SECTION 4 ARRANGEMENT AND INSTALLATION OF PIPING SYSTEMS

1 General

1.1 Application

1.1.1 Specific requirements

Specific requirements for yacht piping systems and machinery piping systems are given in Ch 1, Sec 5 to Ch 1, Sec 9.

1.2 Documentation to be submitted

1.2.1 Documents

The documents listed in Tab 1 are to be submitted.

1.2.2 Additional information

The information listed in Tab 2 is also to be submitted.

1.3 Definitions

1.3.1 Piping and piping systems

a) Piping includes pipes and their connections, flexible hoses and expansion joints, valves and their actuating systems, other accessories (filters, level gauges, etc.) and pump casings

b) Piping systems include piping and all the interfacing equipment such as tanks, pressure vessels, heat exchangers, pumps and centrifugal purifiers, but do not include boilers, turbines, internal combustion engines and reduction gears

Note 1: The equipment other than piping is to be designed in accordance with the relevant Sections of Part C, Chapter 1.

1.3.2 Design pressure

a) The design pressure of a piping system is the pressure considered by the manufacturer to determine the scantling of the system components. It is not to be taken less than the maximum working pressure expected in this system or the highest setting pressure of any safety valve or relief device, whichever is the greater

b) The design pressure of steam piping located upstream of pressure reducing valves (high pressure side) is not to be less than the setting pressure of the boiler or superheater safety valves

c) The design pressure of a piping system located on the low pressure side of a pressure reducing valve where no safety valve is provided is not to be less than the maximum pressure on the high pressure side of the pressure reducing valve

d) The design pressure of a piping system located on the delivery side of a pump or a compressor is not to be less than the setting pressure of the safety valve for displacement pumps or the maximum pressure resulting from the operating (head-capacity) curve for centrifugal pumps, whichever is the greater.

Table 1 : Documents to be submitted

Item No	Document **(1)**
1	Drawing showing the arrangement of the sea chests and yacht side valves
2	Diagram of the bilge (and ballast) systems (in and outside machinery spaces)
3	Diagram of the scuppers and sanitary discharge systems
4	Diagram of the air, sounding and overflow systems
5	Diagram of cooling systems (sea water and fresh water)
6	Diagram of fuel oil system
7	Drawings of the fuel oil tanks not forming part of the yacht's structure
8	Diagram of the lubricating oil system
9	Diagram of the hydraulic systems intended for essential services or located in machinery spaces
10	Diagram of the compressed air system
11	Diagram of the hydraulic and pneumatic remote control systems
12	Diagram of the remote level gauging system
13	Diagram of the exhaust gas system
14	Diagram of drip trays and gutterway draining system
15	Arrangement of the ventilation system
17	Drawings and specification of valves and accessories, where required in [8.3]
(1)	Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

Table 2 : Information to be submitted

Item No	Document
1	Nature, service temperature and pressure of the fluids
2	Material, external diameter and wall thickness of the pipes
3	Type of the connections between pipe lengths, including details of the weldings, where provided
4	Material, type and size of the accessories
5	Capacity, prime mover and, when requested, location of the pumps
6	For plastic pipes: • the chemical composition • the physical and mechanical characteristics in function of temperature • the characteristics of inflammability and fire resistance • the resistance to the products intended to be conveyed

1.3.3 Design temperature

The design temperature of a piping system is the maximum temperature of the medium inside the system.

1.3.4 Flammable oils

Flammable oils include fuel oils, lubricating oils, thermal oils and hydraulic oils.

1.4 Symbols and units

1.4.1 The following symbols and related units are commonly used in this Section. Additional symbols, related to some formulae indicated in this Section, are listed wherever it is necessary.

p : Design pressure, in MPa

T : Design temperature, in °C

t : Rule required minimum thickness, in mm

D : Pipe external diameter, in mm.

1.5 Class of piping systems

1.5.1 Purpose of the classes of piping systems

Piping systems are subdivided into three classes, denoted as class I, class II and class III, for the purpose of acceptance of materials, selection of joints, heat treatment, welding, pressure testing and the certification of fittings.

1.5.2 Definitions of the classes of piping systems

Classes I, II and III are defined in Tab 3.

1.6 Materials

1.6.1 General

Materials to be used in piping systems are to be suitable for the medium and the service for which the piping is intended.

Table 3 : Class of piping systems

Media conveyed by the piping system	Class I	Class II **(1)** **(4)**	Class III **(7)**
Flammable media: • heated above flashpoint, or • having flashpoint < 60°C	without special safeguards **(3)**	with special safeguards **(3)**	not applicable
Fuel oil **(8)** Lubricating oil Flammable hydraulic oil **(5)**	p > 1,6 or T > 150	other **(2)**	p ≤ 0,7 and T ≤ 60
Other media **(5)** **(6)**	p > 4 or T > 300	other **(2)**	p ≤ 1,6 and T ≤ 200

(1) Valves under static pressure on oil fuel tanks or lubricating oil tanks belong to class II.

(2) Pressure and temperature conditions other than those required for class I and class III.

(3) Safeguards for reducing leakage possibility and limiting its consequences:
e.g. pipes led in positions where leakage of internal fluids will not cause a potential hazard or damage to surrounding areas which may include the use of pipe ducts, shielding, screening etc.

(4) Valves and fittings fitted on the yacht side and collision bulkhead belong to class II. See also [10.4.3] b).

(5) Steering gear hydraulic piping system belongs to class I irrespective of p and T.

(6) Including water, air, gases, non-flammable hydraulic oil.

(7) The open ended pipes, irrespective of T, generally belong to class III (as drains, overflows, vents, exhaust gas lines, boiler escape pipes, etc.).

(8) Design pressure for fuel oil systems is to be determined in accordance with Tab 4.

Note 1: p : Design pressure, as defined in [1.3.2], in MPa.

Note 2: T : Design temperature, as defined in [1.3.3], in °C.

Note 3: Flammable media generally include the flammable liquids as oil fuel, lubricating oil and flammable hydraulic oil.

Table 4 : Definition of the design pressure for fuel oil systems

Working pressure P, in bar	Working temperature T, in °C	
	T ≤ 60	T > 60
P ≤ 7	3 bar or max. working pressure, whichever is the greater	3 bar or max. working pressure, whichever is the greater
P > 7	max. working pressure	14 bar or max. working pressure, whichever is the greater

1.6.2 Use of metallic materials

a) Metallic materials are to be used in accordance with Tab 5

b) Materials for class I and class II piping systems are to be manufactured and tested in accordance with the appropriate requirements of the Rule Note NR216 Materials and Welding

c) Materials for class III piping systems are to be manufactured and tested in accordance with the requirements of acceptable national or international standards or specifications

d) Mechanical characteristics required for metallic materials are specified in the Rule Note NR216 Materials and Welding.

1.6.3 Use of plastics

a) Plastics may be used for piping systems belonging to class III in accordance with [5] to [7]. The use of plastics for other systems or in other conditions will be given special consideration

b) Plastics intended for piping systems dealt with in this Section are to be of a type approved by the Society.

2 Design of metallic piping systems

2.1 General

2.1.1 Conditions of use

Metallic pipes are to be used in piping systems in accordance with the provisions of Tab 5.

2.2 Thickness of pressure piping

2.2.1 Calculation of the thickness of pressure pipes

a) The thickness t, in mm, of pressure pipes is to be determined by the following formula but, in any case, is not to be less than the minimum thickness given in Tab 6 to Tab 9.

$$t = \frac{t_0 + b + c}{1 - \frac{a}{100}}$$

where:

t_0 : Coefficient, in mm, equal to:

$$t_0 = \frac{p \cdot D}{2Ke + p}$$

with:

p and D : As defined in [1.4.1]

K : Permissible stress defined in [2.2.2]

e : Weld efficiency factor to be:

- equal to 1 for seamless pipes and pipes fabricated according to a welding procedure approved by the Society
- specially considered by the Society for other welded pipes, depending on the service and the manufacture procedure

b : Thickness reduction due to bending defined in [2.2.3], in mm

c : Corrosion allowance defined in [2.2.4], in mm

a : Negative manufacturing tolerance percentage:

- equal to 10 for copper and copper alloy pipes, cold drawn seamless steel pipes and steel pipes fabricated according to a welding procedure approved by the Society
- equal to 12,5 for hot laminated seamless steel pipes
- subject to special consideration by the Society in other cases

b) The thickness thus determined does not take into account the particular loads to which pipes may be subjected. Attention is to be drawn in particular to the case of high temperature and low temperature pipes.

2.2.2 Permissible stress

a) The permissible stress K is given:

- in Tab 10 for carbon and carbon-manganese steel pipes
- in Tab 11 for alloy steel pipes, and
- in Tab 12 for copper and copper alloy pipes

as a function of the temperature. Intermediate values may be obtained by interpolation.

b) Where, for carbon steel and alloy steel pipes, the value of the permissible stress K is not given in Tab 10 or Tab 11, it is to be taken equal to the lowest of the following values:

$$\frac{R_{m,20}}{2,7} \qquad \frac{R_e}{A} \qquad \frac{S_R}{A} \qquad S$$

where:

$R_{m,20}$: Minimum tensile strength of the material at ambient temperature (20°C), in N/mm²

R_e : Minimum yield strength or 0,2% proof stress at the design temperature, in N/mm²

S_R : Average stress to produce rupture in 100000 h at design temperature, in N/mm²

S : Average stress to produce 1% creep in 100000 h at design temperature, in N/mm²

A : Safety factor to be taken equal to:

- 1,6 when R_e and S_R values result from tests attended by the Society
- 1,8 otherwise

c) The permissible stress values adopted for materials other than carbon steel, alloy steel, copper and copper alloy is to be specially considered by the Society.

Table 5 : Conditions of use of metallic materials in piping systems

Material	Allowable classes	Maximum design temperature **(1)**	Particular conditions of use
Carbon and carbon-manganese steels	III, II, I	400 **(2)**	Class I and II pipes are to be seamless drawn pipes **(3)**
Copper and aluminium brass	III, II, I	200	• Not to be used in fuel oil systems, except for class III pipes of a diameter not exceeding 25 mm not passing through fuel oil tanks • Not to be used for boiler blow-down valves and pieces for connection to the shell plating **(4)**
Copper-nickel	III, II, I	300	
Special high temperature resistant bronze	III, II, I	260	
Stainless steel	III, II, I	300	Austenitic stainless steel is not to be used for sea water systems
Spheroidal graphite cast iron	III, II **(5)**	350	• Minimum elongation is not to be less than 12% on a gauge length of $5,65.S^{0,5}$, where S is the actual cross-sectional area of the test piece • Not to be used for boiler blow-down valves and pieces for connection to the shell plating
Grey cast iron	III II **(6)**	220	Grey cast iron is not to be used for the following systems: • boiler blow-down systems and other piping systems subject to shocks, high stresses and vibrations • bilge lines in tanks • parts of scuppers and sanitary discharge systems located next to the hull below the freeboard deck or for passengers ships below the bulkhead deck • yacht side valves and fittings • valves fitted on the collision bulkhead • valves fitted to fuel oil and lubricating oil tanks under static pressure head • class II fuel oil systems
Aluminium and aluminium alloys	III, II	200	Aluminium and aluminium alloys are not to be used on the following systems: • flammable oil systems • sounding and air pipes of fuel oil tanks • fire-extinguishing systems • bilge system in boiler or machinery spaces or in spaces containing fuel oil tanks or pumping units • scuppers and overboard discharges except for pipes led to the bottoms or to the shell above the freeboard deck or fitted at their upper end with closing means operated from a position above the freeboard deck

(1) Maximum design temperature is not to exceed that assigned to the class of piping.

(2) Higher temperatures may be accepted if metallurgical behaviour and time dependent strength (ultimate tensile strength after 100 000 hours) are in accordance with national or international standards or specifications and if such values are guaranteed by the steel manufacturer.

(3) Pipes fabricated by a welding procedure approved by the Society may also be used.

(4) Pipes made of copper and copper alloys are to be seamless.

(5) Use of spheroidal cast iron for class I piping systems will be given special consideration by the Society.

(6) Use of grey cast iron is not allowed when the design pressure exceeds 1,3 MPa.

Table 6 : Minimum wall thickness for copper and copper alloy pipes

External diameter, in mm	Minimum wall thickness, in mm	
	Copper	Copper alloy
8 - 10	1,0	0,8
12 - 20	1,2	1,0
25 - 44,5	1,5	1,2
50 - 76,1	2,0	1,5
88,9 - 108	2,5	2,0

Note 1: A different thickness may be considered by the Society on a case by case basis, provided that it complies with recognised standards.

2.2.3 Thickness reduction due to bending

a) Unless otherwise justified, the thickness reduction b due to bending is to be determined by the following formula:

$$b = \frac{Dt_0}{2,5\rho}$$

where:

ρ : Bending radius measured on the centre line of the pipe, in mm

D : as defined in [1.4.1]

t_0 : as defined in [2.2.1].

b) When the bending radius is not given, the thickness reduction is to be taken equal to:

$$\frac{t_0}{10}$$

c) For straight pipes, the thickness reduction is to be taken equal to 0.

Table 7 : Minimum wall thickness for steel pipes

External diameter, in mm	Minimum nominal wall thickness, in(mm			Minimum reinforced wall thickness, in mm **(2)**	Minimum extra-reinforced wall thickness, in mm **(3)**
	Pipes in general **(1)**	Vent, overflow and sounding pipes for integral tanks **(1) (5)**	Sea water pipes, bilge and ballast systems **(1) (4)**		
10,2 - 12,0	1,6	–	–	–	–
13,5 - 19,3	1,8	–	–	–	–
20,0	2,0	–	–	–	–
21,3 - 25,0	2,0	–	3,2	–	–
26,9 - 33,7	2,0	–	3,2	–	–
38,0 - 44,5	2,0	4,5	3,6	6,3	7,6
48,3	2,3	4,5	3,6	6,3	7,6
51,0 - 63,5	2,3	4,5	4,0	6,3	7,6
70,0	2,6	4,5	4,0	6,3	7,6
76,1 - 82,5	2,6	4,5	4,5	6,3	7,6
88,9 - 108,0	2,9	4,5	4,5	7,1	7,8
114,3 - 127,0	3,2	4,5	4,5	8,0	8,8
133,0 - 139,7	3,6	4,5	4,5	8,0	9,5
152,4 - 168,3	4,0	4,5	4,5	8,8	11,0

(1) Attention is drawn to the special requirements regarding:

- bilge and ballast systems
- scupper and discharge pipes
- sounding, air and overflow pipes
- ventilation systems
- CO_2 fire-extinguishing systems (see Part C, Chapter 4).

(2) Reinforced wall thickness applies to pipes passing through tanks containing a fluid distinct from that conveyed by the pipe.

(3) Extra-reinforced wall thickness applies to pipes connected to the shell.

(4) The minimum wall thickness for bilge lines and ballast lines through deep tanks is to be subject to special consideration by the Society.

(5) For sounding pipes, the minimum wall thickness is intended to apply only to the part outside the tank.

Note 1: A different thickness may be considered by the Society on a case by case basis, provided that it complies with recognised standards.

Note 2: For pipes efficiently protected against corrosion, the thickness may be reduced by an amount up to 1 mm.

Note 3: The thickness of threaded pipes is to be measured at the bottom of the thread.

Note 4: The minimum thickness listed in this table is the nominal wall thickness and no allowance is required for negative tolerance and reduction in thickness due to bending.

Note 5: Exhaust gas pipe minimum wall thickness is to be subject to special consideration by the Society.

Table 8 : Minimum wall thickness for austenitic stainless steel pipes

External diameter, in mm	Minimum wall thickness, in 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
Note 1: Diameters and thicknesses according to national or international standards may be accepted.	

Table 9 : Minimum wall thickness for aluminium and aluminium alloy pipes

External diameter, in mm	Minimum wall thickness, in mm
0 - 10	1,5
12 - 38	2,0
43 - 57	2,5
76 - 89	3,0
108 - 133	4,0
159 - 194	4,5
Note 1: A different thickness may be considered by the Society on a case by case basis, provided that it complies with recognised standards. **Note 2:** For sea water pipes, the minimum thickness is not to be less than 5 mm.	

Table 10 : Permissible stresses for carbon and carbon-manganese steel pipes

Specified minimum tensile strength, in N/mm²	Design temperature, in °C			
	≤50	100	150	200
320	107	105	99	92
360	120	117	110	103
410	136	131	124	117
460	151	146	139	132
490	160	156	148	141

Table 11 : Permissible stresses for alloy steel pipes

Type of steel	Specified minimum tensile strength, in N/mm²	Design temperature, in °C		
		≤50	100	200
1Cr1/2Mo	440	159	150	137
2 1/4Cr1Mo annealed	410	76	67	57
2 1/4Cr1Mo normalised and tempered below 750°C	490	167	163	153
2 1/4Cr1Mo normalised and tempered above 750°C	490	167	163	153
1/2Cr 1/2Mo 1/4V	460	166	162	147

Table 12 : Permissible stresses for copper and copper alloy pipes

Material (annealed)	Specified minimum tensile strength, in N/mm²	Design temperature, in °C						
		≤50	75	100	125	150	175	200
Copper	215	41	41	40	40	34	27,5	18,5
Aluminium brass	325	78	78	78	78	78	51	24,5
Copper-nickel 95/5 and 90/10	275	68	68	67	65,5	64	62	59
Copper-nickel 70/30	365	81	79	77	75	73	71	69

Table 13 : Corrosion allowance for steel pipes

Piping system	Corrosion allowance, in mm
Compressed air	1,0
Hydraulic oil	0,3
Lubricating oil	0,3
Fuel oil	1,0
Fresh water	0,8
Sea water	3,0
Note 1: For pipes passing through tanks, an additional corrosion allowance is to be considered in order to account for the external corrosion. **Note 2:** The corrosion allowance of pipes efficiently protected against corrosion may be reduced by no more than 50%. **Note 3:** When the corrosion resistance of alloy steels is adequately demonstrated, the corrosion allowance may be disregarded.	

Table 14 : Corrosion allowance for non-ferrous metal pipes

Piping material **(1)**	Corrosion allowance, in mm **(2)**
Copper	0,8
Brass	0,8
Copper-tin alloys	0,8
Copper-nickel alloys with less than 10% of Ni	0,8
Copper-nickel alloys with at least 10% of Ni	0,5
Aluminium and aluminium alloys	0,5
(1) The corrosion allowance for other materials is to be specially considered by the Society. Where their resistance to corrosion is adequately demonstrated, the corrosion allowance may be disregarded. **(2)** In cases of media with high corrosive action, a higher corrosion allowance may be required by the Society.	

2.2.4 Corrosion allowance

The values of corrosion allowance c are given for steel pipes in Tab 13 and for non-ferrous metallic pipes in Tab 14.

2.2.5 Tees

As well as complying with the provisions of [2.2.1] to [2.2.4], the thickness t_T of pipes on which a branch is welded to form a Tee is not to be less than that given by the following formula:

$$t_T = \left(1 + \frac{D_1}{D}\right) \cdot t_0$$

where:

D_1 : External diameter of the branch pipe

D : as defined in [1.4.1]

t_0 : as defined in [2.2.1].

Note 1: This requirement may be dispensed with for Tees provided with a reinforcement or extruded.

2.3 Junction of pipes

2.3.1 General

a) The junctions between metallic pipe lengths or between metallic pipe lengths and fittings are to be made by:
- direct welding (butt-weld, socket-weld)
- bolted flanges (welded-on or screwed-on)
- threaded sleeve joints, or
- mechanical joints (see [2.3.5]).

The joints are to comply with a recognised standard or to be of a design proven to be suitable for the intended purpose and acceptable to the Society. (See also [3.6]).

The expression "mechanical joints" means devices intended for direct connection of pipe lengths other than by welding, flanges or threaded joints described in [2.3.2], [2.3.3] or [2.3.4]

b) The number of joints in flammable oil piping systems is to be kept to the minimum necessary for mounting and dismantling purposes

c) The gaskets and packings used for the joints are to suit the design pressure, the design temperature and the nature of the fluids conveyed

d) The junction between plastic pipes is to comply with [5] to [7].

2.3.2 Welded metallic joints

a) Welded joints are to be used in accordance with Tab 15. Welding and non destructive testing of welds are to be carried out in accordance with [3]

b) Butt-welded joints are to be of full penetration type, with or without special provision for a high quality of root side

The expression "special provision for a high quality of root side" means that butt welds were accomplished as double welded or by use of a backing ring or inert gas back-up on first pass, or other similar methods accepted by the Society

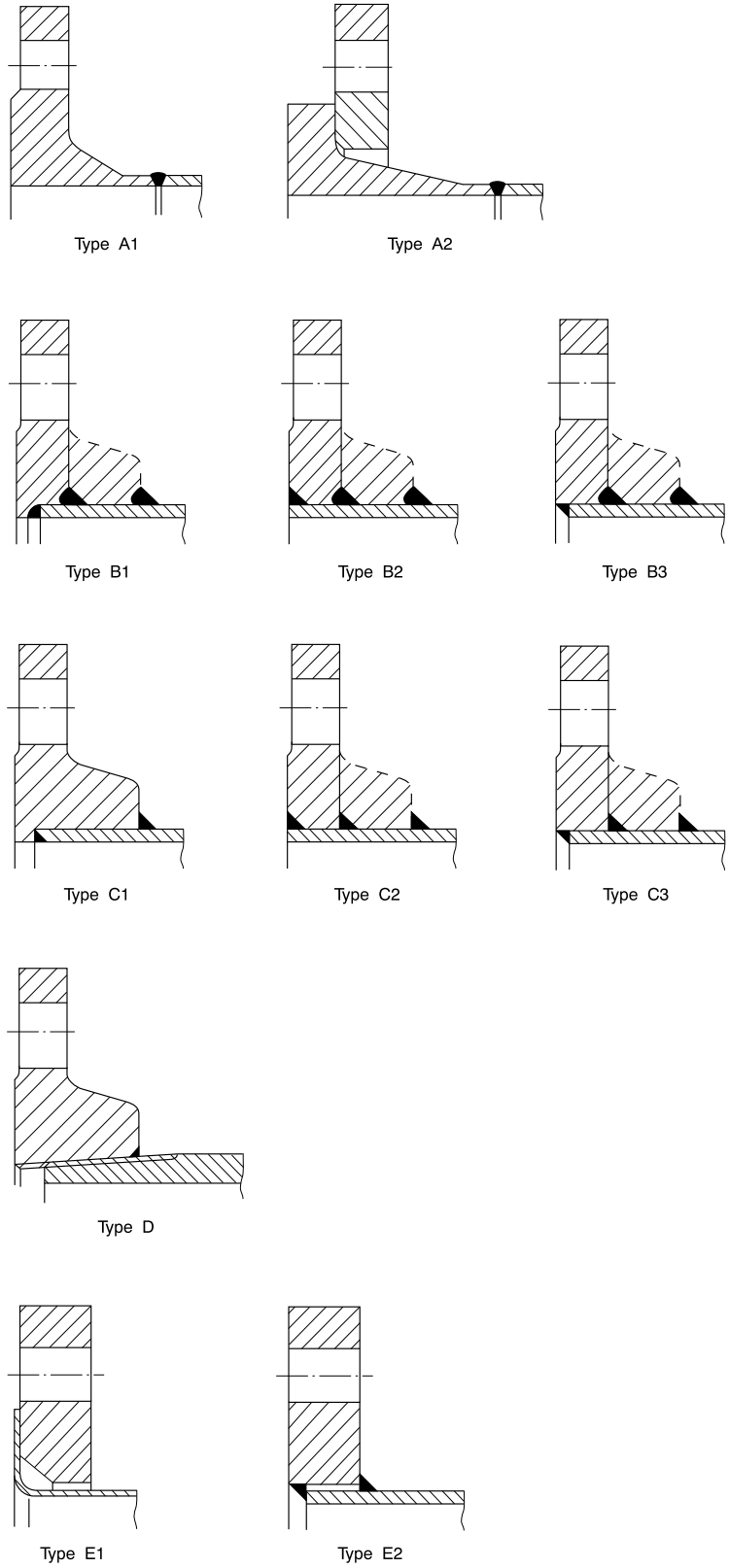
c) Slip-on sleeve and socket welded joints are to have sleeves, sockets and weldments of adequate dimensions in compliance with a standard recognised by the Society.

Table 15 : Use of welded and threaded metallic joints in piping systems

Joints	Permitted classes of piping	Restrictions of use
Butt-welded, with special provision for a high quality of root side **(1)**	III, II, I	no restrictions
Butt-welded, without special provision for a high quality of root side **(1)**	III, II	no restrictions
Slip-on sleeve and socket welded **(2)**	III	no restrictions
Threaded sleeve joints with tapered thread **(3)**	I	not allowed for: • pipes with outside diameter of more than 33,7 mm • pipes inside tanks • piping systems conveying flammable media or services where fatigue, severe erosion or crevice corrosion is expected to occur.
	III, II	not allowed for: • pipes with outside diameter of more than 60,3 mm • pipes inside tanks • piping systems conveying flammable media or services where fatigue, severe erosion or crevice corrosion is expected to occur.
Threaded sleeve joints with parallel thread **(3)**	III	not allowed for: • pipes with outside diameter of more than 60,3 mm • pipes inside tanks • piping systems conveying flammable media or services where fatigue, severe erosion or crevice corrosion is expected to occur.

(1) For expression “special provision for a high quality of root side” see [2.3.2] b).
(2) Particular cases may be allowed by the Society for piping systems of Class I and II having outside diameter ≤ 88,9 mm except for piping systems conveying toxic media or services where fatigue, severe erosion or crevice corrosion is expected to occur.
(3) In particular cases, sizes in excess of those mentioned above may be accepted by the Society if found in compliance with a recognised national and/or international standard.
Note 1: Other applications are to be specially considered by the Society.

Figure 1 : Examples of metallic flange connections



Note 1: For type D, the pipe and flange are to be screwed with a tapered thread and the diameter of the screw portion of the pipe over the thread is not to 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 is to be expanded into the flange.

Note 2: The leg length of the fillet weld, as well as the dimension of the groove penetration in the flange, is to be in general equal to 1,5 times the pipe thickness but not less than 5 mm.

Table 16 : Use of metallic flange connections in piping systems (types as shown in Fig 1)

Type of media conveyed	Class of piping (see Tab 3)		
	I	II	III
Flammable liquids (where heated above flashpoint or having flashpoint < 60°C	A1, A2, B1, B2, B3 **(1) (2)**	A1, A2, B1, B2, B3, C1, C2, C3 **(1)**	not applicable
Fuel oil Lubricating oil	A1, A2, B1, B2, B3	A1, A2, B1, B2, B3, C1, C2, C3, E2 **(4)**	A1, A2, B1, B2, B3, C1, C2, C3, E2
Other media as water, air, gases (refrigerants), non-flammable hydraulic oil, etc	A1, A2, B1, B2, B3 **(3)**	A1, A2, B1, B2, B3, C1, C2, C3, D, E2 **(4)**	A1, A2, B1, B2, B3, C1, C2, C3, D, E1, E2 **(4) (5)**

(1) When design pressure p (see [1.3.2]) exceeds 1 MPa, types A1 and A2 only.
(2) For nominal diameter ND ≥ 150 mm, types A1 and A2 only.
(3) When design temperature T (see [1.3.3] exceeds 400°C, types A1 and A2 only.
(4) Type E2 only, for design pressure p ≤ 1,6 Mpa and design temperature T ≤ 150°C.
(5) Types D and E1 only, for design temperature T ≤ 250°C.
(6) Type E1 only, for water pipelines and for open ended lines (e.g. drain, overflow, air vent piping, etc.).

2.3.3 Metallic flange connections

a) In general, the metallic flange connections used for piping systems are to be in compliance with a standard recognised by the Society

b) The material used for flanges and gaskets is to be suitable for the nature and temperature of the fluid, as well as pipes on which the flanges are to be fitted

c) The dimensions and configuration of flanges and bolts are to be chosen in accordance with recognised standard intended for design pressure and design temperature of the piping system. Otherwise, the flange connections are subject to special consideration

d) Flanges are to be attached to the pipes by welding or screwing. Examples of acceptable metallic flange connections are shown in Fig 1. However, other types of flange connections may be also considered by the Society in each particular case, provided that they are in accordance with national or international standards applicable to the piping system and recognise the boundary fluids, design pressure and temperature conditions, external or cyclic loading and location

e) Permitted applications are indicated in Tab 16.

2.3.4 Slip-on threaded joints

a) Slip-on threaded joints having pipe threads where pressure-tight joints are made on the threads with parallel or tapered threads are to comply with requirements of a recognised national or international standard and are to be acceptable to the Society

b) Slip-on threaded joints may be used for piping systems in accordance with Tab 15

c) Threaded joints may be accepted also in CO_2 piping systems, provided that they are used only inside protected spaces and in CO_2 cylinder rooms.

2.3.5 Mechanical joints

Due to the great variations in design and configuration of mechanical joints, specific recommendation regarding calculation method for theoretical strength calculations is not specified. The Type Approval is to be based on the results of testing of the actual joints.

Below specified requirements are applicable to pipe unions, compression couplings, slip-on joints as shown in Fig 2. Similar joints complying with these requirements may be acceptable.

a) Mechanical joints including pipe unions, compression couplings, slip-on joints and similar joints are to be of approved type for the service conditions and the intended application

b) Where the application of mechanical joints results in reduction in pipe wall thickness due to the use of bite type rings or other structural elements, this is to be taken into account in determining the minimum wall thickness of the pipe to withstand the design pressure

c) Construction of mechanical joints is to prevent the possibility of tightness failure affected by pressure pulsation, piping vibration, temperature variation and other similar adverse effects occurring during operation on board

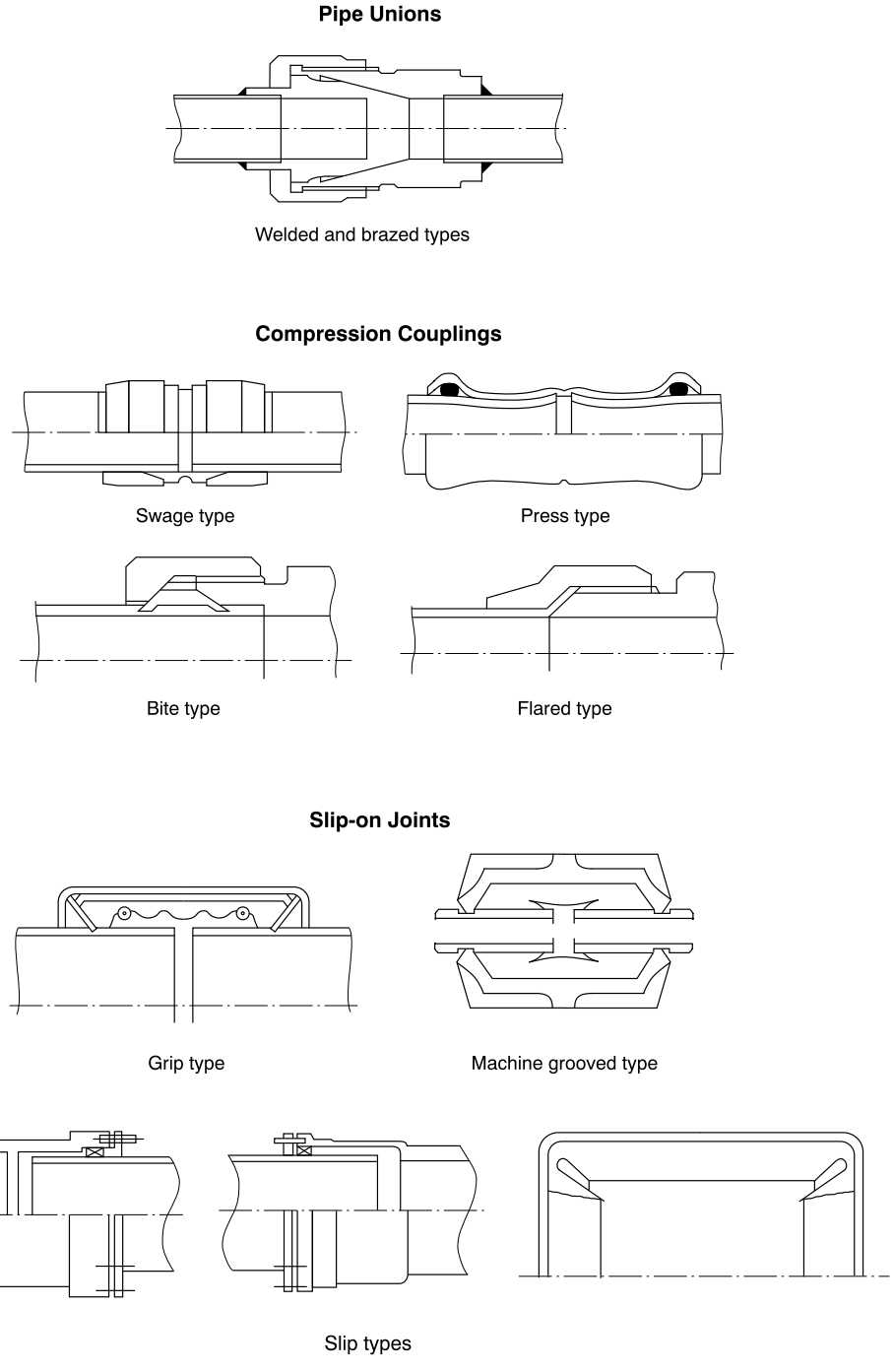
d) Material of mechanical joints is to be compatible with the piping material and internal and external media

e) As far as applicable, the mechanical joints are to be tested to a burst pressure of 4 times the design pressure. For design pressures above 200 bar the required burst pressure is to be specially considered by the Society

f) In general, mechanical joints are to be of fire resistant type as required by Tab 17

g) Mechanical joints, which in the event of damage could cause fire or flooding, are not to be used in piping sections directly connected to the shell openings or tanks containing flammable fluids

Figure 2 : Examples of mechanical joints



h) The mechanical joints are to be designed to withstand internal and external pressure as applicable and, where used in suction lines, are to be capable of operating under vacuum

i) The number of mechanical joints in flammable liquid systems is to be kept to a minimum. In general, flanged joints conforming to recognised standards are to be used

j) Piping in which a mechanical joint is fitted is to be adequately adjusted, aligned and supported. Supports or hangers are not to be used to force alignment of piping at the point of connection

k) Slip-on joints are not to be used in pipelines in cargo holds, tanks, and other spaces which are not easily accessible, unless approved by the Society. Application of these joints inside tanks may be permitted only for the same media that is in the tanks. Unrestrained slip-on joints are to be used only in cases where compensation of lateral pipe deformation is necessary. Usage of these joints as the main means of pipe connection is not permitted

l) Application of mechanical joints and their acceptable use for each service is indicated in Tab 17; dependence upon the class of piping, pipe dimensions, working pressure and temperature is indicated in Tab 18

m) In some particular cases, sizes in excess of those mentioned above may be accepted by the Society if they are in compliance with a recognised national and/or international standard

n) Application of various mechanical joints may be accepted as indicated by Tab 17. However, in all cases, acceptance of the joint type is to be subject to approval for the intended application, and subject to conditions of the approval and applicable Rules

o) Mechanical joints are to be tested in accordance with a program approved by the Society, which is to include at least the following:

1) leakage test
2) vacuum test (where necessary)
3) vibration (fatigue) test
4) fire endurance test (where necessary)
5) burst pressure test
6) pressure pulsation test (where necessary)
7) assembly test (where necessary)
8) pull out test (where necessary).

Table 17 : Application of mechanical joints

Systems		Kind of connections		
		Pipe unions	Compression couplings **(6)**	Slip-on joints
Flammable fluids (flash point ≤ 60°C)				
1	Vent lines	+	+	+ **(3)**
Flammable fluids (flash point > 60°C)				
2	Fuel oil lines	+	+	+ **(2) (3)**
3	Lubricating oil lines	+	+	+ **(2) (3)**
4	Hydraulic oil	+	+	+ **(2) (3)**
Sea water				
5	Bilge lines	+	+	+ **(1)**
6	Fire main and water spray	+	+	+ **(3)**
7	Foam system	+	+	+ **(3)**
8	Sprinkler system	+	+	+ **(3)**
9	Ballast system	+	+	+ **(1)**
10	Cooling water system	+	+	+ **(1)**
11	Non-essential systems	+	+	+
Fresh water				
12	Cooling water system	+	+	+ **(1)**
13	Condensate return	+	+	+ **(1)**
14	Non-essential systems	+	+	+
Sanitary/Drains/Scuppers				
15	Deck drains (internal)	+	+	+ **(4)**
16	Sanitary drains	+	+	+
17	Scuppers and discharge (overboard)	+	+	–
Sounding/Vent				
18	Water tanks/Dry spaces	+	+	+
19	Oil tanks (flash point > 60°C)	+	+	+ **(2) (3)**
Miscellaneous				
20	Starting/Control air **(1)**	+	+	–
21	Service air (non-essential)	+	+	+
23	CO_2 system **(1)**	+	+	–

Note 1:

\+ : Application is allowed

– : Application is not allowed.

(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 are to be of approved fire resistant type as required for Slip-on joints.

Table 18 : 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 types	+ (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	–	+	+

Note 1:
+ : Application is allowed
– : Application is not allowed.

3 Welding of steel piping

3.1 Application

3.1.1

a) The following requirements apply to welded joints belonging to class I or II piping systems

They may also be applied to class III piping systems, at the discretion of the Society

b) The requirements for qualification of welding procedures are given in the Rule Note NR216 Materials and Welding.

3.2 General

3.2.1 Welding processes

a) Welded joints of pipes are to be made by means of electric arc or oxyacetylene welding, or any other previously approved process

b) When the design pressure exceeds 0,7 MPa, oxyacetylene welding is not permitted for pipes with an external diameter greater than 100 mm or a thickness exceeding 6 mm.

3.2.2 Location of joints

The location of welded joints is to be such that as many as possible can be made in a workshop. The location of welded joints to be made on board is to be so determined as to permit their joining and inspection in satisfactory conditions.

3.3 Design of welded joints

3.3.1 Types of joints

a) Except for the fixing of flanges on pipes in the cases mentioned in Fig 1 and for the fixing of branch pipes, joints between pipes and between pipes and fittings are to be of the butt-welded type. However, for class I pipes with an internal diameter not exceeding 50 mm and for class II pipes, socket welded connections of approved types may be used

b) For butt-welded joints between pipes or between pipes and flanges or other fittings, correctly adjusted backing rings may be used; such rings are to be either of the same grade of steel as the elements to be welded or of such a grade as not to adversely influence the weld; if the backing ring cannot be removed after welding, it is to be correctly profiled.

3.3.2 Assembly of pipes of unequal thickness

If the difference of thickness between pipes to be butt-welded exceeds 10% of the thickness of the thinner pipe plus 1 mm, subject to a maximum of 4 mm, the thicker pipe is to be thinned down to the thickness of the thinner pipe on a length at least equal to 4 times the offset, including the width of the weld if so desired.

3.3.3 Accessories

a) When accessories such as valves are connected by welding to pipes, they are to be provided with necks of sufficient length to prevent abnormal deformations during the execution of welding or heat treatment

b) For the fixing by welding of branch pipes on pipes, it is necessary to provide either a thickness increase as indicated in [2.2.5] or a reinforcement by doubling plate or equivalent.

3.4 Preparation of elements to be welded and execution of welding

3.4.1 General

The provisions of Part C, Ch 1, Sec 3 of the Rules for Steel Ship apply to the welding of pressure pipes.

3.4.2 Edge preparation for welded joints

The preparation of the edges is preferably to be carried out by mechanical means. When flame cutting is used, care is to be taken to remove the oxide scales and any notch due to irregular cutting by matching, grinding or chipping back to sound metal.

3.4.3 Abutting of parts to be welded

a) The elements to be welded are to be so abutted that surface misalignments are as small as possible

b) As a general rule, for elements which are butt-welded without a backing ring the misalignment between internal walls is not to exceed the lesser of:

- the value given in Tab 19 as a function of thickness t and internal diameter d of these elements, and
- t/4

Where necessary, the pipe ends are to be bored or slightly expanded so as to comply with these values; the thickness obtained is not to be less than the Rule thickness

c) In the case of welding with a backing ring, smaller values of misalignment are to be obtained so that the space between the backing ring and the internal walls of the two elements to be assembled is as small as possible; normally this space is not to exceed 0,5 mm

d) The elements to be welded are to be adequately secured so as to prevent modifications of their relative position and deformations during welding.

Table 19 : Maximum value of misalignment

d, in mm	t, in mm		
	$t \le 6$	$6 < t \le 10$	$10 < t$
$d < 150$	1,0	1,0	1,0
$150 \le d < 300$	1,0	1,5	1,5
$300 \le d$	1,0	1,5	2,0

3.4.4 Protection against adverse weather conditions

a) Pressure pipes are to be welded, both on board and in the shop, away from draughts and sudden temperature variations

b) Unless special justification is given, no welding is to be performed if the temperature of the base metal is lower than 0°C.

3.4.5 Preheating

a) Preheating is to be performed as indicated in Tab 20, depending on the type of steel, the chemical composition and the pipe thickness

b) The temperatures given in Tab 20 are based on the use of low hydrogen processes. Where low hydrogen processes are not used, the Society reserves the right to require higher preheating temperatures.

Table 20 : Preheating temperature

Type of steel		Thickness of thicker part, in mm	Minimum preheating temperature, in °C
C and C-Mn steels	$C + \frac{Mn}{6} \le 0,40$	$t \ge 20$ **(2)**	50
	$C + \frac{Mn}{6} > 0,40$	$t \ge 20$ **(2)**	100
0,3 Mo		$t \ge 13$ **(2)**	100
1 Cr 0,5 Mo		$t < 13$	100
		$t \ge 13$	150
2,25 Cr 1 Mo **(1)**		$t < 13$	150
		$t \ge 13$	200
0,5 Cr 0,5 Mo V **(1)**		$t < 13$	150
		$t \ge 13$	200

(1) For 2,25 Cr 1 Mo and 0,5 Cr 0,5 Mo V grades with thicknesses up to 6 mm, preheating may be omitted if the results of hardness tests carried out on welding procedure qualification are considered acceptable by the Society.

(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.

3.5 Post-weld heat treatment

3.5.1 General

a) As far as practicable, the heat treatment is to be carried out in a furnace. Where this is impracticable, and more particularly in the case of welding on board, the treatment is to be performed locally by heating uniformly a circular strip, extending on at least 75 mm on both sides of the welded joint; all precautions are to be taken to permit accurate checking of the temperature and slow cooling after treatment

b) For austenitic and austenitic ferritic steels, post-weld head treatment is generally not required.

3.5.2 Heat treatment after welding other than oxyacetylene welding

a) Stress relieving heat treatment after welding other than oxyacetylene welding is to be performed as indicated in Tab 21, depending on the type of steel and thickness of the pipes.

b) The stress relieving heat treatment is to consist in heating slowly and uniformly to a temperature within the range indicated in Tab 21, soaking at this temperature for a suitable period, normally one hour per 25 mm of thickness with a minimum of half an hour, cooling slowly and uniformly in the furnace to a temperature not exceeding 400°C and subsequently cooling in still atmosphere.

c) In any event, the heat treatment temperature is not to be higher than $(T_T - 20)$°C, where T_T is the temperature of the final tempering treatment of the material

Table 21 : Heat treatment temperature

Type of steel	Thickness of thicker part, in mm	Stress relief treatment temperature, in °C
C and C-Mn steels	t ≥ 15 **(1) (3)**	550 to 620
0,3 Mo	t ≥ 15 **(1)**	580 to 640
1 Cr 0,5 Mo	t ≥ 8	620 to 680
2,25 Cr 1 Mo 0,5 Cr 0,5 Mo V	any **(2)**	650 to 720

(1) Where steels with specified Charpy V notch impact properties at low temperature are used, the thickness above which post-weld heat treatment is to be applied may be increased, subject to the special agreement of the Society.

(2) For 2,25Cr 1Mo and 0,5Cr 0,5Mo V grade steels, heat treatment may be omitted for pipes having thickness lower than 8 mm, diameter not exceeding 100 mm and service temperature not exceeding 450°C.

(3) For C and C-Mn steels, stress relieving heat treatment may be omitted up to 30 mm thickness, subject to the special agreement of the Society.

3.5.3 Heat treatment after oxyacetylene welding

Stress relieving heat treatment after oxyacetylene welding is to be performed as indicated in Tab 22, depending on the type of steel.

Table 22 : Heat treatment after oxyacetylene welding

Type of steel	Heat treatment and temperature, in °C
C and C-Mn	Normalising 880 to 940
0,3 Mo	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

3.6 Inspection of welded joints

3.6.1 General

a) The inspection of pressure pipe welded joints is to be performed at the various stages of the fabrication further to the qualifications defined in [3.1.1], item c)

b) The examination mainly concerns those parts to be welded further to their preparation, the welded joints once they have been made and the conditions for carrying out possible heat treatments

c) The required examinations are to be carried out by qualified operators in accordance with procedures and techniques to the Surveyor's satisfaction.

3.6.2 Visual examination

Welded joints, including the inside wherever possible, are to be visually examined.

3.6.3 Non-destructive examinations

a) Non-destructive tests for class I pipes are to be performed as follows:

- butt-welded joints of pipes with an external diameter exceeding 75 mm are to be subjected to full X-ray examination or equivalent
- welded joints other than butt-welded joints and which cannot be radiographed are to be examined by magnetic particle or liquid penetrant tests
- fillet welds of flange connections are to be examined by magnetic particle tests or by other appropriate non-destructive tests.

b) Non-destructive tests for class II pipes are to be performed as follows:

- butt-welded joints of pipes with an external diameter exceeding 100 mm are to be subjected to at least 10% random radiographic examination or equivalent
- welded joints other than butt-welded joints are to be examined by magnetic particle tests or by other appropriate non-destructive tests
- fillet welds of flange connections may be required to be examined by magnetic particle tests or by other appropriate non-destructive tests, at the discretion of the Surveyor.

3.6.4 Defects and acceptance criteria

a) Joints for which non-destructive examinations reveal unacceptable defects are to be re-welded and subsequently to undergo a new non-destructive examination. The Surveyor may require that the number of joints to be subjected to non-destructive examination is larger than that resulting from the provisions of [3.6.3]

b) The acceptance criteria of defects are:

- for class I pipes, those defined in the Rule Note NR216 Materials and Welding for the special quality level
- for class II pipes, those defined in the Rule Note NR216 Materials and Welding for the normal quality level.

4 Bending of steel pipes

4.1 Application

4.1.1 This Article applies to pipes made of:

- alloy or non-alloy steels
- copper and copper alloys.

4.2 Bending process

4.2.1 General

The bending process is to be such as not to have a detrimental influence on the characteristics of the materials or on the strength of the pipes.

4.2.2 Bending radius

Unless otherwise justified, the bending radius measured on the centreline of the pipe is not to be less than:

- twice the external diameter for copper and copper alloy pipes
- 3 times the external diameter for cold bent steel pipes.

4.2.3 Acceptance criteria

a) The pipes are to be bent in such a way that, in each transverse section, the difference between the maximum and minimum diameters after bending does not exceed 10% of the mean diameter; higher values, but not exceeding 15%, may be allowed in the case of pipes which are not subjected in service to appreciable bending stresses due to thermal expansion or contraction

b) The bending is to be such that the depth of the corrugations is as small as possible and does not exceed 5% of their length.

4.2.4 Hot bending

a) In the case of hot bending, all arrangements are to be made to permit careful checking of the metal temperature and to prevent rapid cooling, especially for alloy steels

b) Hot bending is to be generally carried out in the temperature range 850°C-1000°C for all steel grades; however, a decreased temperature down to 750°C may be accepted during the forming process.

4.3 Heat treatment after bending

4.3.1 Copper and copper alloy

Copper and copper alloy pipes are to be suitably annealed after cold bending if their external diameter exceeds 50 mm.

4.3.2 Steel

a) After hot bending carried out within the temperature range specified in [4.2.4], the following applies:
   - for C, C-Mn and C-Mo steels, no subsequent heat treatment is required
   - for Cr-Mo and C-Mo-V steels, a subsequent stress relieving heat treatment in accordance with Tab 21 is required

b) After hot bending performed outside the temperature range specified in [4.2.4], a subsequent new heat treatment in accordance with Tab 22 is required for all grades

c) After cold bending at a radius lower than 4 times the external diameter of the pipe, a heat treatment in accordance with Tab 22 is required.

5 Design of plastic piping systems

5.1 General

5.1.1 Application

These requirements are applicable to all piping systems with parts made of rigid plastic.

5.1.2 Use of plastic pipes

Plastic may be used in piping systems in accordance with the provisions of [1.6.3], provided that the plastic pipes are of an approved type by the Society and that the requirements of the present [5] to [7] are complied with.

5.1.3 Specification

The specification of the plastic piping is to be submitted in accordance with the provisions of [1.2.2] (refer to Tab 2 item 6). It is to comply with a recognised national or international standard approved by the Society. In addition, the requirements stated below are to be complied with.

5.1.4 Marking

Plastic pipes and fittings are to be permanently marked with identification, including:

- pressure ratings
- the design standards that the pipe or fitting is manufactured in accordance with
- the material of which the pipe or fitting is made.

5.2 Definitions

5.2.1 Plastic

Plastic includes both thermoplastic and thermosetting plastic materials with or without reinforcement, such as PVC and FRP (reinforced plastics pipes).

5.2.2 Piping systems

Piping systems include the pipes, fittings, joints, and any internal or external liners, coverings and coatings required to comply with the performance criteria.

5.2.3 Joints

Joints include all pipe assembling devices or methods, such as adhesive bonding, laminating, welding, etc.

5.2.4 Fittings

Fittings include bends, elbows, fabricated branch pieces, etc. made of plastic materials.

5.2.5 Nominal pressure

Nominal pressure is the maximum permissible working pressure which is to be determined in accordance with [5.3.3].

5.2.6 Fire endurance

Fire endurance is the capability of the piping system to perform its intended function, i.e. maintain its strength and integrity, for some predicted period of time while exposed to fire.

5.3 Strength

5.3.1 General

a) The piping is to have sufficient strength to take account of the most severe concomitant conditions of pressure, temperature, the weight of the piping itself and any static and dynamic loads imposed by the design or environment

b) The strength of the pipes is to be determined at the maximum possible working temperature by the tests mentioned in [7.1.2].

5.3.2 Pipe thickness

Plastic pipes thickness is to be calculated using a maximum allowable stress not higher than 1/7 of the ultimate tensile strength of the material at the service temperature.

5.3.3 Permissible pressure

Piping systems are to be designed for a nominal pressure determined from the following conditions:

a) Internal pressure

The nominal internal pressure is not to exceed the smaller of:

- P_{sth} / 4
- P_{lth} / 2,5

where:

P_{sth} : Short-term hydrostatic test failure pressure, in MPa

P_{lth} : Long-term hydrostatic test failure pressure (>100 000 hours), in MPa.

b) External pressure (to be considered for any installation subject to vacuum conditions inside the pipe or a head of liquid acting on the outside of the pipe)

The nominal external pressure is not to exceed P_{col} / 3, where:

P_{col} : Collapse pressure

Note 1: The external pressure is the sum of the vacuum inside the pipe and the static pressure head outside the pipe.

c) The collapse pressure is not to be less than 0,3 MPa.

5.3.4 Permissible temperature

a) In general, plastic pipes are not to be used for media with a temperature above 60°C or below 0°C, unless satisfactory justification is provided to the Society

b) The permissible working temperature range depends on the working pressure and is to be justified by appropriate tests

c) The maximum permissible working temperature is to be at least 20°C lower than the minimum heat distortion temperature of the pipe material, determined according to ISO 75 method A or equivalent

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

5.3.5 Axial strength

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

b) In the case of fibre reinforced plastic pipes, the sum of the longitudinal stresses is not to exceed half of the nominal circumferential stress derived from the nominal internal pressure condition (see [5.3.3]).

5.3.6 Impact resistance

Plastic pipes and joints are to have a minimum resistance to impact in accordance with a recognised national or international standard.

5.4 Requirements depending on service and/or location

5.4.1 Fire endurance

The requirements for fire endurance of plastic pipes and their associated fittings are given in Tab 23 for the various systems and locations where the pipes are used.

Specifically:

- a 60 min fire endurance test in dry conditions is to be carried out according to Appendix 1 of IMO Res. A.753(18), where indicated "L1" in Tab 23
- a 30 min fire endurance test in dry conditions is to be carried out according to Appendix 1 of IMO Res. A.753(18), where indicated "L2" in Tab 23
- a 30 min fire endurance test in wet conditions is to be carried out according to Appendix 1 of IMO Res. A.753(18), where indicated "L3" in Tab 23
- no fire endurance test is required, where indicated "0" in Tab 23
- a metallic material with a melting point greater than 925°C is to be used, where indicated "X" in Tab 23.

Note 1: "NA" means "not applicable".

5.4.2 Flame spread

a) All pipes, except those fitted on open decks and within tanks, cofferdams, pipe tunnels and ducts, are to have low spread characteristics not exceeding average values listed in IMO Resolution A.653(16). Other recognised national standards may also be referred to

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

5.4.3 Fire protection coating

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

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

Table 23 : Fire endurance of piping systems

PIPING SYSTEM	LOCATION							
	Machinery spaces of category A **(6)**	Other machinery spaces and pump rooms **(7)**	Vehicle spaces **(8)**	Fuel oil tanks **(9)**	Ballast water tanks **(10)**	Cofferdams, void spaces, pipe tunnels and ducts **(11)**	Accommodation, service and control spaces **(12)**	Open decks
FLAMMABLE LIQUIDS (FLASH POINT > 60°C)								
Fuel oil	X	X	X	0	0	0	L1	L1
Lubricating oil	X	X	X	NA	NA	0	L1	L1
Hydraulic oil	X	X	X	0	0	0	L1	L1
SEA WATER								
Bilge main and branches	L1 **(4)**	L1 **(4)**	X	0	0	0	NA	L1
Fire main and water spray	L1	L1	X	NA	0	0	X	L1
Foam system	L1	L1	NA	NA	NA	0	L1	L1
Sprinkler system	L1	L1	X	NA	0	0	L3	L3
Ballast	L3	L3	L3	0	0	0	L2	L2
Cooling water, essential services	L3	L3	NA	NA	0	0	NA	L2
Non-essential systems	0	0	0	0	0	0	0	0
FRESH WATER								
Cooling water, essential services	L3	L3	NA	0	0	0	L3	L3
Non-essential systems	0	0	0	0	0	0	0	0
SANITARY, DRAINS, SCUPPERS								
Deck drains (internal)	L1 **(2)**	L1 **(2)**	L1 **(2)**	0	0	0	0	0
Sanitary drains (internal)	0	0	0	0	0	0	0	0
Scuppers and discharges (over-board)	0 **(1) (5)**	0 **(1) (5)**	0 **(1) (5)**	0	0	0	0 **(1) (5)**	0
SOUNDING, AIR								
Water tanks, dry spaces	0	0	0	0	0	0	0	0
Oil tanks (flash point > 60°C)	X	X	X	0	0 **(9)**	0	X	X
MISCELLANEOUS								
Control air	L1 **(3)**	L1 **(3)**	L1 **(3)**	0	0	0	L1 **(3)**	L1 **(3)**
Service air (non-essential)	0	0	0	0	0	0	0	0

(1) Where non-metallic piping is used, remote controlled valves to be provided at yacht side (valve is to be controlled from outside space).

(2) For drains serving only the space concerned, "0" may replace "L1".

(3) When controlling functions are not required by the Rules, "0" may replace "L1".

(4) On Yacht or Charter Yachts carrying more than 12 passengers "X" is to replace "L1".

(5) Scuppers serving open decks in positions 1 and 2, as defined in Pt B, Ch 2, Sec 2, are to be "X" throughout unless fitted at the upper end with a means of closing capable of being operated from a position above the freeboard deck in order to prevent downflooding.

(6) Machinery spaces of category A are defined in Ch 1, Sec 1, [1.4.3].

(7) Spaces, other than category A machinery spaces, containing propulsion machinery, internal combustion engines, generators and major electrical machinery, pumps, oil filling stations, refrigerating, stabilising, ventilation and air-conditioning machinery, and similar spaces, and trunks to such spaces.

(8) Vehicle spaces are defined in Ch 4, Sec 9.

(9) All spaces used for fuel oil and trunks to such spaces.

(10) All spaces used for ballast water and trunks to such spaces.

(11) Empty spaces between two bulkheads separating two adjacent compartments.

(12) Accommodation spaces, service spaces and control stations are defined in Ch 4, Sec 1, [3.4].

5.4.4 Electrical conductivity

a) Piping systems conveying fluids with a conductivity less than 1000 pS/m (1pS/m=10^{-9} siemens per meter), such as refined products and distillates, are to be made of conductive pipes

b) Regardless of the fluid to be conveyed, plastic pipes passing through hazardous areas are to be electrically conductive

c) Where electrical conductivity is to be ensured, the resistance of the pipes and fittings is not to exceed:

1×10^5 Ohm/m

d) Where pipes and fittings are not homogeneously conductive, conductive layers are to be provided, suitably protected against the possibility of spark damage to the pipe wall.

5.5 Pipe and fitting connections

5.5.1 General

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

b) Pipes and fittings may be assembled using adhesive-bonded, welded, flanged or other joints

c) When used for joint assembly, adhesives are to be suitable for providing a permanent seal between the pipes and fittings throughout the temperature and pressure range of the intended application

d) Tightening of joints, where required, is to be performed in accordance with the manufacturer's instructions

e) Procedures adopted for pipe and fitting connections are to be submitted to the Society for approval, prior to commencing the work.

5.5.2 Bonding of pipes and fittings

a) The procedure for making bonds is to be submitted to the Society for qualification. It is to include the following:

- materials used
- tools and fixtures
- joint preparation requirements
- cure temperature
- dimensional requirements and tolerances
- acceptance criteria for the test of the completed assembly

b) When a change in the bonding procedure may affect the physical and mechanical properties of the joints, the procedure is to be requalified.

6 Arrangement and installation of plastic pipes

6.1 Arrangement and installation of plastic pipes

6.1.1 General

Plastic pipes and fittings are to be installed by the Shipyard in accordance with the Manufacturer's guidelines and taking account of the following provisions, as deemed necessary.

6.1.2 Supporting of pipes

a) Selection and spacing of pipe supports in shipboard systems are to be determined as a function of allowable stresses and maximum deflection criteria

b) The selection and spacing of pipe supports are to take into account the following data:

- pipe dimensions
- mechanical and physical properties of the pipe material
- mass of pipe and contained fluid
- external pressure
- operating temperature
- thermal expansion effects
- load due to external forces
- thrust forces
- water hammer
- vibrations
- maximum accelerations to which the system may be subjected

Combinations of loads are also to be considered

c) Support spacing is not to be greater than the pipe manufacturer's recommended spacing

d) Each support is to evenly distribute the load of the pipe and its content over the full width of the support. Measures are to be taken to minimise wear of the pipes where they are in contact with the supports

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

6.1.3 Provisions for expansion

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

- the high difference in the coefficients of thermal expansion
- deformations of the yacht's structure

b) Calculations of the thermal expansions are to take into account the system working temperature and the temperature at which the assembly is performed.

6.1.4 Provisions of mechanical damage

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

b) Pipes are to be protected from mechanical damage where necessary.

6.1.5 Earthing

a) Where, in pursuance of [5.4.4], pipes are required to be electrically conductive, the resistance to earth from any point in the piping system is not to exceed 1×10^6 Ω

b) Where provided, earthing wires are to be accessible for inspection.

6.1.6 Penetration of fire divisions and watertight bulkheads or decks

a) Where plastic pipes pass through "A" or "B" class divisions, arrangements are to be made to ensure that fire endurance is not impaired. These arrangements are to be tested in accordance with 'Recommendations for Fire Test Procedures for "A", "B" and "F" Bulkheads' (IMO Resolution A754 (18) as amended)

b) When plastic pipes pass through watertight bulkheads or decks, the watertight integrity of the bulkhead or deck is to be maintained. If the bulkhead or deck is also a fire division and destruction by fire of plastic pipes may cause the inflow of liquid from tanks, a metallic shut-off valve operable from above the freeboard deck is to be fitted at the bulkhead or deck.

6.2 Systems connected to the hull

6.2.1 Bilge and sea water systems

a) Where, in pursuance of [5.4.1], plastic pipes are permitted in bilge and sea water systems, the yacht side valves required in [8.4] and, where provided, the connecting pipes to the shell are to be made of metal in accordance with [1.6]

b) Yacht side valves are to be provided with remote control from outside the space concerned. (See Tab 23, note (1)).

6.2.2 Scuppers and sanitary discharges

a) Where, in pursuance of [5.4.1], plastic pipes are permitted in scuppers and sanitary discharge systems connected to the shell, their upper end is to be fitted with closing means operated from a position above the freeboard deck in order to prevent downflooding. See Tab 23, notes (1) and (5)

b) Discharge valves are to be provided with remote control from outside the space concerned.

6.3 Application of fire protection coatings

6.3.1 Where necessary for the required fire endurance as stated in [5.4.3], fire protection coatings are to be applied on the joints, after performing hydrostatic pressure tests of the piping system.

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

7 Certification, inspection and testing of plastic pipes

7.1 Certification

7.1.1 Type approval

Plastic pipes and fittings are to be of a type approved by the Society for the intended use. For this purpose, the material tests required in [7.1.2] and, where applicable, the bonding qualification test detailed in [7.1.3] are to be performed.

7.1.2 Material tests

a) Tests are to be performed according to a procedure approved by the Society to determine, for each type of pipe and fitting, the following characteristics:

- ultimate tensile strength
- short-term and long-term design strength
- collapse
- impact resistance
- fire endurance
- low flame spread characteristics
- electrical resistance (for electrically conductive pipes)

For the above tests, representative samples of pipes and fittings are to be selected to the satisfaction of the Society

b) The ultimate tensile strength is to be determined by means of a hydrostatic test on pipe samples subjected to increasing pressure up to failure, the pressure being increased at such a rate that failure occurs in not less than 5 minutes. Such test is to be carried out under the standard conditions: atmospheric pressure equal to 100kPa, relative humidity 30%, environmental and carried fluid temperature 298 K (25°C)

The ultimate tensile strength is to be determined using the tangential stress based on the initial diameter of the pipe. Small deformations of the pipe sample during the test may be accepted

c) Alternatively, hydrostatic test failure pressure and collapse pressure may be determined by a combination of tests and calculations, subject to the agreement of the Society

d) After the impact resistance test, the specimen is to be subjected to hydrostatic pressure equal to 2,5 times the design pressure for at least 1 hour.

7.1.3 Bonding qualification test

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

b) When the test assembly has been cured, it is to be subjected to a hydrostatic test pressure at a safety factor of 2,5 times the design pressure of the test assembly, for not less than one hour. No leakage or separation of joints is allowed. The test is to be conducted so that the joint is loaded in both longitudinal and circumferential directions

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

- when the largest size to be joined is 200 mm nominal outside diameter or smaller, the test assembly is to be the largest piping size to be joined
- when the largest size to be joined is greater than 200 mm nominal outside diameter, the size of the test assembly is to be either 200 mm or 25% of the largest piping size to be joined, whichever is the greater.

7.2 Workshop tests

7.2.1 Each pipe and fitting is to be tested by the manufacturer at a hydrostatic pressure not less than 1,5 times the nominal pressure.

7.3 Testing after installation on board

7.3.1 Hydrostatic testing

a) Piping systems for essential systems are to be subjected to a test pressure of not less than 1,5 times the design pressure or 0,4 MPa, whichever is the greater

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

7.3.2 Earthing test

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

8 General requirements

8.1 Protection against overpressure

8.1.1 General

a) These requirements deal with the protection of piping systems against overpressure, with the exception of heat exchangers and pressure vessels, which are dealt with in Part C, Ch 1, Sec 3 of the Rules for Steel Ships

b) Safety valves are to be sealed after setting.

8.1.2 Protection of flammable oil systems

Provisions are to be made to prevent overpressure in any flammable oil tank or in any part of the flammable oil systems, including the filling pipes.

8.1.3 Protection of pump and compressor discharges

a) Provisions are to be made so that the discharge pressure of pumps and compressors cannot exceed the pressure for which the pipes located on the discharge of these pumps and compressors are designed

b) When provided on the pump discharge for this purpose, safety valves are to lead back to the pump suction or to any other suitable place

c) The discharge capacity of the safety valves installed on pumps and compressors is to be such that the pressure at the discharge side cannot exceed by more than 10% the design pressure of the discharge pipe in the event of operation with closed discharge.

8.1.4 Protection of pipes

a) Pipes likely to be subjected to a pressure exceeding their normal working pressure are to be provided with safety valves or equivalent overpressure protecting devices

b) In particular, pipes located on the low pressure side of pressure reducing valves are to be provided with safety valves unless they are designed for the maximum pressure on the high pressure side of the pressure reducing valve. See also [1.3.2] and [8.5.1]

c) The discharge capacity of the devices fitted on pipes for preventing overpressure is to be such that the pressure in these pipes cannot exceed the design pressure by more than 10%.

8.2 Flexible hoses and expansion joints

8.2.1 General

a) The Society may permit the use of flexible hoses and expansion joints, both in metallic and non-metallic materials, provided they are approved for the intended service

b) Flexible hoses and expansion joints are to be of a type approved by the Society, designed in accordance with [8.2.3] and tested in accordance with [10.2.1]

c) Flexible hoses and expansion joints are to be installed in accordance with the requirements stated in [9.9.2]

d) Flexible hoses and expansion joints intended for piping systems with a design temperature below the ambient temperature will be given special consideration by the Society.

8.2.2 Documentation

The information, drawings and documentation listed in [1.2.1] and [1.2.2] are to be submitted to the Society for each type of flexible hose or expansion joint intended to be used.

8.2.3 Design of flexible hoses and expansion joints

a) Flexible pipes and expansion joints are to be made of materials resistant to the marine environment and to the fluid they are to convey. Metallic materials are to comply with [1.6]

b) Flexible pipes and expansion joints are to be designed so as to withstand:
- external contact with hydrocarbons
- internal pressure
- vibrations
- pressure impulses

c) Flexible pipes intended to convey fuel oil or lubricating oil and end attachments are to be of fire-resisting materials of adequate strength and are to be constructed to the satisfaction of the Society

Where a protective lining is provided for this purpose, it is to be impervious to hydrocarbons and to hydrocarbon vapours

d) Flexible pipes intended to convey:
- gaseous fluid at a pressure higher than 1 MPa
- fuel oil or lubricating oil

are to be fitted with a metallic braid

e) As a general rule, flexible hoses are to be fitted with crimped connections or equivalent. For pipes subject to a pressure not exceeding 0,5 MPa, as well as for scavenge air and supercharge air lines of internal combustion engines, clips made of galvanised steel or corrosion-resistant material with thickness not less than 0,4 mm may be used

For flexible piping of 25 mm diameter and above not less than two clips are to be fitted at each end

f) Flexible pipes and expansion joints are to be so designed that their bursting pressure at the service temperature is not less than 4 times their maximum service pressure, with a minimum of 2 MPa. Exemptions from this requirement may be granted for expansion joints of large diameter used on sea water lines

g) The junctions of flexible hoses and expansion joints to their couplings are to withstand a pressure at least equal to the bursting pressure defined in f)

h) Where necessary, non-metallic pipes and hoses are to show a suitable resistance against collapse due to external pressure or bending.

8.2.4 Conditions of use of flexible hoses and expansion joints

a) The use of flexible hoses and expansion joints is to be limited as far as practicable

b) The position of flexible hoses and expansion joints is to be clearly shown on the piping drawings submitted to the Society

c) The use of non-metallic expansion joints on pipes connected to sea inlets and overboard discharges will be given special consideration by the Society. As a rule, the fitting of such joints between the yacht side and the valves mentioned in [8.4.3] is not permitted. Furthermore, unless the above-mentioned valves are fitted with remote controls operable from places located above the freeboard deck, efficient means are to be provided, wherever necessary, to limit the flooding of the yacht in the event of rupture of the expansion joints

d) Expansion joints may be fitted in sea water lines, provided they are arranged with guards which effectively enclose, but do not interfere with, the action of the expansion joints and reduce to the minimum practicable any flow of water into the machinery spaces in the event of failure of the flexible elements

e) Use of expansion joints in water lines for other services, including ballast lines in machinery spaces, in duct keels and inside double bottom water ballast tanks, and bilge lines inside double bottom tanks and deep tanks, will be given special consideration by the Society.

8.3 Valves and accessories

8.3.1 General

a) Valves and accessories are normally to be built in accordance with a recognised standard. Otherwise, they are subject to special consideration for approval by the Society

Valves and fittings in piping systems are to be compatible with the pipes to which they are attached in respect of their strength (see [1.3.2] for design pressure) and are to be suitable for effective operation at the maximum working pressure they will experience in service

Valves and accessories which are fitted:

- in a class I piping system, or
- in a class II piping system, or
- on the yacht side, on the collision bulkhead, on fuel oil tanks or on lubricating oil tanks under static pressure

are to be subject to the applicable testing and inspection required by the Rules. See [10.6.1]

b) Shut-off valves are to be provided where necessary to isolate pumps, heat exchangers, pressure vessels, etc., from the rest of the piping system when necessary, and in particular:

- to allow the isolation of duplicate components without interrupting the fluid circulation
- for survey or repair purposes.

8.3.2 Design of valves and accessories

a) Materials of valve and accessory bodies are to comply with the provisions of [1.6]

b) Connections of valves and accessories with pipes are to comply with the provisions of [2.3]

c) All valves and accessories are to be so designed as to prevent the loosening of covers and glands when they are operated

d) Valves are to be so designed as to shut with a right-hand (clockwise) motion of the wheels

e) Valves are to be provided with local indicators showing whether they are open or shut, unless this is readily apparent.

8.3.3 Valves with remote control

a) All valves which are provided with remote control are also to be designed for local manual operation

b) The remote control system and means of local operation are to be independent. In this respect, arrangement of the local operation by means of a fixed hand pump is to be specially considered by the Society

c) In the case of valves which are to be provided with remote control in accordance with the Rules, opening and/or closing of the valves by local manual means is not to render the remote control system inoperable

d) Power failure of the remote control system is not to cause an undesired change of the valve position.

8.4 Sea inlets and overboard discharges

8.4.1 General

Except where expressly stated in Ch 1, Sec 6, the requirements of this sub-article do not apply to scuppers and sanitary discharges.

8.4.2 Design of sea inlets and overboard discharges

a) All inlets and discharges in the shell plating are to be fitted with efficient and accessible arrangements for preventing the accidental admission of water into the yacht

b) As an alternative to a):
   - non-return valves may be fitted in lieu of valves or cocks on discharges which are led through the yacht side from spaces above the main deck, in yacht of length not exceeding 24 m
   - openings over 400 mm above waterline in motoryachts of length not exceeding 15 m are not to be fitted with such arrangements

c) The valves required in a) together with their yacht-side connections are not to substantially lower the hull resistance

d) In sea water systems, hoses are to be secured by at least 2 clips. Hose clamps are to be made of austenitic stainless steel or equivalent

e) Sea inlets and overboard discharges are to be fitted with valves complying with [8.3], [8.4.3] and [8.4.6]

f) Machinery space main and auxiliary sea inlets and discharges in connection with the operation of machinery are to be fitted with readily accessible valves between the pipes and the shell plating or between the pipes and fabricated boxes attached to the shell plating. The valves may be controlled locally and are to be provided with indicators showing whether they are open or closed

g) Sea inlets are to be so designed and arranged as to limit turbulence and to avoid the admission of air due to motion of the yacht

h) Sea inlets are to be fitted with gratings complying with [8.4.4]

i) Provisions are to be made for clearing sea inlet gratings

j) Sea chests are to be suitably protected against corrosion.

8.4.3 Fitting of valves for metallic hulls

a) Sea inlet and overboard discharge valves are to be secured:
   - directly on the shell plating, or
   - on sea chests built on the shell plating, with scantlings in compliance with Part B of the Rules, or
   - on extra-reinforced and short distance pieces attached to the shell (see Tab 7)

b) The bodies of the valves and distance pieces are to have a spigot passing through the plating without projecting beyond the external surface of such plating or of the doubling plates and stiffening rings, if any

c) Valves are to be secured by means of:
   - bolts screwed through the plating with a countersunk head, or
   - studs screwed in heavy pads themselves secured to the hull or chest plating, without penetration of the plating by the stud holes

   Other screwing means be admitted by the Society, namely in the case of small size valves

d) The use of butterfly valves is to be specially considered by the Society. In any event, butterfly valves not fitted with flanges are not to be used for water inlets or overboard discharges unless provisions are made to allow disassembling at sea of the pipes served by these valves without any risk of flooding.

8.4.4 Gratings

a) Gratings are to have a free flow area not less than twice the total section of the pipes connected to the inlet

b) When gratings are secured by means of screws with a countersunk head, the tapped holes provided for such screws are not to pass through the plating or doubling plates outside distance pieces or chests

c) Screws used for fixing gratings are not to be located in the corners of openings in the hull or of doubling plates

d) In the case of large sea inlets, the screws used for fixing the gratings are to be locked and protected from corrosion

e) When gratings are cleared by use of compressed air or steam devices, the chests, distance pieces and valves of sea inlets and outlets thus arranged are to be so constructed as to withstand the maximum pressure to which they may be subjected when such devices are operating.

8.4.5 Materials of valves

a) The materials of the valve bodies and connecting pieces are to comply with Tab 5

b) Yacht side valves serving piping systems made of plastics are to comply with [6.2.1]

c) On yacht or charter yacht of length less than 24 m, valves in plastic or equivalent material with appropriate strength may be fitted at the discretion of the Society

d) The combination of different materials has to take into consideration the possibility of galvanic action.

8.4.6 Fitting of valves for wood or composite hulls

a) Suitable pads into which the attached fittings are spigotted are to be provided for the openings in the planking

b) Other securing means may be accepted after special consideration in case of small size fittings.

8.5 Control and monitoring

8.5.1 General

a) Local indicators are to be provided for at least the following parameters:
   - pressure, in pressure vessels, at pump or compressor discharge, at the inlet of the equipment served, on the low pressure side of pressure reducing valves
   - temperatures, in tanks and vessels, at heat exchanger inlet and outlet
   - levels, in tanks and vessels containing liquids

b) Safeguards are to be provided where an automatic action is necessary to restore acceptable values for a faulty parameter

c) Automatic controls are to be provided where it is necessary to maintain parameters related to piping systems at a pre-set value.

8.5.2 Level gauges

a) Level gauges used in flammable oil systems are to be of a type approved by the Society and are subject to the following conditions:

- cylindrical gauges may be used provided they are fitted with self-closing valves at their lower end as well as at their upper end if the latter is below the maximum liquid level
- in the case of tanks not subject to filling by power pumps, with the exception of fuel oil service tanks, the valves need not be of the self-closing type. Such valves are, however, to be readily accessible and instruction plates are to be fitted adjacent to them specifying that they are to be kept closed

b) On yachts over 500 GT or carrying more than 12 passengers, level gauges used in flammable oil systems are subject to the following conditions:

- in yachts carrying more than 12 passengers, they are not to require penetration below the top of the tank and their failure or overfilling of the tanks is not to permit release of fuel
- in yachts over 500 GT, their failure or overfilling of the tank is not to permit release of fuel into the space. The use of cylindrical gauges is prohibited. The Society may permit the use of oil-level gauges with flat glasses and self-closing valves between the gauges and fuel tanks
- their glasses are to be made of heat-resistant material and efficiently protected against shocks.

9 Arrangement and installation of piping systems

9.1 General

9.1.1 Unless otherwise specified, piping and pumping systems covered by the Rules are to be permanently fixed on board ship.

9.2 Location of tanks and piping system components

9.2.1 Flammable oil systems

Location of tanks and piping system components conveying flammable fluids under pressure is to comply with [9.10].

9.2.2 Piping systems with open ends

Attention is to be paid to the requirements for the location of open-ended pipes on board ships having to comply with the provisions of [9.5].

9.2.3 Pipe lines located inside tanks

a) The passage of pipes through tanks, when permitted, normally requires special arrangements such as reinforced thickness or tunnels, in particular for:

- bilge pipes
- ballast pipes
- scuppers and sanitary discharges
- air, sounding and overflow pipes
- fuel oil pipes

b) Junctions of pipes inside tanks are to be made by welding or flange connections. See also [2.3.3].

9.2.4 Overboard discharges

Overboard discharges are to be so located as to prevent any discharge of water into the lifeboats while they are being lowered.

9.2.5 Piping and electrical apparatus

As far as possible, pipes are not to pass near switchboards or other electrical apparatus. If this requirement is impossible to satisfy, gutterways or masks are to be provided wherever deemed necessary to prevent projections of liquid or steam on live parts.

9.3 Passage through watertight bulkheads or decks

9.3.1 Penetration of watertight bulkheads and decks

a) Where penetrations of watertight bulkheads and internal decks are necessary for piping and ventilation, arrangements are to be made to maintain the watertight integrity

b) Lead or other heat sensitive materials are not to be used in piping systems which penetrate watertight subdivision bulkheads or decks, where deterioration of such systems in the event of fire would impair the watertight integrity of the bulkhead or decks

This applies in particular to the following systems:

- bilge system
- ballast system
- scuppers and sanitary discharge systems

c) Where bolted connections are used when passing through watertight bulkheads or decks, the bolts are not to be screwed through the plating. Where welded connections are used, they are to be welded on both sides of the bulkhead or deck

d) Penetrations of watertight bulkheads or decks by plastic pipes are to comply with [5] to [7].

9.3.2 Passage through the collision bulkhead

a) On yachts over 500 GT or carrying more than 12 passengers, a maximum of two pipes may pass through the collision bulkhead below the freeboard deck, unless otherwise justified. Such pipes are to be fitted with suitable valves operable from above the freeboard deck and the valve chest is to be secured at the bulkhead inside the fore peak. Such valves may be fitted on the after side of the collision bulkhead provided that they are readily accessible under all service conditions and the space in which they are located is not a cargo space. All valves are to be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable

b) The remote operation device of the valve referred to in a) is to include an indicator to show whether the valve is open or shut.

9.4 Independence of lines

9.4.1 As a general rule, bilge and ballast lines are to be entirely independent and distinct from lines conveying lubricating oil and fuel oil, with the exception of:

- pipes located between collecting boxes and pump suctions
- pipes located between pumps and overboard discharges
- pipes supplying compartments likely to be used alternatively for ballast, fuel oil, provided such pipes are fitted with blind flanges or other appropriate change-over devices, in order to avoid any mishandling.

9.5 Prevention of progressive flooding

9.5.1 Principle

a) In order to comply with the subdivision and damage stability requirements of Pt B, Ch 3, Sec 3, provision is to be made to prevent any progressive flooding of a dry compartment served by any open-ended pipe, in the event that such pipe is damaged or broken in any other compartment by collision or grounding

b) For this purpose, if pipes are situated within assumed flooded compartments, arrangements are to be made to ensure that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage. However, the Society may permit minor progressive flooding if it is demonstrated that its effects can be easily controlled and the safety of the yacht is not impaired. Refer to Pt B, Ch 3, Sec 3.

9.5.2 Extent of damage

For the definition of the assumed transverse extent of damage, reference is to be made to Pt B, Ch 3, Sec 3.

9.5.3 Piping arrangement

a) The assumed transverse extent of damage is not to contain any pipe with an open end in a compartment located outside this extent, except where the section of such pipe does not exceed 50 cm^2.

Note 1: Where several pipes are considered, the limit of 50 cm^2 applies to their total section.

b) Where the provisions of a) cannot be fulfilled, and after special examination by the Society, pipes may be situated within the assumed transverse extent of damage penetration provided that:

- either a closable valve operable from above the bulkhead deck is fitted at each penetration of a watertight subdivision and secured directly on the bulkhead, or
- a closable valve operable from above the bulkhead deck is fitted at each end of the pipe concerned, the valves and their control system being inboard of the assumed extent of damage, or
- the tanks to which the pipe concerned leads are regarded in the damage stability calculations as being flooded when damage occurs in a compartment through which the pipe passes

c) Valves required to be operable from above the bulkhead deck are to be fitted with an indicator to show whether the valve is open or shut

Where the valve is remote controlled by other than mechanical means, and where the remote control system is located, even partly, within the assumed extent of damage penetration, this system is to be such that the valve is automatically closed by loss of power

d) Air and overflow pipes are to be so arranged as to prevent the possibility of flooding of other tanks in other watertight compartments in the event of any one tank being flooded

This arrangement is to be such that in the range of positive residual righting levers beyond the angle of equilibrium stage of flooding, the progressive flooding of tanks or watertight compartments other than that flooded does not occur.

9.6 Provision for expansion

9.6.1 General

Piping systems are to be so designed and pipes so fixed as to allow for relative movement between pipes and the yacht's structure, having due regard to the:

- temperature of the fluid conveyed
- coefficient of thermal expansion of the pipes material
- deformation of the yacht's hull.

9.6.2 Fitting of expansion devices

All pipes subject to thermal expansion and those which, due to their length, may be affected by deformation of the hull, are to be fitted with expansion pieces or loops.

9.7 Supporting of the pipes

9.7.1 General

Unless otherwise specified, the fluid lines referred to in this Section are to consist of pipes connected to the yacht's structure by means of collars or similar devices.

9.7.2 Arrangement of supports

Shipyards are to take care that:

a) The arrangement of supports and collars is to be such that pipes and flanges are not subjected to abnormal bending stresses, taking into account their own mass, the metal they are made of, and the nature and characteristics of the fluid they convey, as well as the contractions and expansions to which they are subjected

b) Heavy components in the piping system, such as valves, are to be independently supported.

9.8 Protection of pipes

9.8.1 Protection against shocks

Pipes are to be efficiently protected against mechanical shocks , particularly in their most exposed parts.

9.8.2 Protection against corrosion and erosion

a) Pipes are to be efficiently protected against corrosion, particularly in their most exposed parts, either by selection of their constituent materials, or by an appropriate coating or treatment

b) The layout and arrangement of sea water pipes are to be such as to prevent sharp bends and abrupt changes in section as well as zones where water may stagnate. The inner surface of pipes is to be as smooth as possible, especially in way of joints. Where pipes are protected against corrosion by means of galvanising or other inner coating, arrangements are to be made so that this coating is continuous, as far as possible, in particular in way of joints

c) If galvanised steel pipes are used for sea water systems, the water velocity is not to exceed 3 m/s

d) If copper pipes are used for sea water systems, the water velocity is not to exceed 2 m/s

e) Arrangements are to be made to avoid galvanic corrosion.

9.8.3 Protection against frosting

Pipes are to be adequately insulated against cold wherever deemed necessary to prevent frost.

This applies specifically to pipes passing through refrigerated spaces and which are not intended to ensure the refrigeration of such spaces.

9.8.4 Protection of high temperature pipes and components

a) All pipes and other components where the surface temperature may exceed 80°C are to be efficiently insulated. Where necessary, precautions are to be taken to protect the insulation from being impregnated with flammable oils

b) Particular attention is to be paid to lagging in way of flanges.

9.8.5 Protection of flexible or heat sensitive pipes

a) Pipes made of heat sensitive materials are to be protected against contact with hot surfaces

b) Flexible pipes are to be secured to rigid pipes or fittings by corrosion resistant clips or pressed ferrules. For flexible piping of 25 mm diameter and above not less than two clips are to be fitted at each end

c) Where rubber or other heat sensitive material is used for hose, the run of hose is to be as direct as practicable, and the hose is to be adequately supported. If necessary, the hoses are to be protected against mechanical damage and contact with hot surfaces.

9.9 Valves, accessories and fittings

9.9.1 General

a) Cocks, valves and other accessories are generally to be arranged so that they are easily visible and accessible for manoeuvring, control and maintenance. They are to be installed in such a way as to operate properly

b) Handles of valves or cocks are to be permanently fitted.

9.9.2 Flexible hoses and expansion joints

a) Flexible hoses and expansion joints are to be so arranged as to be accessible at all times

b) Flexible hoses and expansion joints are to be as short as possible

c) The radius of curvature of flexible hoses is not to be less than the minimum recommended by the manufacturer

d) The adjoining pipes are to be suitably aligned, supported, guided and anchored

e) Isolating valves are to be provided permitting the isolation of flexible hoses intended to convey flammable oil or compressed air

f) Expansion joints are to be protected against over extension or over compression

g) Where they are likely to suffer external damage, flexible hoses and expansion joints of the bellows type are to be provided with adequate protection.

9.9.3 Thermometers

Thermometers and other temperature-detecting elements in fluid systems under pressure are to be provided with pockets built and secured so that the thermometers and detecting elements can be removed while keeping the piping under pressure.

9.9.4 Pressure gauges

Pressure gauges and other similar instruments are to be fitted with an isolating valve or cock at the connection with the main pipe.

9.9.5 Nameplates

a) Accessories such as cocks and valves on the fluid lines referred to in this Section are to be provided with nameplates indicating the apparatus and lines they serve except where, due to their location on board, there is no doubt as to their purpose

b) Nameplates are to be fitted at the upper part of air and sounding pipes.

9.10 Additional arrangements for flammable fluids

9.10.1 General

The requirements in [9.10.3] and [9.10.4] apply to:

- fuel oil systems, in all spaces
- lubricating oil systems, in machinery spaces
- other flammable oil systems, in locations where means of ignition are present.

9.10.2 Prohibition of carriage of flammable oils in forepeak tanks

In yachts of more than 400 tons gross tonnage or carrying more than 12 passengers, fuel oil, lubricating oil and other flammable oils are not to be carried in forepeak tanks or tanks forward of the collision bulkhead.

9.10.3 Prevention of flammable oil leakage ignition

a) As far as practicable, the piping arrangement in the flammable oil systems is to comply generally with the following:

- The conveying of flammable oils through accommodation and service spaces is to be avoided. Where it is not possible, the arrangement may be subject to special consideration by the Society, provided that the pipes are of a material approved having regard to the fire risk
- The pipes are not to be located immediately above or close to the hot surfaces (exhaust manifolds, silencers, etc..), electrical installations or other sources of ignition. Otherwise, suitably protection (screening and effective drainage to the safe position) is to be provided to prevent of spraying or leakage onto the sources of ignition
- Parts of the piping systems conveying heated flammable oils under pressure exceeding 0,18 MPa are to be placed above the platform or in any other position where defects and leakage can readily be observed. The machinery spaces in way of such parts are to be adequately illuminated

b) No flammable oil tanks are to be situated where spillage or leakage therefrom can constitute a hazard by falling on:

- hot surfaces, including those of heaters, exhaust manifolds and silencers
- electrical equipment
- air intakes
- other sources of ignition

c) Parts of flammable oil systems under pressure exceeding 0,18 MPa such as pumps, filters and heaters are to comply with the provisions of b) above

d) Mechanical joints, expansion joints and flexible parts of flammable oil lines are to be screened or otherwise suitably protected to avoid as far as practicable oil spray or oil leakages onto hot surfaces, into machinery air intakes, or on other sources of ignition

e) Any relief valve of fuel oil and lubricating oil systems is to discharge to a safe position, such as an appropriate tank.

9.10.4 Provisions for flammable oil leakage containment

a) Tanks used for the storage of flammable oils together with their fittings are to be so arranged as to prevent spillages due to leakage or overfilling

b) Drip trays with adequate drainage to contain possible leakage from flammable fluid systems are to be fitted:

- under independent tanks
- under burners
- under purifiers and any other oil processing equipment
- under pumps, heat exchangers and filters
- under valves and all accessories subject to oil leakage
- surrounding internal combustion engines

c) The coaming height of drip trays is to be appropriate for the service and not less than 80 mm

d) Where drain pipes are provided for collecting leakages, they are to be led to an appropriate drain tank.

9.10.5 Drain tank

a) The drain tank is not to form part of an overflow system and is to be fitted with an overflow alarm device

b) In yachts required to be fitted with a double bottom, appropriate precautions are to be taken when the drain tank is constructed in the double bottom, in order to avoid flooding of the machinery space where drip trays are located, in the event of accidentally running aground.

9.10.6 Valves

All valves and cocks forming part of flammable oil systems are to be capable of being operated from readily accessible positions and, in machinery spaces, from above the working platform.

9.10.7 Level switches

Level switches fitted to flammable oil tanks are to be contained in a steel or other fire-resisting enclosure.

10 Certification, inspection and testing of piping systems

10.1 Application

10.1.1 This Article defines the certification and workshop inspection and testing programme to be performed on:

- the various components of piping systems
- the materials used for their manufacture.

On board testing is dealt with in Ch 1, Sec 10.

10.2 Type tests

10.2.1 Type tests of flexible hoses and expansion joints

a) Type approval tests are to be carried out on a flexible hose or an expansion joint of each type and each size, in accordance with Tab 24

b) The flexible pipes or expansion joints subjected to the tests are to be fitted with their connections.

10.2.2 Type tests of air pipe closing appliances

Type approval tests are to be carried out on each type and size of air pipe closing device, in accordance with Tab 25.

Table 24 : Type tests to be performed for flexible hoses and expansion joints

Test	Flexible hoses and expansion joints in non-metallic material	Flexible hoses and expansion joints in metallic material
Bursting test	X	X
Fire-resistance test	X **(1)**	NR
Vibration test	X **(2)**	X **(2)**
Pressure impulse test	X	NR
Flexibility test	X **(3)**	X
Elastic deformation test	NR	X
Cyclic expansion test	X	X **(4)**
Resistance test	X **(5)**	X **(5)**

(1) only for flexible hoses and expansion joints used in flammable oil and sea water systems.
(2) only for flexible hoses and expansion joints fitted to engines, pumps, compressors or other sources of high vibrations.
(3) only for flexible hoses conveying low temperature fluids.
(4) only for piping systems subjected to expansion cycles
(5) internal to the conveyed fluid and external to UV.
Note 1: X = required, NR = not required.

Table 25 : Type tests to be performed for air pipe closing appliances

Test to be performed	Type of air closing appliance	
	Float type	Other types
Tightness test **(1)**	X	X
Flow characteristic determination **(2)**	X	X
Impact test of floats	X	
Pressure loading test of floats	X **(3)**	

(1) the tightness test is to be carried out during immerging/emerging in water, in the normal position and at an inclination of 40 degrees.
(2) pressure drop is to be measured versus flow rate using water.
(3) only for non-metallic floats.
Note 1: X = required

10.3 Testing of materials

10.3.1 General

a) Detailed specifications for material tests are given in the Rule Note NR 216 Materials and Welding.

b) Requirements for the inspection of welded joints are given in the Rule Note NR 216 Materials and Welding.

10.3.2 Tests for materials

a) Where required in Tab 26, materials used for pipes, valves and other accessories are to be subjected to the following tests:

- tensile test at ambient temperature
- flattening test or bend test, as applicable
- tensile test at the design temperature, except if one of the following conditions is met:
  - the design temperature is below 200°C
  - the mechanical properties of the material at high temperature have been approved
  - the scantling of the pipes is based on reduced values of the permissible stress

b) Plastic materials are to be subjected to the tests specified in [5] to [7].

10.4 Hydrostatic testing of piping systems and their components

10.4.1 General

Pneumatic tests are to be avoided wherever possible. Where such testing is absolutely necessary in lieu of the hydraulic pressure test, the relevant procedure is to be submitted to the Society for acceptance prior to testing.

10.4.2 Hydrostatic pressure tests of piping

a) Hydrostatic pressure tests are to be carried out to the Surveyor's satisfaction for:

- all class I and II pipes and their integral fittings
- all compressed air pipes, and fuel oil and other flammable oil pipes with a design pressure greater than 0,35 MPa and their associated integral fittings

b) These tests are to be carried out after completion of manufacture and before installation on board and, where applicable, before insulating and coating

Note 1: Classes of pipes are defined in [1.5.2]

c) Pressure testing of small bore pipes (less than 15 mm) may be waived at the discretion of the Surveyor, depending on the application

d) The test pressure is to be equal to 1,5 time the design pressure p

e) Where it is necessary to avoid excessive stress in way of bends, branches, etc., the Society may give special consideration to the reduction of the test pressure to a value not less than 1,5 p. The membrane stress is in no case to exceed 90% of the yield stress at the testing temperature

f) Hydrostatic testing may be carried out after assembly on board of the piping sections under the conditions stated in Ch 1, Sec 15, [3.12.3].

10.4.3 Hydrostatic tests of valves, fittings and heat exchangers

a) Valves and fittings non-integral with the piping system and intended for class I and II pipes are to be subjected to hydrostatic tests in accordance with standards recognised by the Society, at a pressure not less than 1,5 times the design pressure P defined in [1.3.2]

b) Valves and distance pieces intended to be fitted on the yacht side below the load waterline are to be subjected to hydrostatic tests under a pressure not less than 0,5 MPa

c) The shells of appliances such as heaters, coolers and heat exchangers which may be considered as pressure vessels are to be tested under the conditions specified in Part C, Chapter 1, Section 3 of the Rules for Steel Ships

d) The nests of tubes or coils of heaters, coolers and heat exchangers are to be submitted to a hydraulic test under the same pressure as the fluid lines they serve

e) For coolers of internal combustion engines, see Part C, Chapter 1, Section 2 of the Rules for Steel Ships.

10.4.4 Hydrostatic tests of fuel oil bunkers and tanks not forming part of the yacht's structure

Fuel oil bunkers and tanks not forming part of the yacht's structure are to be subjected to a hydrostatic test under a pressure corresponding to the maximum liquid level in such spaces or in the air or overflow pipes, with a minimum of 2,40 m above the top. The minimum height is to be 3,60 m for tanks intended to contain fuel oil with a flashpoint below 60°C.

10.4.5 Hydrostatic tests of pumps and compressors

a) Cylinders, covers and casings of pumps and compressors are to be subjected to a hydrostatic test under a pressure at least equal to the test pressure p_H, in MPa, determined by the following formulae:

- $p_H = 1,5\ p$ where $p \leq 4$
- $p_H = 1,4\ p + 0,4$ where $4 < p \leq 25$
- $p_H = p + 10,4$ where $p > 25$

where:

p : Design pressure, in MPa, as defined in [1.3.2]

p_H is not to be less than 0,4 MPa

b) Intermediate coolers of compressors are to undergo a hydrostatic test under a pressure at least equal to the pressure p_H defined in a). When determining p_H, the pressure p to be considered is that which may result from accidental communication between the cooler and the adjoining stage of higher pressure, allowance being made for any safety device fitted on the cooler

c) The test pressure for water spaces of compressors and their intermediate coolers is not to be less than 1,5 times the design pressure in the space concerned, subject to a minimum of 0,2 MPa

d) For air compressors and pumps driven by internal combustion engines, refer to Part C, Chapter 1, Section 2 of the Rules for Steel Ships.

10.4.6 Hydrostatic test of flexible hoses and expansion joints

a) Each flexible hose or expansion joint, together with its connections, is to undergo a hydrostatic test under a pressure at least equal to twice the maximum service pressure, subject to a minimum of 1 MPa

b) During the test, the flexible hose or expansion joint is to be repeatedly deformed from its geometrical axis.

10.5 Testing of piping system components during manufacturing

10.5.1 Pumps

Bilge and fire pumps are to undergo a performance test.

10.5.2 Centrifugal separators

Centrifugal separators used for fuel oil and lubricating oil are to undergo a running test, normally with a fuel water mixture.

10.6 Inspection and testing of piping systems

10.6.1 The inspections and tests required for piping systems and their components are summarised in Tab 26.

Table 26 : Inspection and testing at works for piping systems and their components

N°	Item	Tests for materials **(1)**		Inspections and tests for the product **(1)**			Reference to the Rules
		Tests required	Type of material certificate **(2)**	During manufacturing (NDT)	After completion	Type of product certificate	
1	Valves, pipes and fittings						
	a) class I, d ≥ 32 mm or	X	C				[10.3.2]
	class II, d ≥ 100 mm			X **(5)**			[3.6.2]
					X	C **(3)**	[10.4.3]
	b) class I, d < 32 mm or	X	W				[10.3.2]
	class II, d < 100 mm			X **(5)**			[3.6.2]
					X	C **(3)**	[10.4.3]
2	Flexible hoses and expansion joints	X **(6)**	W				[10.3.2]
					X	C **(3)**	[10.4.6]
3	Pumps and compressors						
	a) all				X	C **(3)**	[10.4.5]
	b) bilge and fire pumps				X	C **(3)**	[10.5.1]
4	Centrifugal separators				X	C **(3)**	[10.5.2]
5	Prefabricated pipe lines						
	a) class I and II with:						
	- d ≥ 75 mm, or			X **(7)**			[3.6.2]
	- t ≥ 10 mm				X	C **(3)**	[10.4.2]
	b) class I and II with:						
	- d < 75 mm, and			X **(7)**			[3.6.2]
	- t < 10 mm				X	W	[10.4.2]
	c) class III **(4)**				X	W	[10.4.2]

(1) X = test is required.
(2) C = class certificate
W = works' certificate.
(3) or alternative type of certificate, depending on the Survey Scheme. See Part A.
(4) where required by [10.4.2].
(5) if of welded construction.
(6) if metallic.
(7) for welded connections.