RULES FOR
CLASSIFICATION OF

SHIPS

NEWBUILDINGS

MACHINERY AND SYSTEMS
MAIN CLASS

PART 4 CHAPTER 6

PIPING SYSTEMS

JULY 2008

CONTENTS PAGE

DET NORSKE VERITAS

Veritasveien 1, NO-1322 Høvik, Norway Tel.: +47 67 57 99 00 Fax: +47 67 57 99 11

CHANGES IN THE RULES

General

The present edition of the rules includes additions and amendments decided by the Board as of June 2008, and supersedes the July 2006 edition of the same chapter.

The rule changes come into force as described below.

This chapter is valid until superseded by a revised chapter. Supplements will not be issued except for an updated list of minor amendments and corrections presented in Pt.0 Ch.1 Sec.3. Pt.0 Ch.1 is normally revised in January and July each year.

Revised chapters will be forwarded to all subscribers to the rules. Buyers of reprints are advised to check the updated list of rule chapters printed in Pt.0 Ch.1 Sec.1 to ensure that the chapter is current.

Main changes coming into force 1 January 2009

- **General**

The purpose of the amendments has been to harmonize the rules with the new type approval programme for valves; in addition, the requirements for hydraulic cylinders have been clarified, i.e.:

— Some of the requirements previously only included in the type approval program for valves, have now been moved to the rules.
— Requirements for hydraulic cylinders, used for cleats and manoeuvring of watertight doors and hatches, have been included in the rules.
— References to the type approval program for hydraulic cylinders have been corrected.

Corrections and Clarifications

In addition to the above stated rule requirements, a number of corrections and clarifications have been made in the existing rule text.

Comments to the rules may be sent by e-mail to *rules@dnv.com*
For subscription orders or information about subscription terms, please use *distribution@dnv.com*
Comprehensive information about DNV and the Society's services is found at the Web site http://www.dnv.com

Computer Typesetting (FM+SGML) by Det Norske Veritas
Printed in Norway

CONTENTS

SECTION 1
GENERAL REQUIREMENTS

A. Classification

A 100 Application

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

102 Compliance with the rules is required for installations and equipment necessary for performing the main functions given in Pt.1 Ch.1 Sec.1 A200.

103 The Rules give system requirements and prescribe minimum requirements for materials, design, manufacture, inspection and testing.

B. Definitions

B 100 Terms

101 *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.

102 *A piping system* is defined to include piping, as well as components in direct connection to the piping such as pumps, 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 design requirements in Ch.7 apply.

103 *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 B1.

Table B1 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, thermal oil	> 16	or > 300	≤ 16	and ≤ 300	≤ 7	and ≤ 170
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.6 A 303
t = Design temperature, as defined in Sec.6 A 304

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.

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.4 and Pt.5 Ch.5.

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

C. Documentation

C 100 Plans and particulars

101 Plans showing machinery arrangement shall be submitted for information.

These 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.

The plans shall be accompanied by a list of the components and specification of make and type.

102 The following plans and particulars shall be submitted in triplicate for approval:

— Bilge and ballast arrangements. For passenger ships the criterion numeral, as defined in the International Convention for the Safety of Life at Sea shall be stated together with the number of flooded compartments which the ship is required to withstand under damage conditions.
— Air, sounding and overflow piping arrangements.
— Arrangement of cooling systems.
— Sea valves connection to the shell and sea chests.
— Arrangement of lubricating oil systems.
— Arrangement of fuel oil systems, including all fittings on settling and daily service tanks.
— Quick closing arrangement of oil tank valves.
— Arrangement of boiler feed water and condensate systems.
— Arrangement of steam systems.
— Arrangement of compressed air and starting air systems.
— Arrangement of hydraulic and pneumatic systems for:
  - windlasses
  - starting of engines
  - remote control of valves and watertight doors
— Valves of unconventional design not in accordance with recognized standards and valves of welded construction for fitting on ship's side and bottom.
— Detachable pipe connections of unconventional design not in accordance with recognized standards.
— Flexible hoses and bellows not in accordance with recognized standards. See also Sec.6.
— Arrangement of exhaust system with outlet through ship side or stern.
— Hydraulic cylinders according to Sec.5 H.

103 The plans shall be diagrammatic, and shall include the following particulars:

— outside diameters and wall thicknesses of pipes
— materials used in pipes, valve bodies and fittings
— pump type and capacity
— type of valves and fittings
— type of expansion elements
— maximum working pressure, if exceeding 7 bar, and temperature if exceeding 60°C
— hydrostatic test pressure after installation on board, where required according to Sec.7 E200.

For plastic pipes shown in system drawings the following information shall be given:

— fire endurance class
— conductive or non-conductive grade
— maximum working pressure and temperature.

104 For 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. For submittance of calculations of thermal expansion stresses, see Sec.6 A400.

105 Detailed information on the installation procedures for plastic pipes shall be submitted for approval.

The documentation shall include information on joining procedure, supporting, clamping and expansion elements.

For installation in gas hazardous spaces the documentation shall also include information on electrical earthing.

106 The control and monitoring system for valves and pumps listed in 102 shall be approved by the Society, if arranged.

For requirements to documentation, see Ch.9.

D. Signboards

D 100 General

101 Signboards provide information or certain conditions to be complied with for the safe handling of machinery components and systems.

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

In Sec.1 of each chapter a summary of the signboards required by the rules in that chapter is introduced.

D 200 References

201 Signboards are required by the rules in:

— Sec.4 K302 regarding oil overflow.

SECTION 2
MATERIALS

A. Piping Systems

A 100 General

101 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, are generally not 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---of---G-u-i-d-a-n-c-e---n-o-t-e---

102 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 700.

A 200 Carbon and low alloy steels

201 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.4.

202 Steel pipes, valves and fittings may be used within the temperature limits given in Sec.6.

A 300 Copper and copper alloys

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

302 Copper and copper alloys are in general not to 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.

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

A 400 Grey cast iron

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

402 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.

403 Grey cast iron can in general 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.

A 500 Nodular cast iron of the ferritic type

501 Nodular cast iron of the ferritic type, with specified minimum elongation of 12%, may be used in class II and III piping and in pipes and valves located on the ship's side and bottom and valves on the collision bulkhead. The use of nodular cast iron in class I piping will be subject to consideration for approval in each case.

502 Nodular cast iron shall not be used for media having a temperature exceeding 350°C.

503 The use of nodular cast iron for media having a temperature below 0°C will be considered in each particular case.

A 600 Nodular cast iron of the ferritic/pearlitic and pearlitic type

601 Nodular cast iron of the ferritic/pearlitic and pearlitic type is in general subject to the limitation of use as grey cast iron as specified in 400.

A 700 Plastic pipes

701 Plastic pipes used in systems and locations according to Table A1 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.

702 All pipes, except those fitted on open decks and within tanks, cofferdams, pipe tunnels and ducts shall have low surface flame spread characteristics not exceeding average values listed in IMO Resolution A.653(16). Surface flame spread characteristics may be determined using the test procedures given in ASTM D3806.

703 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 are generally to 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.

704 In addition to the use permitted by Table A1, 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.

705 Plastic pipes used in refrigerated seawater (RSW) systems need not be of DNV approved type 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.

706 Plastic pipes used in piping systems subject to classification shall be of approved type and tested to an approved specification observing the requirements in Sec.6 A700.

Table A1 Fire endurance requirements matrix

		Location										
		A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
	Piping systems	*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*
CARGO Flammable cargoes (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	L1	L1	L1	NA	NA	NA	NA	NA	0	L1	L1
15	Sprinkler system	L1	L1	L3	X	NA	NA	NA	0	0	L3	L3
16	Ballast	L3	L3	L3	L3	X	0 [10]	0	0	0	L2	L2
17	Cooling water, essential services	L3	L3	NA	NA	NA	NA	NA	0	0	NA	L2
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)	L1 [4]	L1 [4]	NA	L1 [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)	L2	L2	0 [9]	0 [9]	0 [9]	0	0	0	0	0 [9]	0 [9]

ABBREVIATIONS AND FOOTNOTES IN TABLE A1

Abbreviations

L1 Fire endurance test in dry conditions, 60 minutes, Appendix 1 of IMO Res. A.753(18)
L2 Fire endurance test in dry conditions, 30 minutes, Appendix 1 of IMO Res. A.753(18)
L3 Fire endurance test in wet conditions, 30 minutes, Appendix 2 of IMO Res. A.753(18)
0 No fire endurance test required
NA Not applicable
X Metallic materials having a melting point greater than 925°C.

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 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, should 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 downflooding.
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(f) of regulation 13F of Annex I of MARPOL 73/78 is required, «NA» shall replace «0».

LOCATION DEFINITIONS USED IN TABLE A1

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 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).

A 800 Material certificates

801 The materials used in piping systems shall be certified and documented according to Table A2. For definitions related to the various types of documentation of material certification, see Pt.1 Ch.1 Sec.4.

The requirements for material certification and documentation concerning piping systems for chemical carriers and liquefied gas carriers can be found in Pt.5 Ch.4 Sec.2D and Pt.5 Ch.5 Sec.2E, respectively.

Guidance note:

The control and monitoring system for valves and pumps for systems listed in Sec.1 C102 is not required to be delivered with NV product certificate.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Table A2 Material certificates

Component	*Material*	*Class of piping system*	*Nominal diameter (mm)*	*Design temperature (°C)*	*Type of documentation*		
					NV certificate	*Works certificate*	*Test report*
Pipes [1]		I	> 50		x		
		II, III	> 50			x	
		I, II, III	≤ 50				x
Flanges and bolts				> 400	x		
				≤ 400			x
Bodies of valves and fittings [1], source materials of steel expansion bellows, other pressure containing components not considered as pressure vessels	Steel	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 alloys	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.

SECTION 3
DESIGN PRINCIPLES

A. Arrangement

A 100 Piping systems

101 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.

102 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.

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

104 Metallic pipes shall be connected by welding or brazing in accordance with Sec.7 A and B or by detachable connections in accordance with Sec.6 E.

105 Plastic pipes shall be connected by welding, gluing, cementing, lamination or similar methods in accordance with Sec.7 D or by approved detachable connections in accordance with Sec.6 E.

106 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.

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

Guidance note:

For special requirements regarding air, sounding and waterpipes penetrating insulated tank tops, see Pt.5 Ch.10 Sec.4 D304.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

A 200 Operation of valves

201 Sea suction and discharge valves located in dry compartments, 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. The change over to manual operation from possible remote control arrangement shall be simple to execute.

Guidance note:

For remotely controlled sea suction and discharge valves located in engine room each actuator should be fitted with a hand pump ready for use or an equivalent arrangement.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

202 For remotely controlled valves failure in power supply shall not cause:

— opening of closed valves
— closing of open valves on fuel oil tanks and in cooling water system for propulsion and power generating machinery.

203 All valves in cargo and ballast tanks which are hydraulically or pneumatically controlled are also to be arranged for manual operation, e.g. with a handpump connected to the control system.

204 Spindles of sea suction valves, discharge valves below the load line, emergency bilge valves in engine rooms and blow down discharge valves shall extend above the floor plates or by other means be easily accessible and visible.

For vessels with class notation **E0** see also Pt.3 Ch.3 Sec.6.

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

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

206 When the valves are designed for actuator, the system transmitting the torque to the valve stem or the valve stem itself shall be equipped with an interchangeable safety device such as breaking pins or equivalent.

A 300 Valves on ship's sides and bottom

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

Scuppers and sanitary discharges shall be arranged in accordance with Pt.3 Ch.3 Sec.6 K, as applicable.

302 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.3 Sec.6 K.

303 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.

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

305 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.

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

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

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

309 Sea suctions and discharge valves for ships having additional service and type notation for navigation in ice see Pt.5 Ch.1.

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

A 400 Fittings on watertight bulkheads

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

402 For cargo vessel pipes passing through the collision

bulkhead below the deepest load line shall be provided with a shutoff valve fitted directly on the collision bulkhead operable from above the freeboard deck.

403 For valves fitted on the after side of the collision bulkhead, local operation will be acceptable provided that the valves are readily accessible under all service conditions and provided the space is not a cargo space.

404 For a passenger vessel the collision bulkhead may be penetrated below the margin line 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:

— the valve is fitted directly on the collision bulkhead inside the forepeak
— the valve is operable from above the bulkhead deck.

405 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.

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

SECTION 4
SHIP PIPING SYSTEMS

A. General

A 100 Application

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

Additional requirements for piping systems for cargo handling are given in Pt.5 Ch.3, Pt.5 Ch.4 and Pt.5 Ch.5. Requirements for sanitary discharges and scuppers, see Pt.3 Ch.3 Sec.6.

For additional requirements for drainage and piping systems in passenger ships and ferries, see Pt.5 Ch.2, and for fishing vessels, see Pt.5 Ch.6.

102 Passenger ships are in addition to the requirements in this section to comply with the International Convention for Safety of Life at Sea, 1974.

Exemption may be granted for vessels not engaged in international trades subject to acceptance from the flag Administration.

103 Cargo systems in vessels intended for supply services to offshore installations shall comply with the requirements given in Pt.5 Ch.7.

B. Basic Requirements for Drainage of Compartments and Tanks

B 100 General

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

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

102 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 will generally be necessary, except in short, narrow compartments where one suction can provide effective drainage under the above conditions.

103 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.

B 200 Prevention of unintentional ingress of water into compartments or between compartments

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

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

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

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

205 If ejectors are used for drainage of cargo holds the requirement in 201 may be dispensed with provided the arrangement gives equivalent safety against ingress of water.

206 Bilge pipes through deep tanks, see H502.

C. Drainage of Cargo Holds

C 100 General

101 One bilge suction is normally to 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.

102 Ships with one cargo hold shall have suctions as required in 101 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.

103 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.

104 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.6.

Drainage from refrigerated cargo spaces shall comply with the requirements for class notation **Reefer**, see Pt.5 Ch.10.

C 200 Cargo holds carrying alternately liquid cargo, ballast and dry cargo

201 One centre suction will 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°.

202 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 will be made in the "Appendix to the classification certificate".

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

D. Drainage of Cargo Deck Spaces

D 100 General

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

102 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.

103 The total drainage capacity of each part of the deck as defined in 200 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), with a size and pressure as specified in Ch.10.

104 Where the sill of any cargo or service door is below the uppermost load line, see Pt.3 Ch.3 Sec.6.

105 The cross sectional area of each drainage opening shall not be less than that corresponding to a pipe diameter of 100. Each opening shall have a strain off grating with total area of openings not less than 4 times that of the drainage opening.

106 The outlets may be led overboard if the drainage openings in the deck will not be 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 will be 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.

107 Each drainage opening should comply with the requirements in Pt.3 Ch.3 Sec.6. For vessels where requirements for damage stability apply, see also Ch.1 Sec.3 A500.

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

109 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.

110 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).

111 Air pipes from the bilge tank shall be led to open air above the bulkhead deck.

112 Bilge water tanks and bilge wells collecting drainage water from cargo spaces as specified in 100 and 200 shall be arranged with alarm to the bridge indicating ingress of water.

D 200 Additional requirements for cargo spaces with fixed water-spraying system or high-expansion foam system

201 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 4 areas, 2 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 is in no case to be less than that given in 103.

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

$$d = 12\sqrt{\frac{Q}{n\sqrt{h - 0.6}}} \quad \text{(mm)}$$

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 water-spraying or the water content of the foam in the high-expansion foam system in the compartment to be drained.

203 Where the drainage is by means of pumping directly from bilge wells, the capacity of the bilge pumps shall be at least 1/3 in excess of the sprinkler pumps. If pumped from a bilge tank, the bilge pumps shall have at least the same capacity as the sprinkler pumps.

E. Drainage of Dry Compartments other than Machinery Spaces of Category A and Cargo Holds

E 100 General

101 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.

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

103 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.

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

E 200 Spaces other than cargo spaces fitted with automatic water sprinkler systems

201 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.

202 The requirement in 201 may be exempted from upon considerations of stability.

F. Drainage of Machinery Spaces of Category A

F 100 General

101 The bilge drainage arrangements in the machinery space shall comply with requirements given in B. It should 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 should be arranged as specified in 200, 300 and 400.

F 200 Branch bilge suctions

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

202 Where the rise of the bottom of the room is more than 5° one branch suction near the center line will be acceptable.

203 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.

F 300 Direct bilge suctions

301 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.

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

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

F 400 Divided and specially formed machinery spaces

401 Where the machinery space is divided into compart-

ments separated by watertight bulkheads, the number and position of the branch bilge suctions in boiler rooms, auxiliary engine rooms etc shall be the same as for cargo holds. In addition a direct bilge suction shall be arranged for each compartment to an independent pump.

402 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.

G. Drainage of Barges and Pontoons

G 100 General

101 Barges and pontoons are normally to be provided with means for drainage of cargo holds, engine rooms and watertight compartments and tanks which give major contribution to the vessel's buoyancy and floatability.

102 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.

G 200 Barges

201 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 101.

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.

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

Manned barges with restricted service may have 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.

203 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.

204 Unmanned barges shall be provided with drainage facilities for rooms mentioned in 101.

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.

205 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 will be included in the appendix to the classification certificate for the barge.

G 300 Pontoons

301 Manned pontoons shall be provided with bilge or ballast system as specified for manned barges in 200.

302 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, will 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.

303 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.

H. Bilge Pumping and Piping

H 100 General

101 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.

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

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

104 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 Sec.1 B is established.

105 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.

106 For ships of less than 100 gross tonnage with the service area restriction notations **R0**, **R1**, **R2**, **R3** or **R4,** one bilge pump driven by the main engine and one manual pump of sufficient capacity will be accepted. This arrangement presumes that the main engine can be disconnected from the propeller shafting, and the cooling water pumps driven by the main engine shall be able to drain directly from the engine room.

107 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.5 Ch.2 Sec.6 K200.

For ships carrying dangerous goods in cargo holds requirements to bilge pumping arrangement in Pt.5 Ch.11 Sec.2 B600 may be applicable.

H 200 Capacity and types of bilge pumping units

201 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.

202 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.

203 Pumping unit capacity determined from pipe diameter given in 400 is specified in Table H1.

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

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

d = bore of bilge pipe in mm according to 401 or 402.

For ships with spaces protected by water sprinkler systems see also D203.

204 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---of---G-u-i-d-a-n-c-e---n-o-t-e---

Table H1 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

205 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 will 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 H1 (for a given bilge main diameter) should preferably not be used as bilge pumps.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

H 300 Bilge pumping arrangement

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

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

303 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.

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

305 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.

H 400 Sizes of bilge suctions

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

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

L = length of ship (m)
B = breadth of ship (m)
D = depth of ship to bulkhead deck (m).

as defined in Pt.3 Ch.1.

402 For ships where the pumps in the machinery space are not used for bilge drainage outside the machinery space, the size of the main line may be less than stipulated under 401. 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 403.

403 The internal diameter of branch bilge suctions to cargo holds, machinery and boiler spaces shall not be less than stipulated by the following formula, to the nearest 5 mm:

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

l = length of compartment (m).

B and D as given in 401.

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

404 Direct bilge suctions shall have an internal diameter of not less than $1.4\ d_1$ but need not exceed the diameter given in 401.

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.

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

406 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.

407 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 and 50 mm for ships under 61 m.

H 500 Bilge pipes through tanks and holds

501 Bilge suction pipes are, as far as practicable, not to be carried through double bottom tanks. Where this cannot be avoided, the pipe wall thickness shall be as given in Sec.6 Table A2, column 4.

502 In deep tanks used for water ballast or fuel oil the bilge pipes shall be led through pipe tunnels or made of steel with a wall thickness according to Sec.6 Table A2. If possible they should consist of a single pipe length or be welded together.

Non-metallic pipes may be used in lieu of steel pipes as permitted by Sec.2 Table A1.

Expansion bends or approved expansion bellows shall be fitted to the bilge pipes within the tanks. The open ends of these suction pipes in the cargo holds shall be provided with non-return valves.

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

H 600 Bilge wells, mud boxes, valves etc.

601 The bilge wells are normally to have a capacity of at least 0.15 m^3.

602 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.

603 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.

604 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.

605 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.

I. Ballast System and Drainage of Tanks

I 100 Drainage of ballast tanks

101 All ballast tanks shall be connected to at least two drainage pumps. For drainage of top wing tanks see Pt.3 Ch.3 Sec.6.

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

103 The dimensions of pipes are at least to be as specified for branch bilge pipes in H403.

I 200 Filling of ballast tanks

201 Permanent ballast tanks may be filled by pumping or by opening inlet valves to sea.

J. Remotely Controlled Bilge and Ballast Systems

J 100 Arrangement

101 If a main bilge line for the cargo holds is arranged, this shall be placed in a pipe tunnel, 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.

Guidance note:

See Pt.5 Ch.2 Sec.5 E400 for requirements for availability of drainage from forward spaces on bulk carriers

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

102 As alternatives for locating the main bilge line in a pipe tunnel the following alternatives may be accepted:

1) Main bilge line through double bottom ballast tanks with the branch line 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.

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

J 200 Pumps

201 Remotely controlled bilge and ballast pumps shall be provided with operating indications at the remote manoeuvring panel.

K. Air, Overflow and Sounding Pipes

K 100 Air pipes

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

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

103 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 will be decided in each case. For tanks with width exceeding half of the vessel's beam, air pipes on each side will be required.

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

105 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.

106 Air pipes from tanks which can be filled from the sea and from sea chests shall be carried up to above the bulkhead deck.

107 Air pipes to fuel oil tanks, double bottom tanks, cofferdams and all other tanks which can be pumped up and to shaft tunnels and pipe tunnels, shall be carried above the bulkhead deck up to the open air.

Air pipes from lubricating 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.

108 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 will comply with the above.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

109 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.

110 For height and wall thickness of air pipes above deck, see Pt.3 Ch.3 Sec.6 .

111 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 of an approved design.

112 Air pipes for tanks containing heated fuel shall comply with Sec.5 D100.

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

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

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

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

K 200 Sectional area of air pipes

201 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 when the tank is overpumped with the largest available pump.

Documentation of calculated pressure drops in air pipes for water overflow shall be submitted. The calculations shall verify that the dynamic pressure increase during water overflow does not exceed Δp_{dyn} (see Pt.3 Ch.1 Sec.4 C300 or Pt.3 Ch.2 Sec.5 B100, as applicable). Alternatively, arrangements for prevention of overpumping of tanks may be accepted.

The sectional area of the air pipes is in no case to 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 overpumping 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 will 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.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note:

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

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

202 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.

203 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.

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

K 300 Overflow pipes

301 Fuel oil and lubricating oil tanks which can be pumped up and which have openings, for example, for a float sounding system, shall be fitted with overflow pipes discharging to an overflow tank or bunker oil tank with surplus capacity. The tank openings shall be situated above the highest point of the overflow piping.

The requirements in 302 to 401 are applicable to any overflow system when fitted.

302 The overflow tanks shall have a capacity large enough to take an overflow of ten minutes at the normal rate of filling. Where a storage tank is used for overflow purposes a signboard shall be fitted to signify that sufficient volume for overflow is ensured.

303 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.

304 Where tanks for the carriage of oil or water ballast are connected to an overflow system, the pipe arrangement shall be such that water ballast cannot overflow into tanks containing oil.

305 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 must be located higher than the deepest waterline, alternatively individual tank overflow lines must be arranged with loops extending above the waterline.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

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

K 400 Sectional area of overflow pipes

401 The sectional area of overflow pipes shall be dimensioned in accordance with the requirements in 201.

K 500 Sounding pipes

501 All tanks, cofferdams and pipe tunnels 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.

502 The sounding pipes shall be readily accessible at any time and clearly marked.

Sounding pipes are normally to 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 503).

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.

503 Short sounding pipes may be fitted to double bottom oil tanks, in shaft tunnels and machinery spaces and to tanks for lubricating oil and hydraulic oil which can be pumped up, provided the pipes are readily accessible, and the following conditions 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 test cocks are fitted below the self-closing cocks.

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.

504 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.

505 Oil level gauges 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:

— in passenger ships; no penetration below the top of the tank is permitted
— in cargo ships; penetrations below the top of the tank shall be fitted with self-closing valves.

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

507 Remote sounding system of approved type 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 independent remote sounding systems are required. In the case of remote sounding based on the air-bubble principle, two air bubble lines per tank may be accepted provided sufficient redundancy in the central unit is provided.

K 600 Sectional area of sounding pipes

601 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.

K 700 Air and sounding pipes through refrigerated spaces

701 Air and sounding pipes through refrigerated cargo spaces, see Pt.5 Ch.10 Sec.4 D.

K 800 Air and sounding pipes for barges and pontoons

801 Closed compartments and tanks are in general to be provided with air and sounding pipes.

Air and sounding pipes will 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.

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

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

804 Where air pipes of full height will 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.

805 Where the presence of air pipes will 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.

806 Ballast tanks which have been approved without air pipes according to 805, shall be arranged with suitable hatch arrangement for opening during pumping of ballast.

L. Tanks for Liquid Cargoes other than Mineral Oils with Flash Point Above 60°C (Closed Cup)

L 100 General

101 Air and sounding pipes shall satisfy the requirements for fuel oil tanks, see K.

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

103 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.

104 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 C202.

105 For hydraulic testing of pipes in tanks, see Sec.7 E.

106 Requirements for transport of mineral oils with flash point below 60°C, see Pt.5 Ch.3.

M. Oil Pollution Prevention

M 100 Application

101 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.

M 200 Ships of 400 gross tonnage and above

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

202 Combined fuel oil and ballast water tanks are normally not permitted.

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

$$V = K\ C\ D \quad (m^3)$$

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 unless restricted service notation.

For ships fitted with sludge incinerator or similar equipment for onboard processing of sludge, the tank(s) capacity may be reduced to the greater of:

— 50% of the above, or
— 1 m^3 when 400 < gross tonnage < 4 000 and
— 2 m^3 when gross tonnage ≥ 4 000

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

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

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

206 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 M1. 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, 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 M1 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
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.	

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

208 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 will 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---of---G-u-i-d-a-n-c-e---n-o-t-e---

209 For ships above 10 000 gross tonnage an oil content detecting device which will 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---of---G-u-i-d-a-n-c-e---n-o-t-e---

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

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

212 For vessels in dedicated trades the requirements in 208 and 209 may be dispensed with subject to acceptance of the flag Administration and port State Administrations, involved.

M 300 Ships below 400 gross tonnage

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

SECTION 5
MACHINERY PIPING SYSTEMS

A. General

A 100 Redundancy and capacity

101 For definition of redundancy, see Ch.1 Sec.1 B100.

102 Redundancy shall be arranged as specified in Ch.1 Sec.3 B300, 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 A200.

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

103 Redundancy type 2 according to Ch.1 Sec.1 B shall be established, i.e. the time lag involved in restoring the lost function shall not be more than 10 minutes.

104 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 will be accepted. I.e. an easily removable pump of each type may be approved as a standby pump.

A 200 Drip trays

201 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, etc.

202 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.

203 The drip trays shall be drained to a closed waste tank not forming part of an overflow system.

A 300 Oil filters

301 Duplex filters used in systems for flammable liquids shall be arranged with means for preventing opening of a filter under pressure.

B. Cooling Systems

B 100 General

101 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.

102 For systems using fuel oil as a cooling agent, requirements in D are also applicable.

B 200 Cooling water supply

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

202 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.

203 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.

204 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.

205 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.

B 300 Sea inlets for cooling water pumps

301 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---of---G-u-i-d-a-n-c-e---n-o-t-e---

302 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.

303 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.

304 Regarding sea inlets see Sec.3 A300.

305 Regarding sea chest arrangements for ships having additional class notations for navigation in ice, see Pt.5 Ch.1.

C. Lubricating Oil System

C 100 General

101 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.

102 A valve with an easily visible and accessible hand wheel shall be fitted between the main engine crankcase and a double bottom lubricating oil tank if double bottom is required in the engine room and the tank extends to the bottom plating.

C 200 Lubricating oil pre-treatment arrangement

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

202 For non-redundant units it must be possible to clean the filters without interrupting the oil supply.

If automatic cleaning filters are used, means shall be provided to ensure the oil supply in case of failure in the automatic cleaning and change over system.

Guidance note:

A manual back-wash function for emergency purpose is accepted as a means to ensure oil supply when automatic back-wash type filter is installed.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

203 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 201.

C 300 Lubricating oil supply

301 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.

C 400 Emergency supply of lubricating oil to main machinery

401 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.

C 500 Remote shut-off arrangement for lubricating oil tanks

501 Valves on lubricating oil tanks situated above the double bottom and which are open during normal service shall be arranged for remote shut-off if such 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 A200.

D. Fuel Oil Systems

D 100 Flash point of fuel oil

101 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 will 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.5 Sec.16 and in other ships as given in Pt.6 Ch.13.

102 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 vent 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.

103 Liquids for specific purposes and whose flash point is lower than 43°C are preferably to be stored outside the machinery space. If tanks for such liquids are installed in the engine room, installation drawings shall be submitted for approval in each case.

D 200 Fuel oil tanks

201 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.

202 Fuel oil tanks shall be separated from fresh water tanks by means of cofferdams.

203 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.

204 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.

205 Fuel oil daily service tanks for heavy fuel oil shall be constructed with smooth bottoms with slope towards drainage outlet required by 801. Outlets for fuel oil centrifuges, if fitted, shall be taken from the lowest point of the tank bottom.

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

D 300 Fuel oil piping

301 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.

302 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.

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

304 Fuel oil pipes shall not be led through fresh water tanks.

305 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.

306 Piping arrangements for deep tanks carrying alternately dry cargo, fuel oil and water ballast, see Sec.4 C202.

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

D 400 Arrangement of valves, cocks and fittings

401 Every outlet pipe from a fuel oil tank shall be fitted with a shut-off valve.

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.

Where an inlet pipe is connected below the liquid level, a shut-off valve or non-return valve at the tank shall be fitted.

Guidance note 1:

For filling lines entering at the top of a tank and with inside extension towards the bottom, airholes must be drilled in the pipe near the penetration in order to avoid the siphoning effect.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

Oil piping valve arrangement is also affected by requirements for oil fuel tank protection. Reference is made to MARPOL Annex I Reg. 12A.9.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

402 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 will not lead to oil spray on boilers, exhaust pipes or other hot surfaces of the machinery, or on electric motors and appliances.

403 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.

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

D 500 Remotely controlled shut-off arrangement for fuel oil tanks

501 In the engine room, fuel oil valves on tanks shall be "quick-acting shut-off valves", arranged for remote operation. This remote operation shall be carried out from a central position outside the space itself, and at a safe distance from skylights and other openings to the engine and boiler rooms.

This 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.

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.

502 Every oil fuel suction pipe, which is led into the engine room from a tank situated above the double bottom outside this space, is also to be fitted with a quick-acting shut-off valve in the engine room close to the bulkhead. This is not applicable where the valve on the tank is arranged for remote shut-off.

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

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

D 600 Fuel oil preheaters

601 As regards electric oil heaters, see Ch.8.

D 700 Fuel oil pretreatment arrangement

701 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 fuel oil.

702 For auxiliary engines one single fuel oil filter for each engine may be approved.

703 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 701.

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

D 800 Various requirements

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

802 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.

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

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

805 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.

806 For vessels with class notation **E0**, flowmeters in fuel oil lines shall be provided with bypass arrangements. Flowmeters 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.

E. Thermal Oil Systems

E 100 System arrangements

101 Thermal oil systems shall be arranged and installed in accordance with requirements given in Ch.7.

F. Feed Water and Condensate Systems

F 100 Feed water pumps

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

F 200 Feed water piping

201 If feedwater preheaters are fitted in feed water lines bypass arrangements shall be provided enabling repair of a heater without interrupting the feed water supply.

202 Feed water piping shall be fitted with valves at the boiler inlet, as stated in Ch.7 Sec.6.

F 300 Feed water heating

301 For steam boilers with working pressure above 7 bar arrangements for preheating and deaeration of the feedwater 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.

F 400 Feed water tanks

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

402 Feed water tanks in the double bottom shall be separated from oil tanks by cofferdams.

403 Piping for feed tanks shall be so arranged that the water cannot be contaminated by oil or oily water.

F 500 Condensate from steam heating of tanks

501 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.

F 600 Evaporators

601 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.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

G. Steam Systems

G 100 Steam piping

101 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.

102 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 reference is made to Pt.5 Ch.10 Sec.4 A106.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

103 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.

104 For analysis of thermal expansion stresses see Sec.6 A.

G 200 Steam supply to auxiliary machinery

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

G 300 Shut-off valves

301 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.

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

G 400 Safety valves

401 The discharge from safety valves shall be to a point where hazard is not created, see Ch.7 Sec.6.

G 500 Blow down valves on ship's side

501 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. (See also Sec.3 and Ch.7 Sec.6.)

H. Hydraulic Systems

H 100 General

101 The redundancy requirement in A102 applies to pumps, filters and pressure reduction units.

102 Hydraulic systems shall be separated from other piping systems except lubricating oil systems as specified in C101.

103 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 normally be subjected.

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

105 Excessive pressure surges and pulses generated by pumps and valve operations shall be avoided. When necessary, pulsation dampers shall be fitted, preferably connected directly to the source of vibrations.

Design of the system is normally to be such that laminar flow is obtained.

106 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.

107 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.

108 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.

H 200 Hydraulic power supply

201 Requirements for hydraulic power supply to steering gears are given in Pt.4 Ch.14 Sec.1.

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

203 Windlasses arranged for remote control are in addition to be arranged for local manual control.

H 300 Hydraulic cylinders

301 Hydraulic cylinders having $pD > 20\,000$, where;

p = design pressure (bar)
D = internal diameter of cylinder tube (mm)

shall be delivered with the Society's certificate.

Hydraulic cylinders for cleating and manoeuvring of watertight doors and hatches shall be delivered with the Society's certificate regardless of pressure and size. Cleating cylinders where the locking mechanism is placed inside the cylinder are to be type approved.

Requirements for cylinders intended for steering gears, see Pt.4 Ch.14.

Guidance note:

Certification of hydraulic cylinders is covered by DNV Standards for Certification No. 2.9 (Approval Program No.5-778.93).

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

H 400 Accumulators

401 Hydraulic accumulators of the gas or hydraulic fluid type having

$$p V > 1.5$$

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

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

402 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.

403 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.

404 The gas bottles for charging accumulators shall be in accordance with Ch.7. Such bottles shall be clearly marked to prevent mixing up with other types of gas bottles on board.

405 Cast accumulators shall have an inside coating.

H 500 Hydraulic equipment

501 System components and arrangement shall satisfy the requirements in 100 to 400.

502 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.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

503 Local accumulators used as back up 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.

504 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.

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

506 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.

I. Pneumatic Systems

I 100 General

101 The redundancy requirement in A102 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).

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

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

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

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

106 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.

I 200 Pneumatic equipment

201 Components requiring extremely clean air shall not be used. Extremely small openings in air passages shall be avoided.

202 Main pipes shall be inclined relative to the horizontal, and drainage shall be arranged.

203 Pipes and other equipment made of plastic materials are accepted if they have satisfactory mechanical strength, low thermoplasticity, high oil resistance, and are flame retardant. For application, see Sec.2 A700.

204 Air to instrumentation equipment shall be free from oil, moisture and other contamination. Condensation musts 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 normally not be lower than 5°C.

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

I 300 Pneumatic starting arrangements

301 For diesel engine starting systems, see also Ch.3. For starting up from «dead ship», see Ch.1 Sec.3 B313. Electrical starting systems are described in Ch.8.

302 Starting systems for internal combustion engines and gas turbines shall have capacity for a number of starts specified in Table I1 without reloading of air receivers.

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

Table I1 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

303 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.

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

305 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.

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

307 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
PIPES, PUMPS, VALVES, FLEXIBLE HOSES AND DETACHABLE PIPE CONNECTIONS ETC.

A. Pipes

A 100 General

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

102 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.

A 200 Minimum wall thickness

201 The minimum wall thickness is generally not to be less than given in Table A1, Table A2 and Table A3 for pipes of copper or copper alloy, steel and stainless steel, respectively.

202 The outer diameters and wall thicknesses given in the tables are in accordance with ISO-standards. For pipes covered by other standards, thickness slightly less may be accepted.

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

$$t = K\,(0.5 + 0.001\,D_N) \quad (mm)$$

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

A 300 Calculation of wall thickness of pipes being subject to internal pressure

301 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 200.

302 Definition of symbols:

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.

303 *The design pressure p* to be used in the formula in 306, 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 will 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.

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 A1 Minimum wall thickness for pipes of copper and copper alloys

External pipe diameter D (mm)	*Minimum wall thickness (mm)*	
	Copper	*Copper alloy*
D ≤ 10	1	0.8
10 < D ≤ 20	1.2	1
20 < D ≤ 44.5	1.5	1.2
44.5 < D ≤ 76.1	2	1.5
76.1 < D ≤ 108	2.5	2
108 < D ≤ 159	3	2.5
159 < D ≤ 267	3.5	3
267 < D ≤ 470	4	3.5
470 < D ≤ 508	4.5	4

Table A2 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 fuel oil tanks, ballast lines through fuel oil tanks and fuel oil lines through ballast tanks* 1) 2) 3) 4) 5) 7) 8) 9)
10.2 - 12 13.5 - 17.2 20	1.6 1.8 2			
21.3 - 25 26.9 - 33.7 38 - 44.5	2 2 2	 4.5	3.2 3.2 3.6	 6.3
48.3 51 - 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 - 82.5 88.9 - 108 114.3 - 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 - 139.7 152.4 - 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 - 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 - 368 406 - 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.3 Sec.6.

8) For stainless steel pipes, the minimum wall thickness will be specially considered, but it is in general not to be less than given in Table A3.

9) For air pipes on exposed decks, see Pt.3 Ch.3 Sec.6.

Table A3 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.

304 *The design temperature* to be considered for determining the permissible stresses, is normally to be the maximum temperature of the medium inside the pipe. For special cases, the design temperature will 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 normally 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 will be of short duration.

305 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:

$$t + b$$

306 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 will be given special consideration.

307 For steel pipes the permissible stress, σ_t, is in general to 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 A4 Tensile strength and permissible stress in pipes of copper and copper alloys

Pipe material	*Minimum tensile strength (N/mm^2)*	*Design temperature (°C)* [1]										
		up to 50	*75*	*100*	*125*	*150*	*175*	*200*	*225*	*250*	*275*	*300*
		Permissible stress (N/mm^2)										
Copper, annealed	220	42	42	41	41	35	28	19				
Copper, «semi-hard»	250	42	42	41	41	35	28	19				
Aluminium-Brass [2] annealed	330	80	80	80	80	80	52	25				
Copper-Nickel 90/10 annealed	290	70	70	69	67	65	63	60	57	53	49	45
Copper-Nickel 70/30 annealed	360	83	81	79	77	75	73	71	69	67	65	63

1) For pipes conveying compressed air, the permissible stresses shall be reduced by 50% if the pressure is pulsating.

2) Cu: 76.0 - 79.0; Al: 1.8 - 2.3; As: 0.02 - 0.06; Zn: remainder.

Table A5 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 may upon approval be reduced up to 50%.

3) For stainless steels the corrosion allowance may be omitted.

308 For pipes made of copper and copper alloys the permissible stresses are given in Table A4 which refers to copper and copper alloys specified in Pt.2 Ch.2 Sec.11.

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

310 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:

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

R = mean radius of the bend (mm).

In case the bending ratio:

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

is not given, this ratio will be taken equal to 1:3.

311 For steel pipes the corrosion allowance c shall be as specified in Table A5

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.

312 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.

313 The value of t does not account for any negative manufacturing tolerance, therefore the nominal wall thickness, t_1, shall not be less than:

$$t_1 = \frac{t}{1 - \frac{a}{100}}$$

314 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 307. Alternatively, the thicknesses may be calculated according to 315. However, the validity of 315 is limited by a maximum ratio for branch lines wall thickness/ main line wall thickness of 2.

315 The minimum pipe wall thickness of main pipes at a branch connection shall not be less than:

$$t = t_0 + c \quad \text{(mm)}$$

$$t_0 = \frac{pD}{20\sigma_t e + p} \quad \text{(mm)}$$

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

$$\frac{D_b}{\sqrt{D\,t_b}}$$ is shown in Fig.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 Fig. 2.

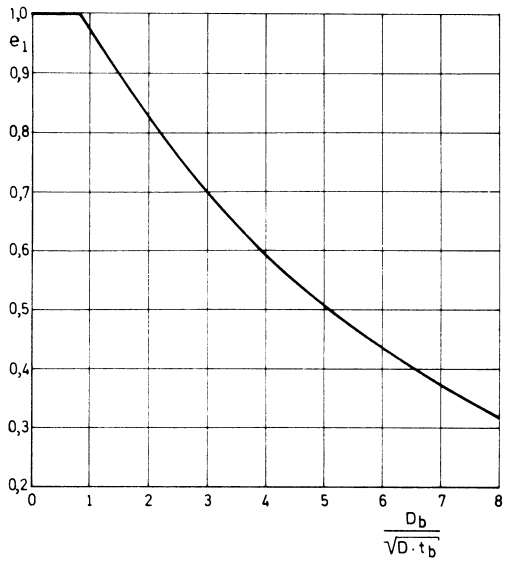


Fig. 1
Basic strength ratio

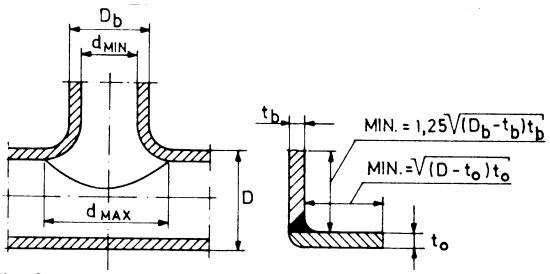


Fig. 2
Details of main pipe and branch pipe

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 Fig. 2.

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 Fig. 2.

Examples of acceptable branch connections for use in piping systems for steam temperature above 400°C are shown in Fig. 3.

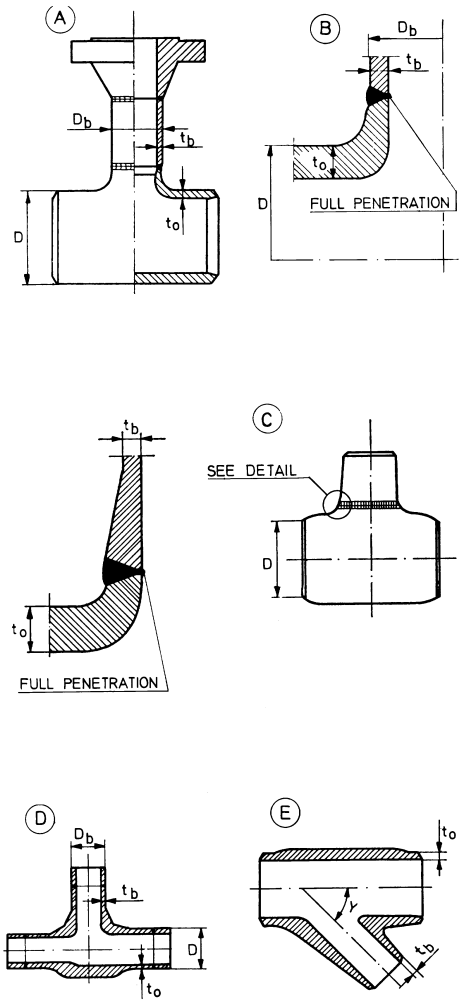


Fig. 3
Examples of acceptable branch connections for steam at temperatures above 400°C

A 400 Thermal expansion stresses

401 For piping systems for steam at temperatures above 400°C, an analysis of thermal stresses is normally to 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.

A 500 Documentation of thermal stress calculation

501 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.

502 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.

A 600 Stress calculation

601 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.

602 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 A6 will be accepted for use in the calculations when other substantiated factors may be lacking.

603 The thermal expansion resultant stress σ_r is defined as:

$$\sigma_r = \sqrt{\sigma_b^2 + 4\tau^2} \quad (N/mm^2)$$

$$\sigma_b = \frac{\sqrt{(i_1 M_1)^2 + (i_0 M_0)^2}}{Z}$$

$= $ total bending stress (N/mm^2)

$$\tau = \frac{M_T}{2Z}$$

$= $ 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 in 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:

$$\pi r_b^2 t_h \text{ and } \pi r_b^2 i_{ib} t_b$$

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)
i_{ib} = in-plane stress concentration factor for branch.

604 The resultant stress σ_r is at no point of the piping system to exceed the corresponding stress range σ_{int}:

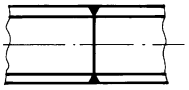
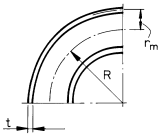
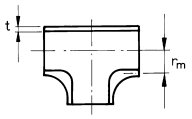
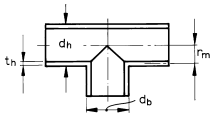
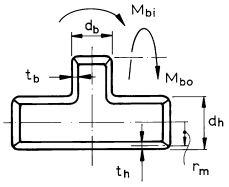
$$\sigma_{int} = 0.75\ \sigma_{tk} + 0.25\ \sigma_{tv}$$

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.

605 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 A6 Stress concentration factors and flexibility factors for metallic pipe-line elements

Type of element	*Sketch*	*Flexibility parameter γ*	*Flexibility factor k*	*In-plane stress concentration factor i_i 1)*	*Out-of-plane stress concentration factor i_0 1)*
Straight buttwelded pipe			1.0	1.0	1.0
Curved pipe		$\frac{tR}{r_m^2}$	$\frac{1.65}{\gamma}\left[\frac{1}{1+6\frac{p}{E_K}\left(\frac{r_m}{t}\right)^{7/3}\left(\frac{R}{r_m}\right)^{1/3}}\right]$	$\frac{0.9}{\gamma^{2/3}}$	$\frac{0.75}{\gamma^{2/3}}$
Welding tee		$4.4\frac{t}{r_m}$	1.0	$\frac{3}{4}i_0 + 0.25$	$\frac{0.9}{\gamma^{2/3}}$
Fabricated tee $\frac{d_b}{d_h} > 0.3$		$\frac{t_h}{r_m}$	1.0	$\frac{3}{4}i_0 + 0.25$	$\frac{0.9}{\gamma^{2/3}}$
Branch-connection with $\frac{d_b}{d_h} \le 0.3$ If $\frac{d_b}{d_h} > 0.3$ as for fabricated tee		$\frac{t_h}{r_m}$	$0.9\left(\frac{d_h}{t_h}\right)^{3/2}\frac{t_b}{t_h}\frac{d_b}{d_h}$ for M_{bi} $0.27\left(\frac{d_h}{t_h}\right)^{3/2}\frac{t_b}{t_h}\frac{d_b}{d_h}$ for M_{bo}	$\frac{3}{4}i_0 + 0.25$	$\frac{0.9}{\gamma^{2/3}}$

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:

$$R_V = \left(1 - \frac{2}{3}C\right)\frac{E_V}{E_K}R$$

$$R_K = C_R \text{ or } R_K = \left(1 - \frac{\sigma_{tv}}{\sigma_r}\frac{E_K}{E_V}\right)R$$

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:

$$\frac{\sigma_{tv}}{\sigma_r}\frac{E_K}{E_V}$$

is in all cases to be less than 1.0.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

A 700 Plastic pipes

701 The nominal internal pressure for a pipe should be determined by dividing the short-term hydrostatic test failure pressure by a safety factor of 4 or the long-term hydrostatic (> 100 000 h) test failure pressure by a safety factor 2.5 whichever is the lesser. The hydrostatic test failure pressure should be verified experimentally or by a combination of testing and calculation methods according to a recognised standard.

702 The nominal external pressure for a pipe shall not be less than 1 bar and shall be determined by dividing the collapse test pressure by a safety factor of 3. The collapse test pressure shall be verified experimentally or by a combination of testing and calculation methods according to a recognised standard.

703 High temperature limits and pressure reductions relative

to nominal pressures should be according to the recognised standard, but in each case the maximum working temperature should be at least 20°C lower than the minimum heat distortion temperature (determined according to ISO 75 method A, or equivalent) of the resin or plastic material. The minimum heat distortion temperature should not be less than 80°C.

704 Temperature limits and pressure reductions are indicated in Table A7 and A8 for some material types. The limits may be extended on basis of acceptable documentation from the pipe manufacturer. The permissible temperatures are stated for long term service. Short periods of marginally higher temperatures may be accepted by case to case considerations.

705 Glassfibre reinforced epoxy and polyester pipes are considerably more exposed to damage from impact and local overloading than steel. Wall thickness of piping and fittings shall be equivalent to nominal pressure 10 bar and piping D > 100 mm shall be rigid enough to carry a load of 100 kg at midspan, where midspan is taken from manufacturer's recommendation. The susceptibility to impact damage shall be duly taken into consideration when handling, installing, and inspecting.

706 The tables are related to water service only. Services involving other media shall be considered case by case.

707 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.

708 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.

709 The need for expansion elements shall be specially considered with respect to the large thermal expansion coefficient of the plastic materials.

710 In cases where design loads incorporate a significant cyclic or fluctuating component, fatigue should be considered in material selection and installation design.

711 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).

Table A7 Thermoplastic pipes. Permissible pressures and temperature limits

Material	*Nominal pressure* [1] *PN (bar)*	*Permissible working pressure (bar)*						
		- 20 to 0°C	*30°C*	*40°C*	*50°C*	*60°C*	*70°C*	*80°C*
PVC	10 16		7.5 12	6 9	 6			
ABS	10 16	7.5 12	7.5 12	7 10.5	6 9	 7.5	 6	
HDPE	10 16	7.5 12	6 9.5	 6				

1) According to recognised standards for water supply on shore.

Table A8 Glassfibre reinforced epoxy [1] and polyester pipes (GRP). Permissible pressures and temperature limits

Minimum heat distortion temperature of resin ISO 75 Method A	*Nominal pressure* [2] *PN (bar)*	*Permissible working pressure (bar)*							
		- 50 to 30°C	*40°C*	*50°C*	*60°C*	*70°C*	*80°C*	*90°C*	*95°C*
80	10 16 25	10 16 16	9 14 16	7.5 12 16	6 9.5 15				
100	10 16 25	10 16 16	10 16 16	9.5 15 16	8.5 13.5 16	7 11 16	6 9.5 15		
135	10 16 25	10 16 16	10 16 16	10 16 16	10 16 16	9.5 15 16	8.5 13.5 16	7 11 16	6 9.5 16

1) Minimum heat distortion temperature 135°C.

2) According to recognised standards for marine use.

B. Pumps and Fans or Blowers

B 100 General

101 The following pumps shall be delivered with the Society's certificate:

— sea-water cooling pumps for main engine
— fresh-water cooling pumps for main engine
— main condenser circulating pumps
— condensate pumps for main condenser
— air pumps for main condenser
— feed-water pumps
— circulating pumps for boilers with forced circulation
— fuel oil transfer pumps and booster pumps
— fuel oil service pumps
— fuel injection valve cooling pumps
— lubricating oil pumps for main engine and main reduction gear

— bilge pumps
— ballast pumps
— fire pumps and emergency fire pumps
— hydraulic pumps for steering gears, windlasses, variable pitch propellers, side thrusters, cargo pumps and hydraulically operated valves
— cargo pumps (cargo pumps for non-flammable liquids on offshore supply vessels need not be delivered with the Society's certificate)
— inert gas cooling water pumps
— circulation pumps for thermal-oil
— other pumps considered necessary for performing of the main functions listed in Pt.1 Ch.1 Sec.1 A200.

Drawings of pumps are normally not required submitted for approval.

102 The following fans or blowers shall be delivered with the Society's certificate:

— inert gas blowers
— force draft fans for main boilers (turbine ships)
— fans serving gas dangerous spaces.

B 200 Relief valves

201 Displacement pumps shall be fitted with relief valves. For pumps transporting flammable liquids, the discharge from the relief valve is normally to be led back to suction side of the pump.

B 300 Hydrostatic tests

301 Pump housings, except those for cargo oil pumps, shall be hydrostatically tested at a pressure of 1.5 times the maximum working pressure. However, the test pressure need not exceed the maximum working pressure by more than 70 bar.

Cargo oil pumps shall be tested to 1.3 times the maximum working pressure, with a minimum of 14 bar. For centrifugal pumps the maximum pressure shall be the maximum pressure head on the head-capacity curve. For displacement pumps the maximum working 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 will normally not be required.

B 400 Capacity tests

401 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.

402 Special survey arrangement for testing of pumps may be agreed upon.

B 500 Fans or blowers

501 Fans serving gas dangerous spaces shall comply with the requirements of Pt.5 Ch.3 Sec.6 A200.

502 For inert gas fans see Pt.5 Ch.3 Sec.11.

C. Valves

C 100 Valve design

101 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.

102 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---of---G-u-i-d-a-n-c-e---n-o-t-e---

103 Screwed-on valve bonnets are normally not to 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 will only be accepted for Class III service.

104 Screwed-on valve bonnets shall be secured against loosening when the valve is operated.

105 Valves are normally to be closed by turning the handwheel clockwise.

106 Indicators shall be provided to show the open and closed position of the valve, unless this can be observed in some other way.

107 Handles on cocks shall be removable only when the cocks are in closed position.

108 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.

109 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.

110 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.

111 Non-integral seats or seat linings shall be locked in such a manner that they cannot become loose in service.

112 Valves with threaded end flanges or piping connections are subject for the restrictions given in E.

113 Valve bodies of nominal size DN 50 and larger shall be self draining or be equipped with drain plug.

C 200 Hydrostatic tests

201 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.

202 Butterfly valves fitted on ship's side and bottom are also to be hydrostatically tested at a pressure equal to 5 bar applied independently on each side of the closed disc.

C 300 Certification of valves

301 DNV product certificates are required for valves with $D_N > 100$ mm having a design pressure, $p > 16$ bar and for ship side valves with $D_N > 100$ mm regardless of pressure rating. For other valves manufacturers certificate may be accepted.

302 Valves shall be delivered with material certificates in accordance with Sec.2 Table A2.

D. Flexible Hoses

D 100 General

101 Short lengths of flexible hoses may be used when necessary to admit relative movements between machinery and fixed piping systems. The hoses with couplings shall be type approved.

Fire tests are required for hoses intended for systems conveying flammable liquids or for use in sea water cooling systems.

102 In fresh cooling water lines for diesel engines and compressors the requirements in 101 may be dispensed with provided each engine 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.

103 For hoses of non-metallic materials documentation, showing the suitability of the hose for its intended use, shall be submitted for approval.

104 Every hose shall be hydrostatically tested at a hydrostatic pressure of 1.5 times the working pressure.

D 200 Installation

201 Flexible hoses shall be accessible for inspection.

202 Flexible hoses shall not be used in bilge- and ballast systems.

203 Means shall be provided to isolate flexible hoses used in systems for fuel oil, lubricating oil, sea-water cooling and compressed air.

204 When used in systems conveying flammable fluids flexible hoses shall be shielded from hot surfaces and other sources of ignition.

E. Detachable Pipe Connections

E 100 Flange connections

101 Flanges with their pressure-temperature ratings in accordance with a recognised national standard will normally be accepted.

102 Examples of accepted flange connections for steel piping are shown in Fig.4.

Typical applications of these types of connections are given in Table E1 depending upon the class of piping, media, size, pressure and temperature.

Other types of flange connections will be considered in each particular case.

Guidance note:

For type D the pipe and flange should 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.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

E 200 Pipe couplings other than flanges

201 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. The approval shall be based on DNV Type Approval Programme 5-792.20.

Examples of mechanical joints are shown in Table E2.

202 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 sea openings or tanks containing flammable fluids.

The number of mechanical joints in oil systems shall be kept to a minimum. In general, flanged joints conforming to recognised standards shall be used.

203 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.

204 Unrestrained slip-on joints shall be used only in cases where compensation of lateral pipe deformation is necessary. The use of these joints as a means of pipe connection is not permitted.

205 Application of mechanical joints and their acceptable use for each service is indicated in Table E3.

Dependence upon the Class of piping, pipe dimensions, working pressure and temperature is indicated in Table E4.

206 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.

E 300 Expansion bellows

301 The use of expansion bellows shall be restricted as far as practicable.

302 Expansion bellows are subject to approval for their intended use. 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.

Guidance note:

Documentation and calculation of expansion bellows may be carried out in accordance with the EJMA standard.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

303 The positions of expansion bellows shall be clearly shown in the drawing of the piping systems.

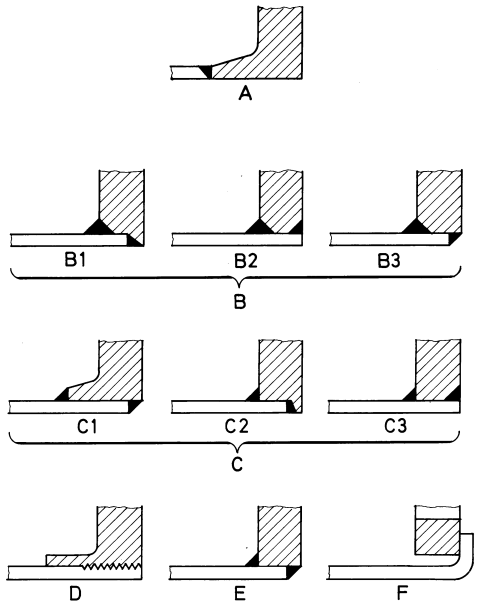


Fig. 4
Types of pipe flanges

Table E1 Type of flange connections

Class of piping	*Steam*		*Lubricating and fuel 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.

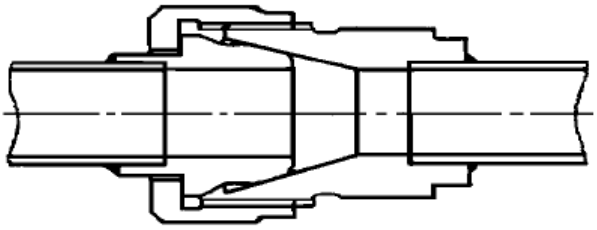
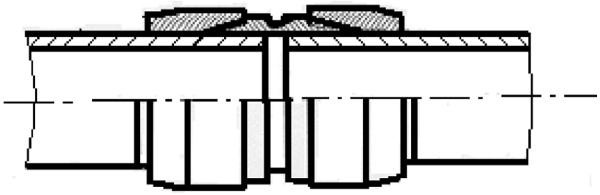
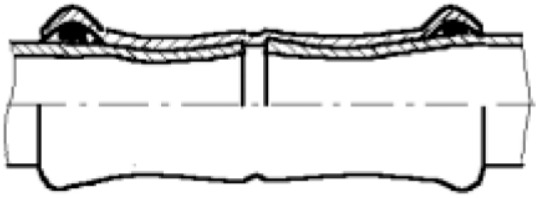
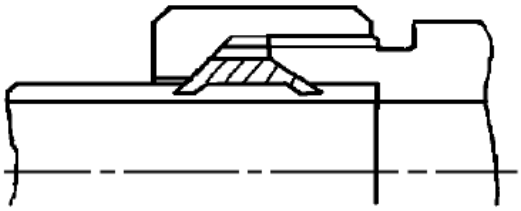
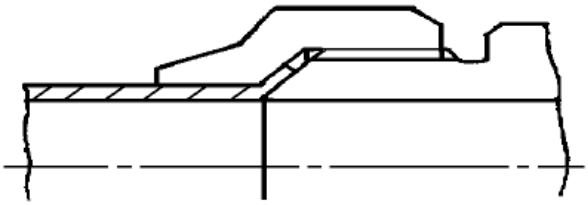
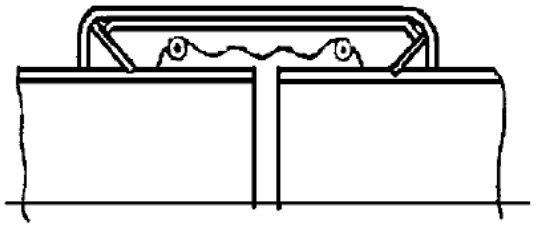
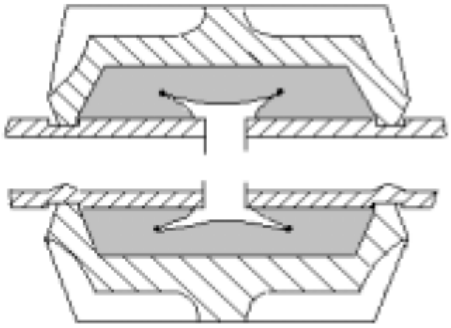
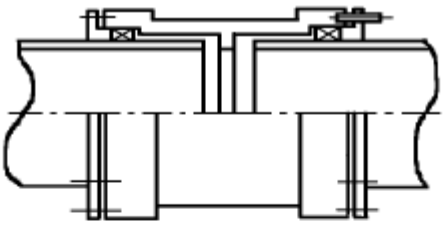
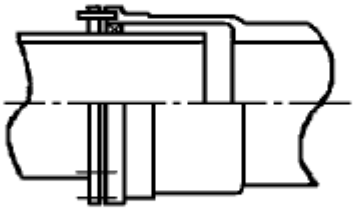
Table E2 Examples of mechanical joints	
Pipe Unions	
Welded and Brazed Types	
Compression Coupling	
Swage Type	
Press Type	
Bite Type	
Flared Type	

Table E2 Examples of mechanical joints (Continued)	
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 shallshallshall be subject to approval for the intended application, and subject to conditions of the approval and applicable Rules.

Table E3 Application of mechanical joints

Systems		*Kind of connections*		
		Pipe Unions	*Compression Couplings 6)*	*Slip-on Joints*
Flammable fluids (flash point ≤ 60°C)				
1	Cargo oil lines	+	+	+5)
2	Crude oil washing lines	+	+	+5)
3	Vent lines	+	+	+3)
Inert gas				
4	Water seal effluent lines	+	+	+
5	Scrubber effluent lines	+	+	+
6	Main lines	+	+	+2)5)
7	Distributions lines	+	+	+5)
Flammable fluids (flash point > 60°C)				
8	Cargo oil lines	+	+	+5)
9	Fuel oil lines	+	+	+3)2)
10	Lubricating oil lines	+	+	+2)3)
11	Hydraulic oil	+	+	+2)3)
12	Thermal oil	+	+	+2)3)
Sea water				
13	Bilge lines	+	+	+1)
14	Fire main and water spray	+	+	+3)
15	Foam system	+	+	+3)
16	Sprinkler system	+	+	+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)	+	+	+4)
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)	+	+	+

Table E3 Application of mechanical joints (Continued)				
Systems		*Kind of connections*		
		Pipe Unions	*Compression Couplings 6)*	*Slip-on Joints*
31	Brine	+	+	+
32	CO_2 system 1)	+	+	-
33	Steam	+	+	+7)

Abbreviations:
+ Application is allowed
– Application is not allowed

Footnotes:

1) Inside machinery spaces of category A - only approved fire resistant types
2) 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
4) Above free board deck only
5) In pump rooms and open decks - only approved fire resistant types
6) If Compression Couplings include any components which readily deteriorate in case of fire, they shall be of approved fire resistant type as required for Slip-on joints
7) Approved slip type joints as shown in Table E2, provided that they are restrained on the pipes, may be used for pipes on deck with a design pressure of 10 bar or less.

Table E4 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

F. Socket Welded Joints and Slip-on Sleeve Welded Joints

F 100 General

101 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.

102 Socket welded joints and slip-on sleeve welded joints may be used for class III pipes.

103 Socket welded joints and slip-on sleeve welded joints shall not be used in overboard pipes where substantial thickness is required.

104 Joint designs and socket dimensions in accordance with a recognised national standard will normally be accepted.

105 Socket welded joints and slip-on sleeve welded joints in stainless steel pipes will be subject to the Society's consideration in each case.

SECTION 7
MANUFACTURE, WORKMANSHIP, INSPECTION AND TESTING

A. Welding

A 100 General

101 The welding of joints shall be carried out by qualified welders using approved welding procedures and welding consumables, see Pt.2 Ch.3. Welding of steels having a minimum specified yield strength above 400 MPa requires welding procedure qualification testing performed on the actual material and welding consumables to be used as for production welding.

102 Oxy-acetylene welding shall not be used for steel pipes in class I and II with outer diameter greater than 101.6 mm or wall thickness exceeding 10 mm.

103 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.

104 Welding of pipes of aluminium-brass is subject to special consideration and requires approval based on welding procedure qualification testing (WPQT). Testing shall be performed in accordance with Pt.2 Ch.3 and a recognised standard.

105 Welding of a material grade where the welding shops have limited experience, requires the welding procedures to be based on welding procedure qualification testing. The welding shop shall establish a plan for training and qualification of welders and for qualification of the welding procedures to be applied.

A 200 Welded connections

201 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.

202 Branches shall be welded to the main pipe by means of full penetration welds. For class I and II pipes a welding procedure test (WPQT) may be required. For reinforcement in way of branches, see Sec.6 A.

203 Joint preparation and alignment shall be in accordance with a recognised national standard.

204 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.

205 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 procedures. When welding materials require preheating, the same preheating shall be applied during tack welding.

206 For pipe-flange connections, see Sec.6 E.

A 300 Preheating of steel pipes

301 Preheating of the different types of steel will be dependent upon their thickness and chemical composition as indicated in Table A1. In any case, dryness shall be ensured using, if necessary, suitable preheating.

302 The values in Table A1 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 A1 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 on welding procedure qualification 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.

303 Austenitic stainless steel shall not be preheated.

304 The heating procedure and the temperature control shall be to the satisfaction of the surveyor.

A 400 Heat treatment after welding of steel pipes

401 The heat treatments shall not impair the specified properties of the material; verifications may be required to this effect as necessary.

The heat treatments are preferably to 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.

402 For austenitic stainless steel heat treatment after welding is normally not required.

403 For other alloy steel grades the necessary heat treatment after welding will be considered in each case.

404 Stress relieving heat treatment after welding for other than the oxy-acetylene welding process is required as indicated in Table A2 depending on the type of steel and thickness. Unless otherwise specified, for oxy-acetylene welding, the heat treatment indicated in Table A3 depending on the type of steel is required.

The stress relieving heat treatment shall consist of heating the piping slowly and uniformly to a temperature within the range indicated in Table A3, soaking at this temperature for a suitable period, in general 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.

In any case, 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 A2 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 A3 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

A 500 Non-destructive testing

501 In general, the welded joints including the inside wherever possible shall be visually examined. Non-destructive tests will 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 76.1 mm, 100% radiographic testing (RT) is required.
— for class II pipes with an outer diameter greater than 101.6 mm and for class I pipes with an outer diameter ≤ 76.1 mm, at least 10% random radiographic testing is required. More stringent requirements may be applied at the surveyors 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 76.1 mm, 100% magnetic particle testing (MT) is required.
— for class II pipes with an outer diameter greater than 101.6 mm and for class I pipes with an outer diameter ≤ 76.1 mm, random magnetic particle testing at the discretion of the surveyor is required.

In addition welded joints in pipes for thermal oil shall be subject to at least 10% random radiographic testing.

502 Heating coils in cargo tanks shall be subject to NDT in accordance with Table A4.

Table A4 Non-destructive testing (NDT) 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 surveyors 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 will dissolve flux residues and reveal leaks.

503 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.

504 Non-destructive testing shall be performed by operators certified in accordance with a recognised scheme, using suitable equipment and procedures. The radiographs shall be marked in such a way that their position on the pipe line may easily be located.

505 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.

506 The repair of defects revealed during non-destructive testing shall be carried out according to agreement with the surveyor. All such weld repairs shall be examined using the relevant testing method.

B. Brazing of Copper and Copper Alloys

B 100 General

101 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.

102 Filler materials to be used in contact with sulphur- containing oil at a 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.

103 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.

C. Pipe Bending

C 100 General

101 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:

$$\eta = 2\frac{D_{max} - D_{min}}{D_{max} + D_{min}} \ 100\%$$

D = outer pipe diameter.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

102 Pipe bends in class I and II pipes shall be free from wrinkles on the inner side of the bend.

103 Copper alloy pipes in seawater systems are as far as possible to be free from wrinkles.

104 For tolerances in wall thickness and allowance for bending, see Sec.6 A305 and Sec.6 A310.

C 200 Heat treatment after bending

201 Hot forming is generally to be carried out in the temperature range 850°C to 1 000°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 generally 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 A2 is required
- for other alloy steel heat treatment after bending will 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 A3 is generally required for all grades.

202 After cold forming, when r ≤ 4D (where r is the mean bending radius and D is the outside diameter of pipe) consideration shall be given to a complete heat treatment in accordance with Table A3, in any case, a stress relieving heat treatment in accordance with Table A2 is required for all grades other than carbon-manganese steel with minimum specified tensile strength, $R_m \geq 410$ N/mm^2.

203 Aluminium-brass pipes shall be stress-relieved or soft annealed at a temperature of 350 to 400°C or 600 to 650°C respectively, after cold working.

204 Normalising is normally to be performed in a furnace. Stress-relieving may be performed locally covering the deformed zone. Method of heat-treatment and temperature control shall be to the satisfaction of the surveyor.

205 Hot forming of austenitic stainless steel shall be carried out in the temperature range 850 to 1 150°C. Cold forming may be carried out when r ≥ 2.5 D (where r is the mean bending radius and D is the outside diameter of pipe).

D. Joining of Plastic Pipes

D 100 General

101 Joining or bonding of plastic pipes by welding, gluing, lamination 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.

102 Each joining or bonding procedure shall be qualified before the installation commences.

103 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 104 to 105. The test procedure and acceptance criterion shall be as described in 104 to 105.

104 *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 4 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.

105 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.

106 The joining or bonding procedure should 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.

107 Any change in the joining or bonding procedure which may affect the physical or mechanical properties of the joint or bond will imply requalification of the procedure.

108 The pipe manufacturer should maintain a record of earlier certifications of procedures and operators.

109 *Electrical conductivity*

Piping systems in or through gas hazardous areas shall be electrically conductive according to Sec.6 A708. 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.

E. Hydrostatic Tests of Piping

E 100 Hydrostatic testing before installation on board

101 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 surveyor at the following pressure:

$$P_H = 1.5\ p$$

P_H = test pressure in bar
p = design pressure in bar as defined in Sec.6 A303.

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:

$$P_H = 1.5\frac{\sigma_{t100}}{\sigma_t}\ p$$

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 surveyor, 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.

102 Pressure testing of small bore pipes (less than about 50 mm) may be waived at the discretion of the surveyor, depending on the application.

103 Non-integral fittings and pressure containing components other than valves, pump housing and pressure vessels shall be tested as specified in 101. The requirements for hydrostatic testing of valves and pumps are given in Sec.6 B and C.

E 200 Hydrostatic testing after assembly on board

201 The piping shall be hydrostatically tested in the presence of the surveyor after installation on board, according to Table E1.

Table E1 Hydrostatic testing after installation on board

Piping system	*Test pressure*
Fuel oil piping	1.5 maximum working pressure, minimum 4 bar
Heating coils in tanks	
Bilge and fire pipes	
Class III pipelines for steam, compressed air and feed water	
Hydraulic piping	1.5 maximum working pressure. The test pressure need not exceed the working pressure by more than 70 bar
Piping systems made from non-metallic material (plastic)	1.5 maximum working pressure. Minimum 6 bar. Minimum duration 1 hour

202 If pipes specified in 101, are being welded together during assembly on board, they shall be hydraulically tested as specified in 101 after welding. If a 100% radiographic examination and heat treatment after welding is carried out, the surveyor may refrain from the hydraulic test.

203 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.

F. Functional Testing

F 100 General

101 All piping systems shall be properly flushed, checked for leakage and functionally tested under working conditions to the satisfaction of the surveyor.