Joint types*			
	Butt welds [1]		*Sleeve or lap type welded or brazed joints*	
	Erection welds	*Shop welds*	*Erection joints*	*Shop welded or brazed joints*
Mild steel	10%	5%	10%	5%
Stainless steel	10%	5%	10%	5%
Cu-Ni or Al-brass	10%	5%	Spot-check NDT. Steam testing onboard [2]	

Notes:

1) If automatic welding is used, the percentage may be reduced at the Society's discretion.

2) Experience shows that pressure tests do not always reveal leaks in joints because a capillary gap can be temporarily sealed by flux residues. A recommended part of the procedure for testing a heating coil system should therefore be to apply a steam test, which shall dissolve flux residues and reveal leaks.

1.5.4 An approved ultrasonic testing (UT) procedure may be accepted, at the discretion of the Society, in lieu of radiographic testing when the conditions are such that a comparable level of weld quality is assured.

For non-magnetic materials dye-penetrant testing (PT) shall be used in lieu of magnetic particle examination.

1.5.5 Non-destructive testing shall be performed by operators certified in accordance with a recognised scheme, using suitable equipment and written procedures established according to recognized standards. The radiographs shall be marked in such a way that their position on the pipe line may easily be located.

1.5.6 The radiographs shall be judged according to ISO 5817 *Arc-welded joints in steel - Guidance on quality levels for imperfections*, and are at least to meet the requirements for quality level B for welds in class I piping and for quality level C otherwise.

The results from surface examination (e.g. MT, PT) shall satisfy the requirements of level B of ISO 5817.

1.5.7 If a non-conforming discontinuity is detected, the lengths welded immediately before and after the section containing the discontinuity shall be examined by the same method. If systematically repeated discontinuities are revealed, the extent of testing shall be increased for welds manufactured under same conditions and where similar defects may be expected.

1.5.8 If non-conforming discontinuities are found to occur regularly, the welding procedures shall be reassessed before continuation of the welding, and necessary actions shall be taken to bring the production to the required quality level.

Detected non-conforming discontinuities shall be repaired unless they are found acceptable by the Society. Removal of weld discontinuities and repair shall be performed in accordance with a procedure approved by the Society.

1.5.9 After repair welding has been performed, the complete weld shall be subjected to at least to the same NDT method(s) as specified for the original weld.

2 Brazing of copper and copper alloys

2.1 General

2.1.1 The clearance between surfaces to be brazed shall be as recommended for the selected type of filler material, to ensure complete capillary distribution of the filler material. For lap joints, the lap length shall be 3 to 5 t, where t is the wall thickness of the pipes to be joined.

2.1.2 Filler materials to be used in contact with sulphur-containing oil at an operating temperature above 100°C and maximum 200°C (such as heating coil systems) shall be of type BAg in accordance with AWS 5.8, or equivalent. Only filler materials where sufficient corrosion resistance can be documented from either relevant service experience or testing, shall be used.

2.1.3 The brazing shall be carried out by qualified brazers using approved brazing procedures (e.g. ASME IX). The filler material shall have a melting point above 450°C. Brazing of copper alloys containing aluminium (Al-bronze and Al-brass) require use of a flux type FB4-A according to AWS 5.31 or equivalent.

3 Pipe bending

3.1 General

3.1.1 The bending procedure shall be such that the flattening of the pipe cross-section is as small as possible.

Guidance note:

For class I and II pipes the out-of-roundness, η should preferably not exceed 7% where η is defined by:

$$\eta = 2\frac{D_{\max} - D_{\min}}{D_{\max} + D_{\min}} 100\,\%$$

where:

D = outer pipe diameter.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.1.2 Pipe bends in class I and II pipes shall be free from wrinkles on the inner side of the bend.

3.1.3 Copper alloy pipes in seawater systems are as far as possible to be free from wrinkles.

3.1.4 For tolerances in wall thickness and allowance for bending, see Sec.9 [1.3.5] and Sec.9 [1.3.10].

3.2 Heat treatment after bending

3.2.1 Hot forming shall be carried out in the temperature range 850°C to 1000°C for all grades. However, the temperature may decrease to 750°C during the forming process. When the hot forming is carried out within this temperature range, the following requirements apply:

- for C, C-Mn and C-Mo steel, no subsequent stress relieving heat treatment is required
- for Cr-Mo and Cr-Mo-V steel, a subsequent stress relieving heat treatment in accordance with Table 2 is required
- for other alloy steel heat treatment after bending shall be considered in each case.

When the hot forming is carried out outside the above temperature range, a subsequent new heat treatment in accordance with Table 3 may be required for all grades.

Hot forming of austenitic stainless steel shall be carried out in the temperature range 850°C to 1150°C.

3.2.2 For cold bending of steel pipes, the limitations given in Table 5 shall apply.

Pre-fabricated elbows and bends shall comply with the requirements in Pt.2 Ch.2 Sec.5 [6].

Table 5 Limitation for cold bending of steel pipes

Material	*Yield [MPa]*	*Thickness [mm]*	*Bending radius [°]*			
			r < 1.5D	*1.5D ≤ r < 2.5D*	*2.5D ≤ r < 4D*	*r ≥ 4D*
C and C/Mn steel, excluding low temperature and sour service	≤ 410	< 15	Not accepted	Case by case approval, based on qualification and testing	Accepted	Accepted
		≥ 15	Not accepted	Case by case approval, based on qualification and testing	Either stress relieve heat treated in accordance with Table 2, or based on qualification and testing	Accepted
C and C/Mn steel, including those for low temperature and sour service	All	All	Not accepted	Case by case approval, based on qualification and testing	Either stress relieve heat treated in accordance with Table 2, or based on qualification and testing	Accepted
Ferritic/ austenitic (duplex) steel	All	All	Not accepted	Case by case approval, based on qualification and testing	Either solution annealed or based on qualification and testing	Accepted
Austenitic stainless steels	All	All	Not accepted	Either solution annealed or based on qualification and testing	Accepted	Accepted

3.2.3 Aluminium-brass pipes shall be stress-relieved or soft annealed at a temperature of 350°C to 400°C or 600°C to 650°C respectively, after cold working.

3.2.4 Normalising shall be performed in a furnace. Stress-relieving may be performed locally covering the deformed zone. Method of heat-treatment and temperature control shall be according to [1.4.1].

4 Joining of plastic pipes

4.1 General

4.1.1 Joining or bonding of plastic pipes by welding, gluing, lamination, type approved mechanical joints or similar method:

— shall be carried out in accordance with the pipe manufacturer's installation guidelines
— shall be carried out by qualified personnel certified by the manufacturer.

Guidance note:

For acceptable methods, ISO 14692-4:2002 Glass-reinforced plastics (GRP) piping - 'Part 4: Fabrication, installation and operation' may be used.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.1.2 Each joining or bonding procedure shall be qualified before the installation commences.

4.1.3 Joining or bonding operator's (installer's) certificate shall contain:

— the name of the holder
— the type of joining the holder is qualified for
— reference to joining or installation procedure (procedure date of issue to be stated)
— date of issue and validity period for certificate
— pipe manufacturer's stamp and signature.

In addition to being certified, each joining or bonding operator shall make a test assembly consisting of one pipe-to-pipe joint and one pipe-to-fitting joint in accordance with joining or bonding procedure qualified according to [4.1.4] to [4.1.5]. The test procedure and acceptance criterion shall be as described in [4.1.4] to [4.1.5].

4.1.4 Procedure qualification testing

Each joining or bonding operator shall make a test assembly fabricated in accordance with the joining or bonding procedure to be qualified, consisting of at least:

— one pipe-to-pipe joint
— one pipe-to-fitting joint.

After curing, the assembly shall be subjected to a hydrostatic test pressure at a safety factor of minimum 2.5 times the nominal pressure rating (pressure class) of the piping system. The test duration shall be no less than 1 hour. Acceptance criterion: no leakage or separation of joints.

4.1.5 Pipe size for procedure qualification test assembly shall be:

a) When the largest size to be joined is ≤ 200 mm nominal outside diameter, the test assembly shall be the largest piping size to be joined.
b) When the largest size to be joined is > 200 mm, the size of the test assembly shall be either 200 mm or 25% of the largest piping size to be joined, whichever is greater.

4.1.6 The joining or bonding procedure shall include:

— materials and suppliers
— tools and equipment
— environmental requirements
— joint preparation including surface treatment and cleanliness
— dimensional requirements and tolerances
— curing time and temperature

— tests and examinations with acceptance criteria.

4.1.7 Any change in the joining or bonding procedure which may affect the physical or mechanical properties of the joint or bond shall imply re-qualification of the procedure.

4.1.8 The pipe manufacturer shall maintain a record of earlier certifications of procedures and operators.

4.1.9 Electrical conductivity
Piping systems in or through gas hazardous areas shall be electrically conductive according to Sec.9 [1.7.2]. After installation, the conductivity of the piping system shall be measured, and the resistance to earth from any point in the piping system shall not exceed 10^6 ohm.

5 Hydrostatic tests of piping

5.1 Hydrostatic testing before installation on board

5.1.1 All class I and II pipes and integral fittings, after completion of manufacture but before insulation and coating, if any, shall be subjected to a hydrostatic test in the presence of the Society at the following pressure:

$$P_H = 1.5p$$

where:

P_H = test pressure in bar
p = design pressure in bar as defined in Sec.9 [1.3.3].

For steel pipes and integral fittings for design temperatures above 300°C the test pressure shall be determined by the following formula but need not exceed 2 p:

$$P_H = 1.5\frac{\sigma_{t100}}{\sigma_t}p$$

where:

σ_{t100} = permissible stress at 100°C
σ_t = permissible stress at the design temperature.

The value of the test pressure may be reduced with the approval of the Society, to 1.5 p in order to avoid excessive stress in way of bends, branches, etc.

In any case the membrane stress shall not exceed 0.9 the yield stress at the testing temperature.

For hydraulic piping, the test pressure need not exceed the design pressure by more than 70 bar.

5.1.2 Pressure testing of small bore pipes (less than about 15 mm) may be waived at the discretion of the Society, depending on the application.

5.1.3 Non-integral fittings and pressure containing components other than valves, pump housing and pressure vessels shall be tested as specified in [5.1.1]. The requirements for hydrostatic testing of valves and pumps are given in Sec.9 [2] and Sec.9 [3].

5.2 Hydrostatic testing after assembly on board

5.2.1 The piping shall be hydrostatically tested in the presence of the Society after installation on board or before installation as described in [5.1.1], according to Table 6. If tested before installation, testing on board is not required unless additional welding has been performed.

Table 6 Hydrostatic testing after installation on board

Piping system	*Test pressure*
Fuel oil piping	1.5 × design pressure, minimum 4 bar
Heating coils in tanks	
Bilge and fire pipes for fire main, sprinkler and fire extinguishing systems (unless testing for a given system is specifically addressed by DNV's statutory interpretations)	
Class III pipelines for steam, compressed air and feed water	
Treatment fluid pipes for exhaust gas cleaning systems	
Piping systems made from non metallic material (plastic) for essential service systems as described in Sec.2 [1.7.5]. Shall always be tested after installation on board.	1.5 × design pressure. Minimum 4 bar. Minimum duration 1 hour
Refrigeration piping [1)]	1.5 × design pressure
1) Hydraulic pressure tests may be carried out with any liquid, including water, unless it has an unfavourable effect on the refrigerant. Pneumatic pressure tests may be carried out with nitrogen, CO_2 or air.	

5.2.2 Pressure testing of small bore pipes (less than about 15 mm) may be waived at the discretion of the Society, depending on the application.

5.2.3 If pipes specified in [5.1.1], are being welded together during assembly on board, they shall be hydraulically tested as specified in [5.1.1] after welding. If a 100% radiographic examination and heat treatment after welding is carried out, the Society may refrain from the hydraulic test.

5.2.4 Separate pipe lengths, which have been hydraulically tested in the workshop, may be insulated before the hydrostatic test is carried out, except for connections between the pipe lengths.

6 Functional testing

6.1 General

6.1.1 All piping systems shall be properly flushed, checked for leakage and functionally tested under working conditions to the satisfaction of the Society.

6.1.2 For refrigeration systems the safety instrumentation, including automatic stop functions, refrigerant leakage detection systems, emergency stops, alarm call buttons etc. shall be tested.

CHANGES – HISTORIC

July 2020 edition

Changes July 2020, entering into force 1 January 2021

Topic	*Reference*	*Description*
Direct bilge suction dimension	Sec.4 [8.4.4]	For passenger ships and SPS vessels, the rules now require the direct bilge suction in machinery spaces of category A to have same diameter as the main bilge line.
	Sec.4 [9.1]	
Fuel oil and lubricating oil filters	Sec.5 [1]	The subsection has been split and moved to the relevant media.
	Sec.5 [1.3]	The subsection is deleted and relevant parts are moved to Sec.5 [3.2] and Sec.5 [4.7].
	Sec.5 [3.2]	Moved text from Sec.5 [1.3] and adapted requirements to existing technologies, specific to lubricating oil.
	Sec.5 [4.7]	Moved text from Sec.5 [1.3] and adapted requirements to existing technologies, specific to fuel oil.
Fuel oil sampling points	Sec.5 [4.4.5]	Specifying sampling points to be arranged according to MEPC/Circ.864.
Thermal oil tanks	Sec.5 [5.2.5]	Requirement for water traps in air pipes for thermal oil tanks deleted.
	Sec.5 [5.2.7]	Added new subsection requiring the same as for lubrication oil tanks.
Air ejectors for pump priming	Sec.5 [9.1.10]	Added new subsection on requirement for non-return valves in the air delivery line if air ejectors are used for pump priming.
Design pressures for refrigerating plants	Sec.6 [3.2]	HP minimum design pressure reduced from 24 bar to 22 bar. Footnote in Table 3 added to LP minimum design pressure, allowing consideration for lower design pressure.
Ozone ship installations	Sec.7	The requirements to ozone installations have been amended to include oxygen for generation of ozone.
	Sec.7 [2.2]	Guidance note to system arrangement has been deleted, text modified and made mandatory requirements.
Flexible hose assemblies	Sec.9 [4.1.2]	Change requirement for flexible hoses in gas fuel systems from prescriptive to case-by-case consideration.
Cold bending of pipes	Sec.10 [3.2.2]	Added more specific and user friendly requirements to cold bending procedures.
Class III pipes hydrostatic testing	Sec.10 [5.2.1]	Added that testing is allowed before installation on board the vessel.

July 2019 edition

Changes July 2019, entering into force 1 January 2020

Topic	*Reference*	*Description*
Aligning Sec. 1 Table 1 with IACS UR P2 Table 1	Sec.1 Table 1	A category for toxic or corrosive media added to the table, specifying that piping pertains to class I regardless of pressure and temperature.
Changing the docreq for instrumentation	Sec.1 Table 2	Document type code I200 for lube oil, fuel oil, fresh water, sea water and compressed air systems changed to: - I020 Control system functional description, which shall have status AP - I150 Circuit diagrams, which shall have status FI.
Move and overhaul rules	Sec.1 Table 2	Items for NO_x and SO_x cleaning systems moved to new notation and expanded as needed.
	Sec.1 Table 3	Moved entire table to the **ER** class notation in Pt.6 Ch.7 Sec.7.
	Sec.1 Table 4	Moved items for NO_x and SO_x cleaning systems to the **ER** notation.
Plastic piping application clarifications	Sec.2 [1.7.5]	The text has been changed.
Requirements for operation of valves	Sec.3 [1.2] and Sec.3 [1.3.1]	Paragraphs have been modified to clarify the requirements to the accessibility to the valve controls and not necessarily the valves themselves.
Overflow system	Sec.4 [11.3.2]	Paragraph has been removed.
	Sec.4 [11.3.3]	Paragraph has been removed.
Sounding systems	Sec.4 [11.6.6]	In b) added "inside tanks, " for the independent systems. Added: if air bubbling is used as approved local gauging, 2 air lines or 2 pressure sensors shall still be supplied.
		Since the components for remote sounding has not been required to be delivered with individual approvals, the term "approved type" has been deleted.
Pneumatic systems	Sec.5 [9.1.9]	Added new paragraph, stating that if the service air system is connected to control- or starting air system, there shall be an isolation valve arranged.
Design pressures for refrigerating plant	Sec.6 Table 3	Aligned design pressures with industry standard.
Refrigeration system instrumentation - alarm ppm level	Sec.6 [7.1.2]	Corrected the concentration level for the alarm to 1500 ppm in order to be in accordance with EN 13779:2007.
Move and overhaul rules	Sec.8 [2]	Requirements for exhaust gas cleaning systems for NO_x and SO_x are moved to the new **ER** class notation in Pt.6 Ch.7 Sec.7.
Type of flange connections	Sec.9 Table 7	Included thermal oil and flammable hydraulic oil in flange connection table.

Topic	Reference	Description
Overboard pipes and scuppers	Sec.9 [7]	New subsection covering requirements to overboard pipes and scuppers.

July 2018 edition

Amendments November 2018, entering into force 1 January 2019

Topic	Reference	Description
Certification requirements for scrubber system pumps with arrangement and pressure testing requirements	Sec.1 Table 4	Modified certification requirement for water pumps and treatment fluid pumps for exhaust gas cleaning systems for NOx and SOx.

Changes July 2018, entering into force 1 January 2019

Topic	Reference	Description
Bypass damper design for NOx and SOx systems	Sec.8 [2.3.9]	Changed to refer to Sec.8 [3.3.10].
	Sec.8 [3.3.10]	Updated the rule to clarify what valves are required to be fitted with double barrier, and guidance on the acceptable means to achieve this requirement.
	Sec.8 Table 3	Added alarm for loss of sealing air or underpressure, as applicable in accordance with new requirement in Sec.8 [3.3.10].
Excessive requirements for inline scrubbers	Sec.8 [3.2.8]	Clarified the requirement and changed the list to state that the manufacture of the unit shall be according to requirements for class III piping, while the NDT scope for relevant welded joints shall be according to class II requirements. Also we have added a guidance note for what potential failures should be evaluated.
General maintenance/internal alignment/clarifications	Sec.8 [2.4.1]	Added tank vent piping to the requirement in line with UR M77.
	Sec.8 [2.4.6]	Added exemption for tank vent heads.
	Sec.8 [2.5.5]	Updated guidance note cross reference for R717 systems.
	Sec.8 Table 3	Added SH for NaOH leakage in accordance with Sec.8 [3.6.8] and Sec.8 [3.6.10], including footnote 14.
	Sec.8 [3.3.9]	Added drainage for drain pots.
	Sec.8 [3.6.6]	Added exemption for drip tray drain lines.
	Sec.8 [3.4.11]	Updated to clarify that an additional level detector is still required for engine room.
Material requirement for SCR mixing tube	Sec.8 [2.3.13]	Added to the guidance note for requirement Sec.8 [2.3.13] that "the requirement for stainless steel may be waived if the exhaust line after the injector is not arranged with bends for the distance specified by the manufacturer".

Topic	Reference	Description
Soot cleaning for NOx and SOx bypass valves	Sec.8 [2.3.10]	Changed to refer to Sec.8 [3.3.11].
	Sec.8 [3.3.11]	Updated requirement to clarify what valves are required to be fitted with soot cleaning, and guidance on the acceptable means for such soot cleaning.
Temperature sensitive scrubber material to be accepted	Sec.8 [3.2.1]	Updated requirement to outline the criteria for allowing heat sensitive scrubber unit material.
Unclear criteria in bypass requirement	Sec.8 [2.3.2]	Updated rule with guidance on the required means for ensuring unrestricted flow and no risk of failure leading to shutdown.
	Sec.8 [3.3.2]	

January 2018 edition

Changes January 2018, entering into force 1 July 2018

Topic	Reference	Description
Update of Documentation requirements	Sec.1 Table 2	Documentation requirement for control and monitoring of ventilation systems for spaces containing ozon piping has been removed.
Plastic pipes	Sec.2 [1.7.1]	The requirements for the piping are in conformance with IMO Resolution A.753(18), except for the requirements for smoke generation and toxicity.
Drainage of drip trays to closed tank	Sec.5 [1.2.3]	The following text is added to the paragraph: For drip trays intended for small leakages and located far away from the nearest drain tank, other solutions may be considered.
Requirements for fuel and lubrication oil filters	Sec.5 [1.3.1]	It is specified in the paragraph that the lubrication oil supply shall be ensured to main and auxiliary engines, and any other machinery used for main functions.
Alignment with IACS UR M10	Sec.5 [3.1.3]	Added requirement covering that drain pipes from the engine sump to the drain tank shall be submerged at their outlet ends.
Pre-heaters in the fuel oil service system	Sec.5 [4.8.1]	The term "end preheater" has been removed and replaced by "pre-heaters in the fuel oil service system". It has been made clear that the requirement is applicable only when pre-heating of the fuel is required.
Use of bellows and flanges in thermal oil systems	Sec.5 [5.1.4]	Bellows or similar expansion elements in thermal-oil piping within machinery spaces shall be installed with proper protection in case of bellow rupture or leakages, and is only permitted on the suction side of pumps.
Require additional valve in heating coils for tanks containing oil residues or fuel	Sec.5 [7.3.3]	It is specified in the existing rule text that shut-off valves shall be provided at the inlet and outlet of the tank. Testing device is only required at the outlet, as was required before the update.
Opening for use of R744 refrigeration systems where decks and bulkheads surrounding the refrigeration machinery space is not steel	Sec.6 [4.1.3]	Guidance note has been added: In case of R744, refrigerating machinery rooms surrounded by decks and bulkheads constructed of other materials than steel may be accepted upon special considerations.

Topic	Reference	Description
Hazardous zones around ventilation for refrigeration machinery rooms for ammonia systems	Sec.6 [4.1.4]	Areas on open deck within a distance of 1 m from inlet ventilation openings and within a distance of 3 m from outlet ventilation openings of refrigeration machinery rooms with R717 (ammonia) shall be classified as hazardous zone 2.
Allow CO_2 systems with more than 25 kg filling	Sec.6 [4.1.5]	R744 systems may be accepted with more than 25 kg filling if it can be proven that leakage of the complete refrigerant charge from the system will not result in oxygen concentration below 19% by volume.
Use of flexible hoses in gas fuelled systems	Sec.9 [4.1.2]	For double walled hoses in gas fuel systems where secondary enclosure is required, the double barrier shall be maintained in the hose coupling, e.g. by the use of two o-rings.

July 2017 edition

Changes July 2017, entering into force 1 January 2018

Topic	Reference	Description
Implementation of IACS UR M77 - Storage and use of SCR reductants.	Sec.8 [2.2.1]	Moved requirement to Sec.8 [2.4.3]
	Sec.8 [2.4.1]	Editorial change
	Sec.8 [2.4.2]	Per UR M77, current drafted amendment.
	Sec.8 [2.4.3]	Pipe material requirement moved from Sec.8 [2.2.1] and modified per current drafted amendment to M77
	Sec.8 [2.4.4]	Clarification of what "safe location" means (required by M77)
	Sec.8 [2.4.5]	Per UR M77
	Sec.8 [2.4.6]	Added ref. to UR M77
	Sec.8 [2.4.7]	Added ref. to UR M77
	Sec.8 [2.4.8]	Per UR M77, lubricating oil is not required by UR
	Sec.8 Table 2	Per UR M77, tank temperature monitoring always required
Backflow detection in drain pots - Inline scrubbers	Sec.8 [3.4.12]	Added requirement for backflow detection in exhaust drain pots for inline scrubber systems. This will detect backflow to fuel oil combustion units in case of structural failure or design failure in scrubber unit allowing backflow of water without water build up in the scrubber unit. This has occurred in one instance and is identified as a potential future issue.
Alternative to using dampers in FO systems introduced	Sec.5 [4.10.5]	Add guidance note: *Dampers may be dispensed with if adequate damping is confirmed by the engine manufacturer or engine licenser."*

Topic	*Reference*	*Description*
Test procedures for non-metallic pipes aligned with revised IMO Resolution A.753(18)	Sec.2 [1.7.1]	New test procedures for non-metallic piping in IMO Resolution A.753(18) reflected in the rules. More lenient acceptance criteria for certain systems have been introduced. The references to IMO resolutions and applicability of which pipes to be exempted from fire test have also been updated. Update the rule text as follows: Plastic pipes used in systems and location according to Table 1 shall meet the fire endurance requirements specified therein. The permitted use and the requirements for the piping are in conformance with IMO Resolution A.753(18) *Guidelines for the Application of Plastic Pipes on Ships*except for the requirements for smoke generation and toxicity. All pipes, except those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, if separated from accommodation, permanent manned areas and escape ways by means of an A class bulkhead, shall have low flame spread characteristics not exceeding average values listed in IMO Resolution A.653(16)A753(18) Appendix 3. Surface flame spread characteristics may also be determined using the test procedures given in ASTM D635, or in other national equivalent standards.
Overflow system requirement removed	Sec.4 [11.3.2]	Delete following text: For closed overflow systems and reduced filling rates, these topping rates may be used for capacity calculation of the overflow tank. **Guidance note:** The overflow tank should have a high level alarm, located at 1/3 volume, that the remaining volume is sufficient to stop safely the bunker operation. ---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
Dimensioning of overflow pipes	Sec.4 [11.4]	Delete entire rule paragraph/subsection.
Expansion bellow certification	Sec.1 Table 4	Change "PC" to "TA" for expansion bellows. And add in "Additional description": "For rubber compensators, see class programme DNVGL-CP-0183 [3.5].
	Sec.9 [5.3.2]	Expansion bellows are subject to approval for their intended use and shall be delivered with the Society's product type approval certificate.
Vent head certification	Sec.1 Table 4	Add "TA" for air vent heads.
	Sec.4 [11.1.12]	Change: devices are fitted, they shall be of an type approved design. Type approved.
Refrigeration machinery spaces safety requirements added	Sec.6 [4.1.7] (new paragraph)	Insert a new paragraph with the following text (From old DNV Rules Pt. 5 Ch. 10). Access doors and -hatches shall either be operable from both sides or be fitted with catches to prevent inadvertent closing. All chambers and air cooler rooms are each to be fitted with at least one conveniently located alarm call button.

January 2017 edition

Main changes January 2017, entering into force 1 July 2017

• General

— All remaining redundancy requirements removed (e.g. filters to be redundant or fitted with bypass, minimum two sea chests required for scrubber systems) as exhaust gas cleaning is not considered an essential function
— Redundancy requirements for EGC systems have been removed (filters no longer to be redundant or fitted with bypass, single sea chest now allowed for scrubber systems).
— Aqueous and anhydrous ammonia generally not allowed as reductant in NOx SCR systems.

• Sec.1 General

— Docreq item for NOx systems requiring measurement report has been removed as the requirement is obsolete. Sec.1 [3.1.1] Table 4 has been deleted.

• Sec.8 Pollution prevention

— Sec.8 [2.4] and Table 2: Added specific section for urea based NOx reduction systems, incorporating relevant requirements from fuel oil system requirements, in line with IACS UR for ammonia storage and handling, coming into force in January 2018. Other treatment fluids are still covered by the old rules. This replaces the previous method of cross-referencing the fuel requirements, regarding pipe class, arrangements, testing, material selection, etc.
— Sec.8 [3.2]: Added new requirements for inline exhaust gas cleaning systems, should have been added when these were first introduced in 2014
— Sec.8 [3.6] and Table 3: Added specific section for NaOH based treatment fluid systems for SOx cleaning systems, incorporating the relevant requirements from fuel oil system requirements and thus replacing the old general reference to these rules. Other treatment fluids are still covered by the old rules.
— Sec.8 [3.6]: Added specific section for NaOH based systems incorporating relevant requirements from fuel oil system requirements
— Sec.8 [3.4.1] referring to Sec.5 [2] has been replaced by rules Sec.8 [3.4.1], Sec.8 [3.4.2], Sec.8 [3.4.3], Sec.8 [3.4.4] and Sec.8 [3.4.5].
— Sec.8 [3.6.12]: New requirement for portable storage tanks for NaOH handling and storage.
— Sec.8 [3.2.8], Sec.8 [3.4.12] and Sec.8 [3.9.6]: New requirements for inline exhaust gas cleaning systems, taking into account increased risk of backflow and consequences of structural failures in scrubber unit. The requirements cover the design of the scrubber unit, the drainage arrangements and additional control and monitoring scope.
— Minor clarifications and changes to exhaust gas cleaning system rules in Sec.8 [2.2.1, 2.2.3, 2.3.1, 2.4.10, 2.4.12, Table 2, 3.2.3, 3.3.1, 3.3.8, 3.3.9, 3.4.10, 3.4.11 and Table 3] and Sec.10 [5.2.1].
— Sec.8 [3.10.2]: Clarified required content in test procedure for quay and sea trial for SOx cleaning systems.

• Sec.10 Manufacture, workmanship, inspection and testing

— Minor clarifications and changes to exhaust gas cleaning system rules in Sec.10 [5.2.1].

July 2016 edition

Main changes July 2016, entering into force 1 January 2017

• Sec.1 General requirements

— Sec.1 Table 5: A requirement for product certification of the safety and monitoring system for refrigeration systems has been included.

• Sec.4 Ship piping systems

— Sec.4 [11.3.1]: The rule text has been revised to clarify that the subsequent rules are applicable only if an overflow system is fitted.

• Sec.5 Machinery piping systems

— Sec.5 [1.1.3]: Paragraph regarding general redundancy type requirement has been removed, as the general redundancy requirements are covered in Pt.4 Ch.1 Sec.3.

• Sec.6 Refrigeration systems

— Sec.6 [3.1]: A sentence has been included requiring that group 2 refrigerants shall not be used in air conditioning systems with direct expansion.
— Sec.6 [7.1.6]: A guidance note has been included.

• Sec.9 Pipes, pumps, valves, flexible hoses and detachable pipe connections etc.

— Sec.9 Figure 5 and Sec.9 Table 10 have been moved to [5.1] *Flange connections*.
— Sec.9 Table 11, Sec.9 Table 12 and Sec.9 Table 13 have been moved to [5.2] *Pipe couplings other than flanges*.
— Sec.9 [4.1.2]: Refrigeration systems have been added to the list of systems in which flexible hoses may be accepted
— Sec.9 [4.1.3]: Rule text revised to align with IACS UR P2.12 Rev.2.
— Sec.9 [5.2]: Sub-section revised to align with IACS UR P2.7.4 Rev.8.

October 2015 edition

This is a new document.

The rules enter into force 1 January 2016.

Amendments January 2016

• Sec.1 General requirements

— Table 2: Documentation requirements for control and monitoring of valves and pumps have been included.

About DNV

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