PART III CONSTRUCTION COMPONENTS

TITLE 62 MACHINERY

SECTION 6 PIPING

CHAPTERS

CONTENTS

CHAPTER A
APPROACH

CHAPTER CONTENTS

A1. APPLICATION

100. Characteristics

101. The presente Part II, Title 62, Section 6 applies to seamless steel pipings or welded seam pipings, employed in pressurized piping systems and equipment

102. The requirements of the presente Part III Title 62, Section 6, are applicable to all ships regardless of their GT.

A2. TEST SPECIMENS [W2.4.2.5 Tubes]

100. Test specimens

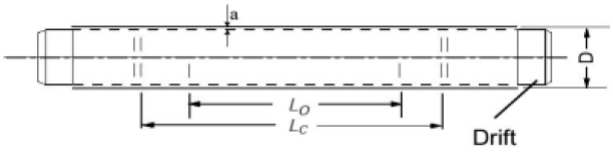
101. The test specimen shall conform with the following:

a. full cross-section specimen with plugged ends :

$$L_0 = 5{,}65\sqrt{S_o}$$

$$L_c \geq 5{,}65\sqrt{S_o} + \frac{D}{2}$$

where Lc is the distance between the grips or the plugs, whichever is the smallest.



b. Strips cut longitudinally

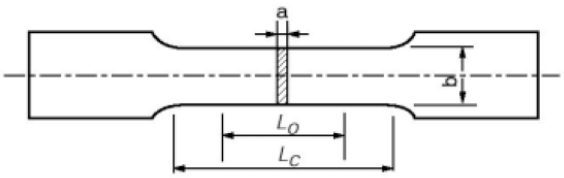
a = t

b ε 12 mm

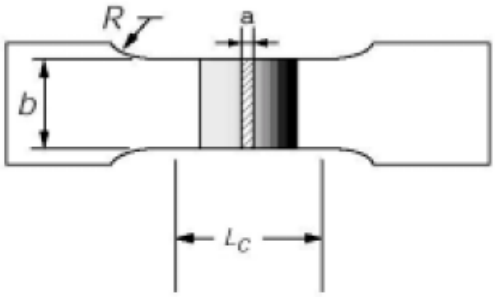
$$L_0 = 5{,}65\sqrt{S_o}$$

$$L_c = L_0 + 2b$$

102. The parallel test length is not to be flattened, but the enlarged ends may be flattened for gripping in the testing machine.



103. Round test specimens may also be used provided that the wall thickness is sufficient to allow the machining of such specimens to the dimensions given in Part III, Title 61, Section 2, Subchapter A4, Item 203, with their axes located at the midwall thickness.



A3. SAMPLE FORMATION

100. Aplication

101. The pipes submitted for testing are to be chosen from lots containing 200 pipes each maximum, having the same nominal diameter, the same wall thickness and the same manufacturing characteristics and thermal treatment.

200. Sample

201. A total of 2% of the piping in each lot are to be tested.

CHAPTER B
RULES FOR PIPING DESIGN, CONSTRUCTION AND TESTING
[IACS UR P2]

CHAPTER CONTENTS

B1. APPLICATION, MATERIALS AND CONSTRUCTION

100. Application

101. The present requirements are related to piping-systems made of carbon, carbon-manganese, alloy steels or non-ferrous material normally installed on board ships for services considered in Table T.B2.101.1 are applicable to all ships regardless of their gross tonnage.

102. These requirements cover the following services:

a. Air, vapour, gas (excluding liquefied gas cargo and process piping), water, lubricating oil, fuel oil, hydraulic fluid systems for steering gear, toxic gas and liquids, cargo oil and tank cleaning piping and open ended lines such as drains, overflows, vents and boiler escape pipes. They do not include pipes forming integral part of a boiler.

b. Hydraulic fluid systems other than those for steering gear shall be specially considered by each individual Classification RBNA.

c. Piping systems intended for liquefied gases (cargo and process) are dealt with in Part II, Title 34, and Part III, Title 61, Section 2, Chapter K

d. These requirements do not apply to cargo piping systems of ships carrying chemicals in bulk

B2. CLASSES OF PIPES

100. Classes of pipes [P2.2]

101. For the purpose of testing, the type of joint to be adopted, heat treatment and welding procedure, pipes are subdivided into three classes as indicated in Figure F.B2.101.1 and Table T.B2.101.1.

FIGURE F B2.101.1 – CLASSES OF PIPES -

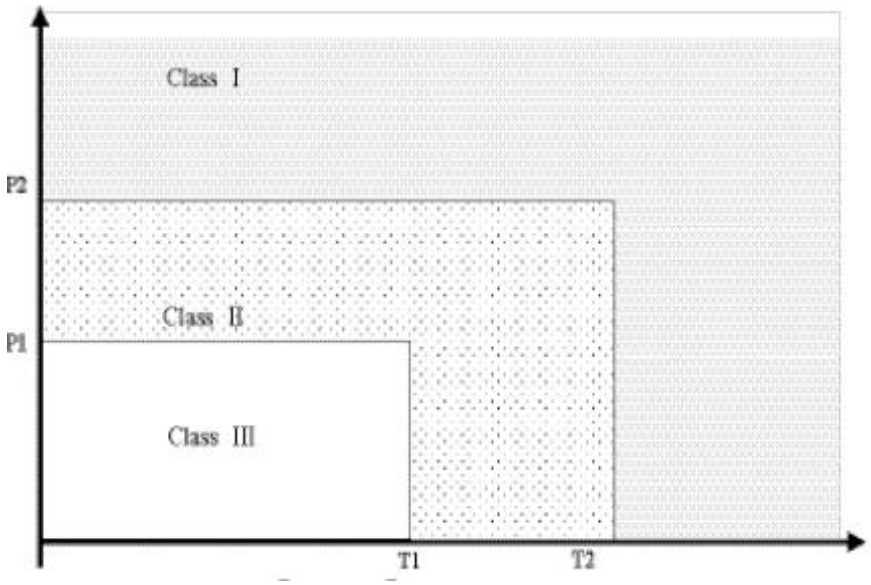


TABLE T.B2.101.1- CLASSES OF PIPES

Piping system for	Class I P ≥	or T≥	Class II	Class III P ≥	or T≥
Toxic or corrosive media	Without special safeguards		With special safeguard (1,2)s	Not applicable	
Flammable media heated above flashpoint or with flashpoint below 60ºC Liquefied gas	Without special safeguards		With special safeguards (1)	Not applicable	
Steam	16	500	Any pressure / temperature combination not belonging to Class I or Class III	7	170
Thermal oil	16	500		7	150
Fuel oil Lubricating oil Flammable hydraulic oil (5)	16	150		7	60
Other media (5) (6)	40	500		16	200

Notes:

(1) 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

(2) Class II pipes are not to be used for toxic media

(3) Cargo oil pipes belong to Class III

(4) P = desigm pressure (bar) as defined in PartII, Title11, Section6, Subchapter D3, Item 700; T = design temperature (º C) as defined in PartII, Title11, Section6, Subchapter D3, Item 800

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

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

B3. MATERIALS

100. Materials [P2.3]

101. The materials to be used for the various pipes, valves and fittings are to be suitable for the medium and service for which the piping is intended (see B3.103 to B3.106).

102. In the case of especially corrosive media, the materials for the piping system will be considered by the RBNA in each particular case.

103. **Steel pipes, valves and other fittings**

a. Pipes belonging to Classes I and II are to be seamless drawn steel pipes or pipes fabricated with a welding procedure, considered by the RBNA to be equivalent to seamless pipes.

b. In general, carbon and carbon-manganese steel pipes, valves and other fittings are not to be employed for temperatures above 400°C. Nevertheless, they may be used for higher temperatures if their metallurgical behaviour and time dependent strength (UTS after 100 000 hours) are in accordance with national or international codes or standards and if such valves are guaranteed by the steel manufacturer. Otherwise, special alloy steel pipes, valve and fittings should be employed according to Rules on materials of the RBNA.

104. **Copper and copper alloy pipes, valves and fittings**

Copper and copper alloy piping shall be of seamless drawn material or other type approved by the Classification RBNA.

a. Copper pipes for Classes I and II are to be seamless.

b. In general, copper and copper alloy piping, valves and fittings shall not be used for media having temperature above the following limits:

b.1. Copper and aluminium brass 200°C

b.2. Copper nickel 300°C

c. Special bronze suitable for high temperature services may be accepted in general up to 260°C.

105. **Nodular cast iron pipes, valves and other fittings**

a. Nodular cast iron of the ferritic type according to the material rules of the RBNA may be accepted for bilge, ballast and cargo oil piping.

b. Ferritic nodular cast iron valves and other fittings may be accepted for media having temperatures not exceeding 350°C.

c. The use of this material for pipes, valves and fittings for other services, in principle Classes II and III, will be subject to special consideration.

d. Nodular cast iron pipes and valves fitted on the ship's side should have specified properties to the RBNA's satisfaction, according to the intention of Regulation 22 of the 1966 Convention on Load Lines.

106. **Ordinary cast iron pipes, valves and fittings**

a. Ordinary cast iron pipes, valves and fittings may be accepted in principle for Class III at the RBNA's judgement.

b. Ordinary cast iron piping may be accepted for cargo oil lines within cargo tanks of tankers.

c. Ordinary cast iron is not to be used for pipes, valves and other fittings handling media having

temperature above 220°C and for piping subject to pressure shock, excessive strains and vibrations.

d. Ordinary cast iron may be accepted for pressures up to 16 bar for cargo oil pipelines on weather decks of oil tankers except for manifolds and their valves and fittings connected to cargo handling hoses.

e. Ordinary cast iron shall not be used for sea valves and pipes fitted on the ship sides, and for valves fitted on the collision bulkhead.

f. The use of cast iron for other services will be subject to special consideration in each case.

B4. WELDING [IACS UR P2.5]

100. General

101. The welding joints belonging to Class I or II piping systems shall be effected by approved procedures. Consumables and welders shall meet the requirements of the RBNA's Rules.

102. Joint preparations and tolerance shall be appropriate to the welding process, in accordance with the RBNA's Rules Part II Title 11 Section 2 or recognized standards.

103. Welding shall be done according to applicable requirements and good practice; the weld preparations and the welded joint shall be inspected as may be necessary in the course of fabrication and after completion of the welding heat treatment. For non-destructive tests, see T2.200 below.

104. The following requirements apply to the fabrication of Classes I and II piping systems operating at ambient or high temperature and made of steel of the types given hereunder:

a. carbon and carbon-manganese steels having minimum tensile strength (Rm) 320, 360, 410, 460 and 490 N/mm2

b. low alloy carbon-molybdenum, chromium-molybdenum, chromium-molybdenum- vanadium steels having chemical composition 0,3 Mo; 1 Cr - 0,5 Mo; 2,25 Cr - 1 Mo; 0,5 Cr - 0,5 Mo - 0,25 V.

105. At the discretion of the RBNA, these requirements may be applied also to the Class III piping systems and to repair welding of pipelines.

106. Refrigerated cargo installations piping systems operating at temperatures lower than -40°C will be given special consideration by each RBNA.

200. Edge preparation for welded joints [P2.5.2]

201. Edge preparation is to be in accordance with recognized standards (Part II, Title 11, Section 2) and/or approved drawings.

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

300. Alignment and assembling [P2.5.3]

301. Unless otherwise agreed by the RBNA, the tolerances on the alignment of the pipes to be welded are to be as follows:

a. Pipes of all diameters and thicknesses welded with permanently fitted backing ring: 0,5 mm.

b. Pipes welded without fitted backing ring:

b.1. inside diameter less than 150 mm, thickness up to 6 mm included -1 mm or t/4 whichever is less;

b.2. inside diameter less than 300 mm, thickness up to 9,5 mm included -1,5 mm or t/4 whichever is less;

b.3. inside diameter 300 mm and over, or over thickness 9,5 mm included -2,0 mm or t/4 whichever is less.

302. For Class III piping systems, the requirements for alignment tolerances may be waived at the iscretion of the RBNA.

303. Assembling for welding is to be appropriate and within the prescribed tolerances.

304. Tack welds should be made with an electrode suitable for the base metal; tack welds which form part of the finished weld should be made using approved procedures.

305. When welding materials require preheating, the same preheating should be applied during tack welding.

400. Preheating

401. Preheating of the different types of steels will be dependent upon their thickness and hemical composition as indicated in Table T. B4.401.1. In any case, dryness is to be ensured using, if necessary, suitable preheating.

TABLE T.B4.401. VALUES ARE BASED ON USE OF LOW HYDROGEN PROCESSES; CONSIDERATION SHOULD BE GIVEN TO USING HIGHER PREHEATING TEMPERATURES WHEN LOW HYDROGEN PROCESSES ARE NOT USED.

Type of steel		Thickness of thicker part (mm)	Minimum preheating temperature (°C)
C and C/Mn steel	$C + \frac{Mn}{6} \leq 0{,}40$	$\geq 20^2$	50
	$C + \frac{Mn}{6} > 0{,}40$	$\geq 20^2$	100
0,3 Mo		$> 13^2$	100
1 Cr – 0,5 Mo		< 13 ≥ 13	100 150
2,25 Cr – 1 Mo and 0,5 Cr – 0,5 Mo – 0,25 V[1]		< 13 ≥ 13	150 200

Notes:
1. For these materials, preheating may be omitted for thicknesses up to 6 mm if the results of hardness tests carried out on welding procedure qualification are considered acceptable by the RBNA.

2. For welding in ambient temperature below 0°C, the minimum preheating temperature is required independent of the thickness unless specifically approved by the RBNA.

500. Heat-treatment after forming and welding [P2.5.5]

501. The heat treatments are not to impair the specified properties of the materials; verifications may be required to this effect as necessary. The heat treatments are preferably to be carried out in suitable furnaces provided with temperature recording equipment. However, also localized heat treatments on a sufficient portion of the length way of the welded joint, carried out with approved procedures, can be accepted.

502. Hot forming is to be generally carried out in the temperature range 1000°C -850°C for all grades; however, the temperature may decrease to 750°C during the forming process.

a. When the hot forming is carried out within this temperature range, the following generally applies:

a.1. for C, C-Mn and C-Mo steels, no subsequent heat treatment is required;

a.2. for Cr-Mo and C-Mo-V steels, a subsequent stress relieving heat treatment accordance with Table T.B4.504.1 is required.

b. When the hot forming is carried outside the above temperature range, a subsequent new heat treatment in accordance with Table T.B5.502.1 is generally required for all grades.

503. After cold forming, when r ≤ 4D (where r is the mean bending radius and D is the outside diameter of pipe) consideration is to be given to a complete heat treatment in accordance with T.B5.502.1; in any case, a stress relieving heat treatment in accordance with TABLE T.B5.504.1 is required for all grades other than carbon and carbon-manganese steels with Rm 320, 360 and 410.

504. Stress relieving heat treatment after welding for other than the oxy-acetylene welding process is required as indicated in Table T.B5.504.1 depending on the type of steel and thickness.

505. The temperature ranges given in the Table are in accordance with common practice. Other values for upper and lower temperature limits may be stipulated by the RBNA. T he stress relieving heat treatment is to consist in heating the piping slowly and uniformly to a temperature within the range indicated in the Table, soaking at this temperature for a suitable period, in general one hour per 25 mm of thickness with minimum half an hour, cooling slowly and uniformly in the furnace to a temperature not exceeding 400°C and subsequently cooling in a still atmosphere.

506. In any case, the heat treatment temperature is not to be higher than tT - 20°C where tT is the temperature of the final tempering treatment of the material.

TABLE T.B4.504.1 STRESS RELIVEVING TREATMENT

Type of steel	Thickness of thicker part (mm)	Stress relief heat treatment temperature (^oC)
C and C-Mn	≥ 15 [1&3]	500 to 620
0,3 Mo	≥ 15 [1]	580 to 640
1 Cr – 0,5 Mo	> 8	620 to 680
2,25 Cr – 1 Mo and 0,5 Cr – 0,5 Mo – 0,25 V	any [2]	650 to 720

Notes:
1. When steels with specified Charpy V notch impact properties at low temperature are used, the thickness above which postweld heat treatment shall be applied may be increased by special agreement with the RBNA.

2. Heat treatment may be omitted for pipes having thickness ≤ 8 mm, diameter ≤ 100 mm and minimum service temperature 450°C.

3. For C and C-Mn steels, stress relieving heat treatment may be omitted up to 30 mm thickness by special agreement with the RBNA

507. Unless otherwise specified, for oxyacetylene welding, the heat treatment indicated in T.B4.502.1 depending on the type of steel is required. The temperature ranges given in the Table are in accordance with common practice. Different values for upper and lower temperature limits may be stipulated by the RBNA

T.B4.502.1 SUBSEQUENT HEAT TREATMENT

Type of steel	Heat treatment and temperature (oC)
C and C-Mn	Normalizing 880 to 940
0,3 Mo	Normalizing 900 to 940
1 Cr – 0,5 Mo	Normalizing 900 to 960 Tempering 640 to 720
2,25 Cr – 1 Mo	Normalizing 900 to 960 Tempering 650 to 780
0,5 Cr – 0,5 Mo – 0,25 V	Normalizing 930 to 980 Tempering 670 to 720

B5. TYPES OF CONNECTIONS [IACS P2.7]

100. Types of connections

101. Direct connections of pipe lengths may be made by direct welding, flanges, threaded joints or mechanical joints, and should be to a recognised standard or of a design proven to be suitable for the intended purpose and acceptable to the RBNA.

102. The expression "mechanical joints" means devices intended for direct connection of pipe lengths other than by welding, flanges or threaded joints described in B5.103, B5.104 and B5.105 below.

103. **Welded connections** : Welding and non destructive testing of welds are to be carried out in accordance with Part III, Title 62, Chapter C.

a. Butt welded joints: Butt welded joints shall be of full penetration type generally 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 RBNA.*

b. Butt welded joints with special provision for a high quality of root side may be used for piping of any Class, any outside diameter

c. Butt welded joints without special provision for a high quality of root side may be used for piping systems of Class II and III irrespective of outside diameter.

d. Slip-on sleeve and socket welded joints Slip-on sleeve and socket welded joints are to have sleeves, sockets and weldments of adequate dimensions conforming to RBNA Rules or recognized Standard.

d.1. Slip-on sleeve and socket welded joints may be used in Class III systems, any outside diameter.

d.2. In particular cases, slip-on sleeve and socket welded joints may be allowed by the RBNA 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.

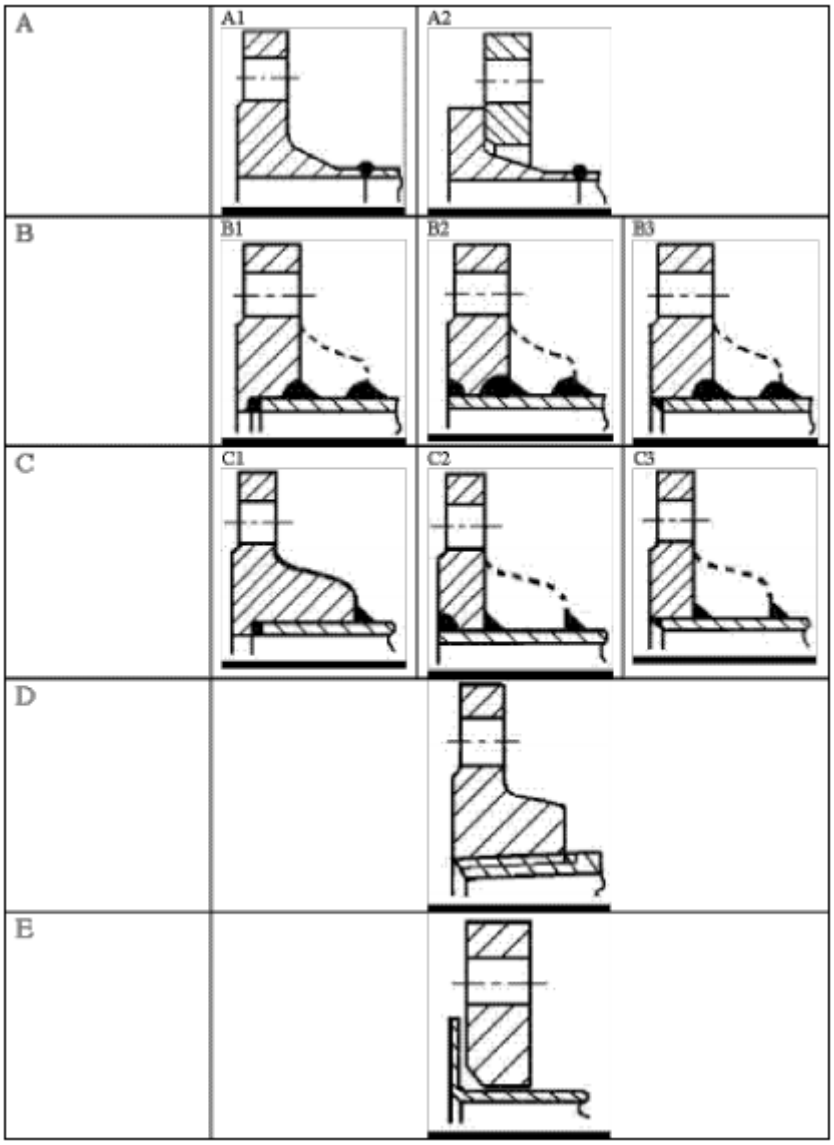
104 **Flange connections**

a. The dimensions and configuration of flanges and bolts are to be chosen in accordance with recognized standards.

b. Gaskets are to be suitable for the media being conveyed under design pressure and temperature conditions and their dimensions and configuration are to be in accordance with recognised standards. For non-standard flanges the dimensions of flanges and bolts are to be subject to special consideration.

c. Examples of flange attachments are shown in Table T.B5.104.1. However, other types of flange attachments may be considered by the RBNA in each particular case.

TABLE T.B5.104.1 EXAMPLE OF FLANGE ATTACHMENTS



d. Note: 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.

e. Flange attachments are to be in accordance with national or international Standards that are applicable to the piping system and are to recognize the boundary fluids, design pressure and temperature conditions, external or cyclic loading and location.

106. **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, shall comply with requirements of a recognized national or international standard.

b. Slip-on threaded joints may be used for outside diameters as stated below except for piping systems conveying toxic or flammable media or services where fatigue, severe erosion or crevice corrosion is expected to occur.

c. Threaded joints in CO2 systems shall be allowed only inside protected spaces and in CO2 cylinder rooms.

d. Threaded joints for direct connectors of pipe lengths with tapered thread are to be allowed for:

d.1. Class I, outside diameter not more than 33.7 mm,

d.2. Class II and Class III, outside diameter not more than 60.3 mm.

e. Threaded joints with parallel thread are to be allowed for Class III, outside diameter not more than 60.3 mm.

f. In particular cases, sizes in excess of those mentioned above may be accepted by the RBNA if in compliance with a recognized national and/or international standard.

200. Mechanical joints

201. Due to the great variations in design and configuration of mechanical joints, no specific recommendation regarding calculation method for theoretical strength calculations is given in these requirements. The Type Approval is to be based on the results of testing of the actual joints.

202. These requirements are applicable to pipe unions, compression couplings, slip-on joints as shown in Table T.B5.201.1. Similar joints complying with these requirements may be acceptable.

203. The application and pressure ratings of different mechanical joints are to be approved by the RBNA. The approval is to be based on the Type Approval procedure. 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.

204. 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.

205. 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.

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

207. Mechanical joints are to be tested where applicable, to a burst pressure of 4 times the design pressure. For design pressures above 200 bar the required burst pressure will be specially considered by the RBNA.

208. In general, mechanical joints are to be of fire resistant type as required by table T.B5.214.1.

209. 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 sea openings or tanks containing flammable fluids.

210. 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.

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

212. 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.

213. 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 RBNA.

a. Application of these joints inside tanks may be permitted only for the same media that is in the tanks.

b. 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.

214. Application of mechanical joints and their acceptable use for each service is indicated in Table T B5.214.1; dependence upon the Class of piping, pipe dimensions, working pressure and temperature is indicated in Table T.B5.214.2. In particular cases, sizes in excess of those mentioned above may be accepted by the RBNA if in compliance with a recognized national and/or international standard.

215. Mechanical joints are to be tested in accordance with a program approved by the RBNA, which is to include at least the following:

a. leakage test

b. .vacuum test (where necessary)

c. vibration (fatigue) test

d. fire endurance test (where necessary)

e. burst pressure test

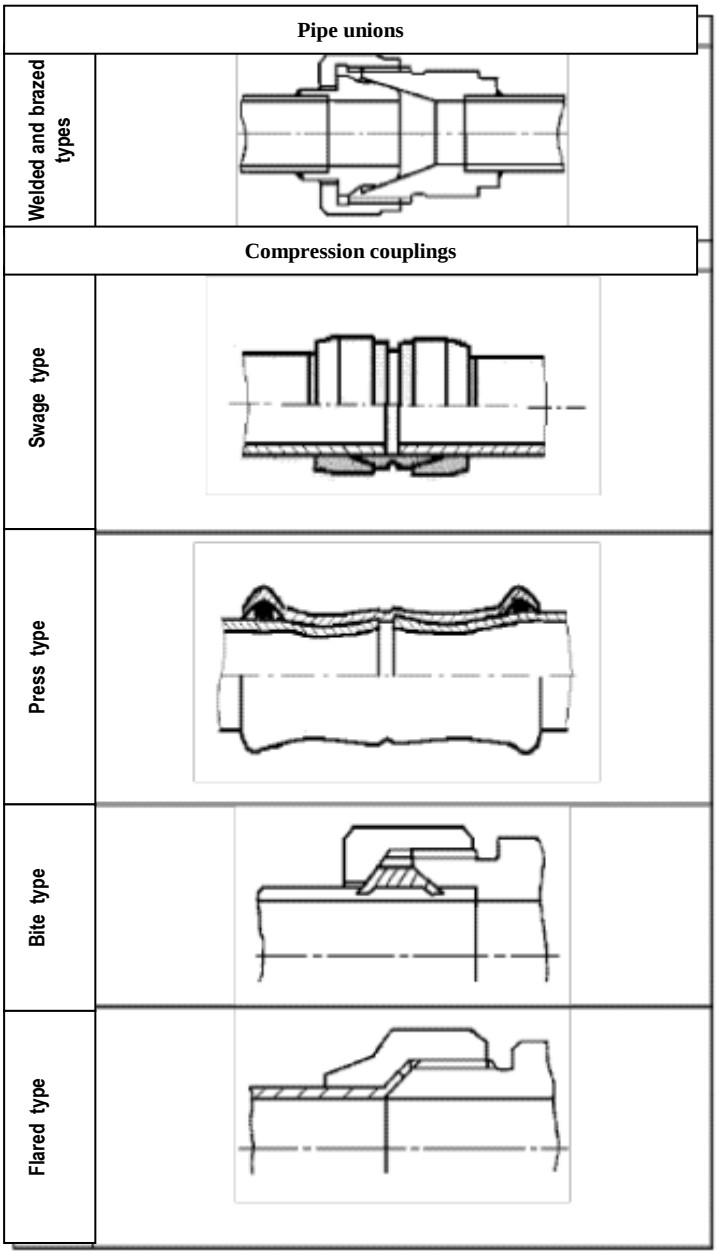
f. pressure pulsation test (where necessary)

g. assembly test (where necessary)

h. pull out test (where necessary)

216. The installation of mechanical joints is to be in accordance with the manufacturer’s assembly instructions. Where special tools and gauges are required for installation of the joints, these are to be supplied by the manufacturer.

TABLE T.B5.201.1 – EXAMPLE OF MECHANICAL JOINTS



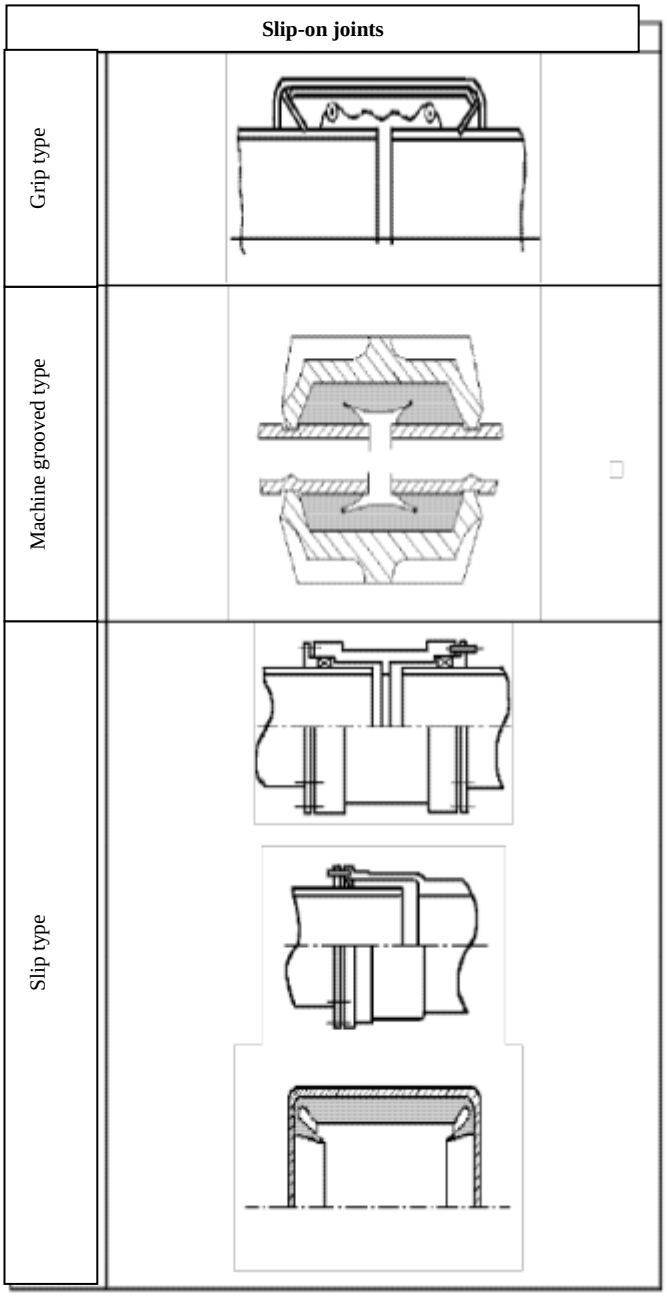

Slip-on joints
Grip type
Machine grooved type
Slip type

TABLE T.B5.214.1 APPLICATION OF MECHANICAL JOINTS

The following table indicates systems where the various kinds of joints may be accepted.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

Systems		Kind of connections		
		Pipe Unions	Compression Couplings [6]	Slip-on Joints
Flammable fluids (Flash point ≤ 60°C)				
1	Cargo oil lines	+	+	+[5]
2	Crude oil washing lines	+	+	+[5]
3	Vent lines	+	+	+[3]
Inert gas				
4	Water seal effluent lines	+	+	+
5	Scrubber effluent lines	+	+	+
6	Main lines	+	+	+[2&5]
7	Distribution lines	+	+	+[5]
Flammable fluids (Flash point > 60 °C)				
8	Cargo oil lines	+	+	+[5]
9	Fuel oil lines	+	+	+[3&2]
10	Lubricating oil lines	+	+	+[2&3]
11	Hydraulic oil	+	+	+[2&3]
12	Thermal oil	+	+	+[2&3]
Sea Water				
13	Blige lines	+	+	+[1]
14	Fire main and water spray	+	+	+[3]
15	Foam system	+	+	+[3]
16	Sprinkler system	+	+	+[3]
17	Ballast system	+	+	+[1]
18	Cooling water system	+	+	+[1]
19	Tank cleaning service	+	+	+
20	Non-essential systems	+	+	+
Fresh Water				
21	Cooling water system	+	+	+[1]
22	Condensate return	+	+	+[1]
23	Non-essential system	+	+	+
Sanitary/Drains/Scuppers				
24	Deck drains (intern)	+	+	+[4]
25	Sanitary drains	+	+	+
26	Scupper and discharge (overboard)	+	+	-
Sounding/Vent				
27	Water tanks/Dry spaces	+	+	+
28	Oil tanks (f.p.>60°C)	+	+	+[2&3]
Miscellaneous				
29	Staring/Control air[1]	+	+	-
30	Service air (non-essential)	+	+	+
31	Brine	+	+	+
32	CO_2 system[1]	+	+	-
33	Steam	+	+	+[7]

Abbreviations:

+ Application is allowed

- Application is not allowed

Footnotes:

1. Inside machinery spaces of category A - only approved fire resistant types.
2. Not inside machinery spaces of category A or accommodation spaces. May be accepted in other machinery spaces provided the joints are located in easily visible and accessible positions.
3. Approved fire resistant types.
4. Above freeboard 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.
7. Slip type joints as shown in Table 6, provided that they are restrained on the pipes, may be used for pipes on deck with a design pressure of 10 bar or less.

TABLE T.B5.214.2 - APPLICATION OF MECHANICAL JOINTS DEPENDING UPON THE CLASS OF PIPING

Type of joints	**Classes of piping system**		
	Class I	Class II	Class III
Pipe Unions			
Welded and brazed type	+ (OD≤60.3 mm)	+ (OD≤60.3 mm)	+
Compression Couplings			
Swage type			**+**
Bite type	+ (OD ≤ 60.3 mm)	+ (OD ≤ 60.3 mm)	**+**
Flared type	+ (OD ≤ 60.3 mm)	+ (OD ≤60.3 mm)	**+**
Press type	**-**	**-**	**+**
Slip-on joints			
Machine grooved type	**+**	**+**	**+**
Grid type	**-**	**+**	**+**
Slip type	**-**	**+**	**+**

Abbreviations:

+ Application is allowed

- Application is not allowed

CHAPTER C
GUIDELINES FOR THE CONSTRUCTION OF PRESSURE VESSEL TYPE TANKS INTENDED FOR THE TRANSPORTATION OF ANHYDROUS AMMONIA AT AMBIENT TEMPERATURES [IACS REC.33]

CHAPTER CONTENTS

C1. GUIDELINES

100. Scope

101. These Guidelines complement the requirements of the Part III, Title 61, Section 2, Chapter K : "Materials and Welding for Gas Tankers", where the tanks are to be constructed for the carriage of anhydrous Ammonia at ambient temperatures. The measures listed in these guidelines with respect to material selection, tank fabrication and inspection will be regarded as being necessary to reduce the risk of ammonia stress corrosion cracking to a minimum.

102 Tanks subject to these Guidelines are designed for service temperatured not lower than 0°C.

103. These Guidelines deal with tanks to be constructed of Carbon-Manganese Steels. Materials having characteristics differing from those specified in these guidelines may be used by special agreement with the RBNA.

200. Approved Materials

201. Plates are to be manufactured from fine grain treated steels and are to be normalized. The nominal yield strength of the steel is to be not more than 355 N/mm^2 and the actual yield strength should not exceed 440 N/mm^2. The chemical composition is to be within the limits as given in Table T.C1.201.1.

202. Internal piping and nozzles are to be manufactured from mild steels in accordance with an approved national standard and are to be normalized.

203. The nominal yield strength of the steel is to be not more than 355 N/mm^2.

204. The actual yield strength should not exceed 440 N/mm^2 and the elongation A5 must be at least 22%. Furthermore, the limitations for carbon, molybdenum and vanadium as given in Table T.C1.201.1 are applicable.

205. Forgings are to be manufactured from mild steels in accordance with an approved national standard and are to be normalized.

206. The nominal yield strength of the steel is to be not more than 355 N/mm^2.

207. The actual yield strength should not exceed 440 N/mm^2 and the elongation A5 must be at least 22%. Furthermore, the limitations for carbon, molybdenum and vanadium as given in Table T.C1.201.1 are applicable.

TABLE T.C1.201.1 - CHEMICAL COMPOSITION FOR FINE GRAIN STEELS, LADLE ANALYSIS[1)]

% maximum (if not otherwise indicated)										
C	Si	Mn	P	S	Al	Cr	Cu	Mo	Ni [2)]	V
0.18	0.10 to 0.50	1.65	0.030	0.025	min. 0.020	0.20	0.35	0.08	0.40	0.10

1) For steel with a normal yield point of 355 N/mm^2 the chemical composition is to be adjusted in such a way as to limit the actual yield point to 440N/mm^2.

2) If nickel will internationally be alloyed, the maximum may be 0.85%

207. Dished Ends: the dished ends are to be made from plate material as given under C1.201 and Table T.C1.201.1, preferably by hot forming process. Cold pressed dished ends are to be normalized.

208. Impact Energy Requirements: all materials of the pressure containment must fulfill the impact energy requirements of Table T.; C1.208.1.

TABLE T.C1.208.1 IMPACT ENERGY REQUIREMENTS IN ISO-V-NOTCH SPECIMENS

Type of product	Test temp. [^{o}C]	Impact Energy [1] Joule min.	
		long.	transv.
Plates	-20	-	27
Pipes		41	-
Forgings		41	27
[1] Avarage value. One value may be below the average value, but not lower than 70% of this value.			

209. The scope of the inspection is to be in accordance with Table T.C1.209.1.

TABLE T.C1.209.1 - SCOPE OF MECHANICAL TESTS AND NDT INSPECTIONS

Type of product	Tensile and notched bar impact test	Ultrasonic inspection
Plates	each rolled length at one side	Surface with a grid of 200mm and edges acc.to an approved Standard
Pipes	batch testing acc.to an approved Standard (same heat)	each length on the whole circumference acc.to an approved Standard
Forging	batch testing acc.to an approved Standard (same heat)	to approved Standard
Pressed Bottoms	one piece from the same mother plate	edges acc. To an approved Standard

300. Tank Design

301. The tanks are to be of a cylindrical or spherical shape. If bilobe tanks are proposed, special considerations will be necessary. Internal stiffening and bearing rings are to be kept to the minimum number necessary. The same applies to all other parts to be welded to the inside of the tank shell.

302. All socket pieces, nozzles and other pipe connections are to be assembled at the tank dome. The connections with the dome are to be prepared as full penetration welds.

303. Parts to be welded to the tank shell like stiffening and bearing rings, clips, brackets and bearings are to be connected with the tank shell by using K-preparation or double fillet welds. Unwelded gaps open to the tank contents are not allowed.

400. Welding Requirements

401. Welding is to be carried out using approved welding consumables of low hydrogen type. Only consumables reasonably free from molybdenum and vanadium are permitted, c.f. Table T.C1.201.1. The strength of the deposited material shall as little as possible overmatch the strength of the base material.

402. In order to keep the welding stresses and the hardness of the weld to a minimum preheating is to be applied. The preheating and interpass temperatures should not be less than 100°C and all welding work is to be carried out using multirun technic.

403. The hardness of the weld including the heat affected zone must not exceed 230 HV. This is to be verified by the procedure approval and workmanship test.

404. Irregularities of the tank construction which may cause local stresses, like misalignments of the welding edges, "peaking" of the weld seams, etc., are to be avoided. For this purpose the tank fabricator must submit tank specifications to RBNA for approval giving the allowable manufacturing tolerances.

405. Welding defects as well as welding spatter and ignition spots on the base material are to be removed by careful grinding.

406. All butt and full penetration welds of the tank shell must be in a condition enabling proper ultrasonic inspection to be carried out on them. If necessary the surfaces of the welds are to be ground.

407. To allow ultrasonic inspections the following measurments are to be taken:

a. Both sides of the welds of crossing joints are to be ground flush with the surrounding plate surface on a length of at least 500 mm starting from the crossing point.

b. The full penetration welds of domes and sumps with the tank shell are to be ground on both sides.

408. The quality of the welds must comply with an approval pressure vessel standard.

500. Stress Relieving

501. Tanks, with the exception of those described under item C1.202, are to be subjected to a stress relieving heat treatment. The temperature is to be 570 + 20°C, the holding time 60 min/ 25 mm wall thickness.

502. If the furnace dimensions or the heat treatment equipment do not allow to heat treat the tank as a whole, the following procedure may be applied subject to the consent of the RBNA:

a. Separate stress relieving heat treatment of the domes, sumps, manholes together with the surrounding parts of the tank shell before mounting them into the tank. Nozzles and socket pieces are to be welded into the dome prior to the heat treatment, and then

b. Mechanical stress relieving of the finished tank.

503. After stress relieving no welding work is to be carried out at the inner side of the tank. Slight grinding may be permitted.

504. After mechanical stress relieving the weld crossings at the side of the tanks are to be hardness tested. If the hardness values as given under item C1.403 are exceeded, special considerations must be given to remedial actions.

600. Tank Inspection by NDT Procedures [6.1]

601. All butt welds and full penetration welds of the tank shell are to be 100% tested by ultrasonic procedures (longitudinal and transverse defects). The testing for transverse defects in the area of the weld crossings are to be carried out from the ground surfaces of the welds. At the discretion of the RBNA the ultrasonic test may partly be replaced by radiographic inspections.

602. All butt and fillet welds are to be 100% magnetic particle tested at the inside of the tank. At the outside of the tank the weld crossings (500 mm at each direction) and the fillet welds are to be magnetic particle tested 100%.

603. At least 10% of the tests described under items C1.601 and C1.602 are to be repeated in the presence of the RBNA's Surveyor after the stress relieving and hydraulic test. These inspections must contain all weld crossings and penetration welds of dome and sumps.

604. The testing procedures are to be approved by RBNA.

700. Repeated Inspection by NDT Procedures

701. In connection with the class renewal survey the following additional NDT inspections are to be carried out:

a. Ultrasonic inspection on all weld crossings and on all full penetration welds of domes and sumps.

b. Magnetic particle inspection on at least 10% of the inside butt and fillet welds. This inspection must cover at least all penetration welds and all weld crossings as well as a part of the bearing ring fillet welds. If defects will be found, the scope of tests is to be increased in accordance with the Surveyor's instructions.

702. Shorter inspection periods may be required by the individual RBNA if cargos have been transported which

may cause stress corrosion cracking, e.g., anhydrous Ammonia.

800. Reports

801. All inspections are to be documented by the NDT personnel. The reports are to be presented to the RBNA's Surveyor for review and endorsement.

CHAPTER D
PRODUCTION AND APPLICATION OF PLASTIC PIPES ON SHIPS
[IACS UR P4]

CHAPTER CONTENTS

D1. PRODUCTION AND APPLICATION OF PLASTIC PIES ON SHIPS

100 Terms and Conditions

Note: This Subchapter addresses the provisions of IMO Res. A.753(18). It is applicable for vessels having GT ≥ 500; however, it is recommended for vessel having GT < 500.

101. **Definitions**

a. "**Plastic(s)**" means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as PVC and fibre reinforced plastics - FRP.

b. "**Pipes/piping systems**" means those made of plastic(s) and include the pipes, fittings, system joints, method of joining and any internal or external liners, coverings and coatings required to comply with the performance criteria.

c. "**Joint**" means joining pipes by adhesive bonding, laminating, welding, etc.

d. "**Fittings**" means bends, elbows, fabricated branch pieces etc. of plastic materials.

e. "**Nominal pressure**" means the maximum permissible working pressure which are to be determined in accordance with the requirements in B4.300.

f. "**Design pressure**" means the maximum working pressure which is expected under operation conditions or the highest set pressure of any safety valve or pressure relief device on the system, if fitted.

g. "**Fire endurance**" means the capability of piping to maintain its strength and integrity (i.e. capable of performing its intended function) for some predetermined period of time while exposed to fire.

200. Scope

201. These requirements are applicable to plastic pipes/piping systems on ships.

202. The requirements are not applicable to flexible pipes and hoses and mechanical couplings used in metallic piping systems.

203. Piping systems made of thermoplastic materials, such as polyethylene(PE), polypropylene(PP), polybutylene (PB) and intended for non-essential services are to meet the requirements of recognized standards and the requirements of the present Chapter D, item D1.500, and for installation Part II, Title 11, Chapter B, Subchapter B4.

300. General Requirements

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

302. **Strength**

a. The strength of the pipes is to be determined by a hydrostatic test failure pressure of a pipe specimen under the standard conditions: atmospheric pressure equal to 100 kPa, relative humidity 30%, environmental and carried fluid temperature 298 kPa (25°C).

b. The strength of fittings and joints is to be no less than that of the pipes.

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

c.1. **Internal Pressure**: For an internal pressure the following is to be taken whichever is smaller:

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

where

P_{sth} = short-term hydrostatic test failure pressure;

P_{lth} = long-term hydrostatic test failure pressure
(> 100,000 h)

c.2. **External Pressure**

For an external pressure:

Pn ext ≤ Pcol/3

where Pcol - pipe collapse pressure.

d. In no case is the collapse pressure to be less than 3 bar.

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

f. The maximum permissible working pressure is to be specified with due regard for maximum possible working temperatures in accordance with Manufacturer's recommendations.

303. **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 B4.301).

303. **Impact Resistance**

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

b. After the test the specimen is to be subjected to hydrostatic pressure equal to 2.5 times the design pressure for at least 1 hour.

304. **Temperature**

a. The permissable working temperature depending on the working pressure is to be in accordance with Manufacturer's recommendations, but in each case it is to be at least 20ºC lower than the minimum heat distortion temperature of the pipe material, determined according to ISO 75 method A, or equivalent.

b. The minimum heat distortion temperature is to be no less than 80ºC.

400. Requirements for Pipes/Piping Systems Depending on Service and/or Locations

401. **Fire endurance**

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

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

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

b.2. Level 2. Piping having passed the fire endurance test specified in Appendix 1 of IMO Res. A.753(18) for a duration of a minimum of 30 minutes in the dry

b.3. condition is considered to meet level 2 fire endurance standard (L2).

b.4. Level 3. Piping having passed the fire endurance test specified in Appendix 2 of IMO Res. A.753 (18) for a duration of a minimum of 30 minutes in the wet condition is considered to meet level 3 fire endurance standard (L3).

Guidance

Abstract from IMO IMO Res A.753(18), Appendix 1.

APPENDIX 1 TEST METHOD FOR FIRE "ENDURANCE TESTING OF PLASTIC PIPING IN THE DRY CONDITION".

Test method

1 A furnace test with fast temperature increase likely to occur in a fully developed liquid hydrocarbon fire. The time/temperature of the furnace should be as follows:

at the end of 5 min: 945°C
at the end of 10 min: 1033°C
at the end of 15 min: 1071°C
at the end of 30 min: 1098°C
at the end of 60 min: 1100°C

Notes:

1 The accuracy of the furnace control should be as follows:

During the first 10 min of the test the area under the curve of mean furnace temperature should not vary by more than +/- 15% of the area under the standard curve.

During the first half hour of the test the area under the curve of mean furnace temperature should not vary by more than +/- 10% of the area under the standard curve.

For any period after the first half hour of the test the area under the curve of mean furnace temperature should not

vary by more than +/- 5% of the area under the standard curve.

At any time after the first 10 min of the test the mean furnace temperature should not differ from the standard curve by more than +/- 100°C.

The locations where the temperatures are measured, the number of temperature measurements and the measurement techniques are to be agreed by the Administration taking into account the furnace control specification as set out in paragraphs 7.1, 7.2 and 7.3 of the annex to Assembly resolution A.754(18).

Test specimen

The test specimen should be prepared with the joints and fittings intended for use in the proposed application. The number of specimens should be sufficient to test typical joints and fittings including joints between non-metal and metal pipes and fittings to be used. The ends of the specimen should be closed. One of the ends should allow pressurized nitrogen to be connected. The pipe ends and closures may be outside the furnace. The general orientation of the specimen should be horizontal and it should be supported by one fixed support with the remaining supports allowing free movement. T he free length between supports should not be less than 8 times the pipe diameter.

Notes:

1 Most materials other than steel used for pipes will require a thermal insulation to be able to pass this test. The test procedure should include the insulation and its covering.

2 The number and size of test specimens required for the approval test should be specified by the Administration.

Test conditions

If the insulation contains, or is liable to absorb, moisture the specimen should not be tested until the insulation has reached an air-dry condition. This condition is defined as equilibrium with an ambient atmosphere of 50% relative humidity at 20 +/- 5°C. Accelerated conditioning is permissible provided the method does not alter the properties of component material. Special samples should be used for moisture content determination and conditioned with the test specimen. These samples should be so constructed as to represent the loss of water vapour from the specimen by having similar thickness and exposed faces.

A nitrogen pressure inside the test specimen should be maintained automatically at. 0.7 bar + 0.1 bar during the test. Means should be provided to record the pressure inside the pipe and the nitrogen flow into and out of the specimen in order to indicate leakage.

Acceptance criteria

During the test, no nitrogen leakage from the sample should occur.

After termination of the furnace test, the test specimen together with fire protection coating, if any, should be allowed to cool in still air to ambient temperature and then tested to the rated pressure of the pipes. The pressure should be held for a minimum of 15 min.

Pipes without leakage qualify as level 1 or 2 depending on the test duration.

Pipes with negligible leakage, i.e. not exceeding 5% flow loss, qualify as level 1W or level 2W depending on the test duration.

Where practicable, the hydrostatic test should be conducted on bare pipe, that is pipe which has had all of its coverings including fire protection insulation removed, so that leakage will be readily apparent.

Alternative test methods and/or test procedures considered to be at least equivalent including open pit testing method, may be accepted in cases where the pipes are too large for the test furnace.

APPENDIX 2 TEST METHOD FOR FIRE ENDURANCE TESTING OF WATER-FILLED PLASTIC PIPING

1 Test method

A propane multiple burner test with a fast temperature increase should be used.

For piping up to 152 mm in diameter, the fire source should consist of two rows of 5 burners as shown in Figure 1.

A constant heat flux averaging 113.6 kW/m² (+/-10%) should be maintained 12.5 +/-1 cm above the centreline of the burner array.

This flux corresponds to a pre-mix flame of propane with a fuel flow rate of 5 kg/h for a total heat release rate of 65 kW. The gas consumption should be measured with an accuracy of least +/- 3% in order to maintain a constant heat flux.

Propane with a minimum purity of 95% should be used.

FIG. 1 FIRE ENDURANCE TEST. BURNER ASSEMBLY

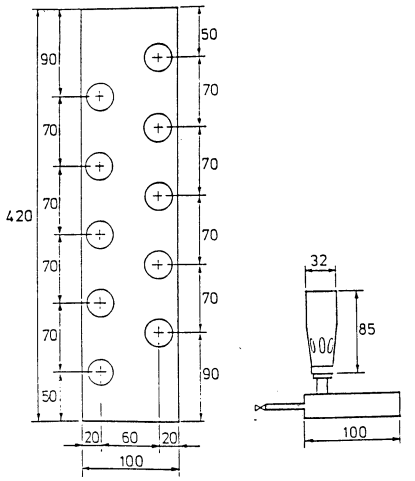


FIG. 1 FIRE ENDURANCE TEST
BURNER ASSEMBLY

For piping greater than 152 mm in diameter, one additional row of burners should be included for each 51 mm increase in pipe diameter.

A constant heat flux averaging 113.6 kW/m² (+/- 10%) should still be maintained at the 12.5 +/- 1 cm height above the centreline of the burner array. The fuel flow should be increased as required to maintain the designated heat flux.

The burners should be type "Sievert No. 2942" or equivalent which produces an air mixed flame. The inner diameter of the burner heads should be 29 mm (see figure 1). The burner heads should be mounted in the same plane and supplied with gas from a manifold. If necessary, each burner should be equipped with a valve in order to adjust the flame height.

The height of the burner stand should also be adjustable. It should be mounted centrally below the test pipe with the rows of burners parallel to the pipe's axis. The distance between the burner heads and the pipe should be maintained at 12.5 +/- 1 cm during the test. The free length of the pipe between its supports should be 0.8 +/- 0.05 m.

2 Test Specimen

Each pipe should have a length of approximately 1.5 m.

The test pipe should be prepared with permanent joints and fittings intended to be used. Only valves and straight joints versus elbows and bends should be tested as the adhesive in the joint is the primary point of failure. The number of pipe specimens should be sufficient to test all typical joints and fittings. The ends of each pipe specimen should be closed. One of the ends should allow pressurized water to be connected.

If the insulation contains, or is liable to absorb, moisture the specimen should not be tested until the insulation has reached an air-dry condition. This condition is defined as equilibrium with an ambient atmosphere of 50% relative humidity at 20 +/- 5°C. Accelerated conditioning is permissible provided the method does not alter the properties of the material.

Special samples should be used for moisture content determination and conditioned with the test specimen. These samples should be so constructed as to represent the loss of water vapour from the specimen by having similar thickness and exposed faces.

The pipe samples should rest freely in a horizontal position on two V-shaped supports. The friction between pipe and supports should be minimized. The supports may consist of two stands, as shown in figure 2.

FIG. 2 FIRE ENDURANCE TEST. STAND WITH MOUNTED SAMPLE

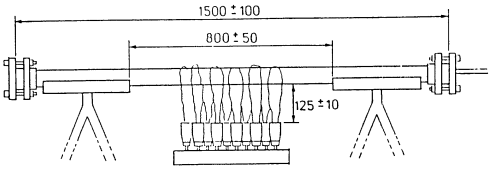


FIG. 2 FIRE ENDURANCE TEST.
STAND WITH MOUNTED SAMPLE

A relief valve should be connected to one of the end closures of each specimen.

3 Test conditions

The test should be carried out in a sheltered test site in order to prevent any draught influencing the test.

Each pipe specimen should be completely filled with deaerated water to exclude air bubbles.

The water temperature should not be less than 15°C at the start and should be measured continuously during the test.

The water inside the sample should be stagnant and the pressure maintained at 3 +/- 0.5 bar during the test.

4 Acceptance criteria

- During the test, no leakage from the sample(s) should occur except that slight weeping through the pipe wall may be accepted.

- After termination of the burner regulation test, the test sample, together with fire protection coating, if any, should be allowed to cool to ambient temperature and then tested to the rated pressure of the pipes. The pressure should be held for a minimum of 15 min without significant leakages, i.e. not exceeding 0.2 l/min. Where practicable, the hydrostatic test should be conducted on bare pipe, that is pipe which has had all of its coverings

including fire protection insulation removed, so that leakage will be readily apparent.

End of guidance

c. Permitted use of piping depending on fire endurance, location and piping system is given in Table T.B4.401.1 "Fire Endurance Requirement Matrix".

TABLE T.B4.401.1 - FIRE ENDURANCE REQUIREMENT MATRIX"

No.	Piping Systems	Location										
	A	A	B	C	D	E	F	G	H	I	J	K
		Machinery spaces category A	Other machinery spaces and pump rooms	Cargo pump room	Ro/Ro cargo holds	Other dry cargo holds	Cargo tanks	Fuel oil tanks	Balast water tanks	Coffer dams void spaces pipe tunnel & ducts	Accommo dation service & control spaces	Open decks
1	2	3	4	5	6	7	8	9	10	11	12	13
CARGO (FLAMMABLE CARGOES flash point ≤ 60°c												
1	Carlgo Lines	NA	NA	L1	NA	NA	O	NA	O[10]	O	NA	L1[2]
2	Crude Oil washing lines	NA	NA	L1	NA	NA	O	NA	O[10]	O	NA	L1[2]
NA	Vent lines	NA	NA	L1	NA	NA	O	NA	O[10]	O	NA	X
INERT GAS												
4	Water seal efluente line	NA	NA	O[1]	NA	NA	O[1]	O[1]	O[1]	O[1]	NA	O
5	Scrubber efluente line	O[1]	O[1]	NA	NA	NA	NA	NA	O[1]	O[1]	NA	O
6	Main line	O	O	L1	NA	NA	NA	NA	NA	O	NA	L1[6]
7	Distribution lines	NA	NA	L1	NA	NA	O	NA	NA	O	NA	L1[2]
FLAMMABLE LIQUIDS flash point ≤ 60°C												
8	Cargo lines	X	X	L1	X	X	NA[3]	O	O[10]	O	NA	L1
9	Fuel oil	X	X	L1	X	X	NA[3]	O	O	O	L1	L1
10	Lubricating oil	X	X	L1	X	X	NA	NA	NA	O	L1	L1
11	Hydraulic oil	X	X	L1	X	X	O	O	O	O	L1	L1
SEAWATER												
12	Bilge & man banches	L1[7]	L11	L1	X	X	NA[3]	O	O	O	NA	L1
13	Fire main & water spray	L1	L1	L1	X	NA	NA	NA	O	O	X	L1
14	Foam system	L1	L1	L1	NA	NA	NA	NA	NA	O	L1	L1
15	Sprinkler system	L1	L1	L3	X	NA	NA	NA	O	O	L3	L3
16	Ballast	L3	L3	L3	L3	X	O[10]	O	O	O	L2	L2
17	Cooling water, essential services	L3	L3	NA	NA	NA	NA	NA	O	O	NA	L2
18	Tnak cleaning services fixed machines	NA	NA	L3	NA	NA	O	NA	O	O	NA	L3[2]
19	Non-essential services	O	O	O	O	O	NA	O	O	O	O	O
FRESHWATER												
20	Cooling water essential services	L3	L3	NA	NA	NA	NA	O	O	O	L3	L3
21	Condensate return	L3	L3	L3	O	O	NA	NA	NA	O	O	O
22	Non-essential systems	O	O	O	O	O	NA	O	O	O	O	O
SANITARY / DRAINS / SCUPPERS												
23	Deck drains (internal)	L1[4]	L1[4]	NA	L1[4]	O	NA	O	O	O	O	O
24	Sanitary items (internal)	O	O	NA	O	O	NA	O	O	O	O	O
25	Scuppers and discharges (overboard)	O [1,8]	O [1,8]	O [1,8]	O [1,8]	O [1,8]	O	O	O	O	O [1,8]	O
SOUNDING / AIR												
26	Water tanks / dry spaces	O	O	O	O	O	O[10]	O	O	O	O	O
27	Oil tanks flash point > 60 °C	X	X	X	X	X	X[3]	O	O[10]	O	X	X
MISCELLANEOUS												
28	Control air	L1[5]	L1[5]	L1[5]	L1[5]	L1[5]	NA	O	O	O	L1[5]	L1[5]
29	Service air (essential)	O	O	O	O	O	NA	O	O	O	O	O
30	Brine	O	O	NA	O	O	NA	NA	NA	O	O	O
31	Auxiliary pressure steam (≤ 7 bar)	L2	L2	O[9]	O[9]	O[9]	O	O	O	O	O[9]	O[9]

Abreviations:

L1 Fire endurance test (appendix 1) in dry conditions, 60 min
L2 Fire endurance test (appendix 1) in dry conditions, 30 min
L3 Fire endurance test (appendix 2) in wet conditions, 30 min
O No fire endurance test required
NA Not applicable
X Metallic materials having a melting point greater than 925ºC

Footnotes:

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

2. Remote closing valves to be provided at the cargo tanks.

3. When cargo tanks contain flammable tanks with f.p. > 60°C, "O" may replace "NA" or "X".

4. For drains serving only the space concerned, "O" may replace "L1".

5. When controlling functions are not required by statutory requirements or guidelines, "O" may replace "L1".

6. For pipe between machinery space and deck water seal, "O" may replace "L1".

7. For passenger vessels, "X" is to replace "L1".

8. Scuppers serving open decks in positions 1 and 2, as defined in regulation 13 of the International Convention on Load Lines, 1966, should be "X" throughout unless fitted at the upper end with the means of closing capable of being operated from a position above the freeboard deck in order to prevent downflooding.

9. For essential services, such as fuel oil tank heating and ships whistle, "X" is to replace "O".

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

TABLE T.B4.401.2 – LOCATION DEFINITIONS

Location	Definition
A - Machinery spaces of category A	Machinery spaces of category A as defined in SOLAS* regulation II-2/3.19.
B - Other machinery spaces and pump rooms	Spaces, other than category A machinery spaces and cargo pump rooms, containing propulsion machinery, boilers, steam and internal combustion engines, generators and major electrical machinery, pumps, oil filling stations, refrigerating, stabilising, ventilation and air-conditioning machinery, and similar spaces and trunks to such spaces.
C - Cargo pump rooms	Spaces containing cargo pumps and entrances and trunks to such spaces.
D - Ro-ro cargo holds	Ro-ro cargo holds are ro-ro cargo spaces and special category spaces and special category spaces as defined in SOLAS* regulation II-2/3.14 and 3.18.
E - Other dry cargo holds	All spaces other than ro-ro cargo holds used for non- liquid cargo and trunks to such spaces.
F - Cargo tanks	All spaces used for liquid cargo and trunks to such spaces.
G - Fuel oil tanks	All spaces used for fuel oil (excluding cargo tanks) and trunks to such spaces.
H - Ballast water tanks	All spaces used for ballast water and trunks to such spaces.
I - Cofferdams, voids, etc.	Cofferdams and voids are those empty spaces between two bulkheads separating two adjacent compartments.
J - Accommodation, servisse	Accommodation spaces, service spaces and control stations as defined in SOLAS* regulation II-2/3.10, 3.12, 3.22.
K - Open decks	Open deck spaces as defined in SOLAS* regulation II-2/26.2.2. (5).

* SOLAS 74 as amended by the 1978 SOLAS Protocol and the 1981 and 1983 amendments (consolidated text).

402. **Flame Spread**

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

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

c. Surface flame spread characteristics may also be determined using the text procedures given in ASTM D635, or in other national equivalent standards.

403. **Fire Protection Coatings**

a. 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:

a.1. The pipes are generally to be delivered from the manufacturer with the protective coating on.

a.2. The fire protection properties of the coating are not to be diminished when exposed to salt water, oil or bilge slops. It is to be demonstrated that the coating is resistant to products likely to come into contact with the piping.

a.3. In considering fire protection coatings, such characteristics as thermal expansion, resistance against vibrations, and elasticity are to be taken into account.

a.4. The fire protection coatings are to have sufficient resistance to impact to retain their integrity.

404. **Electrical Conductivity**: Where electrical conductivity is to be ensured, the resistance of the pipes and fittings is not to exceed 1 x 105 Ohm/m.

500. Material approval and Quality Control During Manufacture

501. Prototypes of pipes and fittings are to be tested to determine short-term and long-term design strength, fire endurance and low surface flame spread characteristics (if applicable), electrical resistance (for electrically conductive pipes), impact resistance in accordance with this Chapter.

502. For prototype testing representative samples of pipes and fittings are to be selected to the satisfaction of the RBNA.

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

504. Each pipe and fitting is to be tested by the Manufacturer at a hydrostatic pressure not less than 1.5 times the nominal pressure. Alternatively, for pipes and fittings not employing hand lay up techniques, the hydrostatic pressure test may be carried out in accordance with the hydrostatic testing requirements stipulated in the recognised national or international standard to which the pipe or fittings are manufactured, provided that there is an effective quality system in place.

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

506. In case the Manufacturer does not have an approved quality system complying with ISO 9000 series or equivalent, pipes and fittings are to be tested in accordance with this Subchapter to the satisfaction of the RBNA's surveyors for every batch of pipes.

507. Depending upon the intended application a RBNA may require the pressure testing of each pipe and/or fitting.

CHAPTER T
INSPECTIONS AND TESTS

CHAPTER CONTENTS

T1. APPLICATION

100. Application

101. The RBNA will carry out the following inspections:

a. Inspection of the conditions of manufacturing;

b. Checking of the mechanical properties of the steel employed in the pipes manufacturing; and

c. Checking the weldability of the steel.

102. The present procedures apply to all ships regardless of their gross tonnage.

T2. TESTING OF MATERIALS

100. Tests for pipes and accessories Classes I and II

101. Material for pipes, valves and relative fittings belonging to Classes I and II and for valves and pipes fitted on the ship's side and for valves fitted on the collision bulkhead are to be tested accordance with the following Subchapter T3.

102. The RBNA may require internal workshop certificates for pipes, valves and fittings belonging to Class III.

200. Non destructive testing of welds and acceptance criteria [IACS UR P2.6]

201. In general, the welded joints including the inside wherever possible shall be visually examined and non destructive tests will be required depending on the class of pipes and type of joint as hereunder indicated.

202. Butt-welded joints - Radiographic examination is to be required as follows:

a. pipes of Class I: full radiographic examination when the outside diameter is greater than 75 mm;

b. pipes of Class II: at least 10% random radiography when the outside diameter is greater than 100 mm.

c. More stringent requirements may be applied at the RBNA’s discretion depending on the kind of materials, welding procedure and controls during the fabrication.

d. An approved ultrasonic testing procedure may be accepted, at the RBNA's discretion, in lieu of radiographic testing when the conditions are such that a comparable level of weld quality is assured.

203. Fillet welds of flange pipe connections are to be examined by the magnetic particle method or by other appropriate non-destructive methods, in case of Class I pipes. In other cases, magnetic particle examination or equivalent non-destructive testing may be required at the discretion of the Surveyor.

204. Ultrasonic examination in addition to the above non-destructive testing may be required in special cases at the RBNA's discretion.

205. Radiographic and ultrasonic examination is to be performed with an appropriate technique by trained operators. At the request of the RBNA, complete details of the radiographic or ultrasonic technique is to be submitted for approval.

206. Magnetic particle examination is to be performed with suitable equipment and procedures, and with a magnetic flux output sufficient for defect detection. The equipment may be required to be checked against standard samples.

207. The welds are to meet the acceptable standard level as required by the individual RBNA. Unacceptable defects are to be removed and repaired according to the satisfaction of the RBNA.

208. After manufacturing the pipes are to be normalized. The heat treatment of hot produced steel pipes might be dispensed with if the final heating has been is done to the adequate temperature.

T3. MECHANICAL TESTS AND DUCTILITY TESTS FOR PIPES AND TUBES [IACS UR W2.8]

100. Application

101. The following mechanical tests and ductility tests are to be carried out:

a. tensile test;

b. flattening test;

c. drift expanding test;

d. flanging test;

e. ring expanding test;

f. ring tensile test;

200. Flattening test specimens

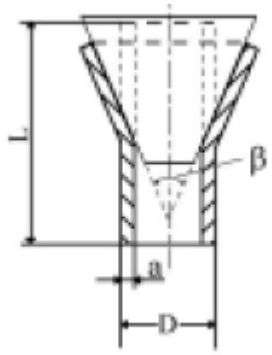
201. Length is to be from 10mm to 100mm. Plain and smoothed ends cut perpendicular to the tube axis. Reference is made to ISO 8492.

202. For pipes detined to pressure piping the ring expanding tes may be dispensed with and the flattening test may be substituted for a bending test.

300. Drift expanding test

201. The lengths *L* of the drift expanding test specimens are to be as follows. Reference is made to ISO 8493.

202. *Metallic tubes*: *L* equal to twice the external diameter *D* of the tube if the angle of the drift is 30°, and *L* equal to 1.5*D* if the angle of the drift is 45° or 60°. The test piece may be shorter provided that after testing the remaining cylindrical portion is not less than 0.5D. The rate of penetration of the mandrel shall not exceed 50mm/min.



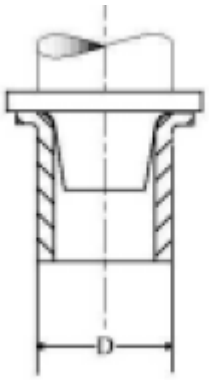
300. Flanging test

301. The flanging test specimen is to be of length *L* equal to approximately 1.5D.

302. The test piece may be shorter provided that after testing the remaining cylindrical portion is not less than 0,5*D*.

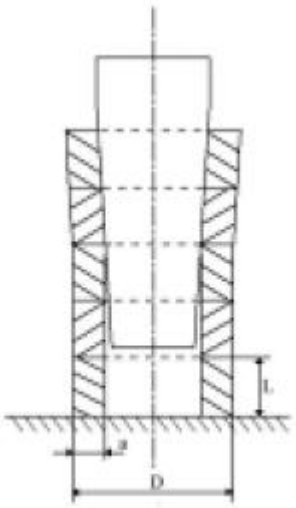
303. The rate of penetration of the forming tool shall not exceed 50mm/min.

304. Reference is made to ISO 8494.



400. Ring expanding test [W2.8.4]

401. The test piece consists of a ring having a length of between 10 and 16 mm. The rate of penetration of the mandrel shall not exceed 30mm/s. Reference is made to ISO 8495.



500. Ring tensile test

501. The ring shall have a length of about 15mm with plain and smoothed ends cut perpendicular to the tube axis.

502. The ring is to be drawn to fracture by means of two mandrels placed inside the ring and pulled in tensile testing machine. The rate shall not exceed 5mm/s.

503. Reference is made to ISO 8496.

T4. HYDROSTATIC TESTS [IACS UR P2.8]

100. Hydrostatic tests of piping [P2.8]

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101. All Classes I and II pipes and integral fittings and, in all cases, all steam pipes, feed pipes, compresses air pipes and fuel oil pipes having a design pressure greater than 3,5 bar and relative integral fittings, after completion of manufacture but before insulation and coating, if any, shall be subject to a hydrostatic test in the presence of the Surveyor at the following value of pressure:

$$P_H = 1{,}5P$$

where
P_H = test pressure (bar)
P = design pressure (bar) as defined in Part II, Title 11, Section 6, Subchapter D3, Item 700.

102. For steel pipes and integral fittings for temperatures above 300°C, the test pressure is to be determined by the following formula but it is not necessary that it exceeds 2P:

$$P_H = 1{,}5P\frac{K_{100}}{K_T}$$

where
K_{100} = permissible stress at 100°C
K_T = permissible stress at the design temperature

103. The value of the test pressure may be reduced, with the approval of the RBNA, to 1,5P in order to avoid excessive stress in way of bends, T-pieces, etc.

104. In no case is the membrane stress to exceed 90 percent of the yield stress at the testing temperature.

105. When, for technical reasons, it is not possible to carry out complete hydrotesting before assembly on board, for all sections of piping, proposals are to be submitted for approval to the RBNA for testing the closing lengths of piping, particularly in respect to the closing seams.

106. When the hydrostatic test of piping is carried out on board, these tests may be carried out in conjunction with the test required under Part II, Title 11, Section 6, Subchapter T1, t1.103.

107. Pressure testing of small bore pipes (less than about 15 mm) may be waived at the discretion of the RBNA depending on the application.

200. Flexible Hoses: Tests [IACS UR P2.12.5 to 12.6]

201. Acceptance of flexible hose assemblies is subject to satisfactory prototype testing.

202. Prototype test programmes for flexible hose assembles are to be submitted by the manufacturer and are to be sufficiently detailed to demonstrate performance in accordance with the specified standards.

203. The tests are, as applicable, to be carried out on different nominal diameters of hose type complete with end fittings for pressure, burst, impulse resistance and fire resistance in accordance with the requirements of the relevant standard. The following standards are to be used as applicable.

a. ISO 6802 - Rubber and plastics hoses and hose assemblies - Hydraulic pressure impulse test without flexing.

b. ISO 6803 - Rubber and plastics hoses and hose assemblies - Hydraulic pressure impulse test with flexing.

c. ISO 15540 - Ships and marine technology - Fire resistance of hose assemblies – Test methods.

d. ISO 15541 - Ships and marine technology - Fire resistance of hose assemblies - Requirements for test bench.

e. ISO 10380 - Pipework - Corrugated metal hoses and hose assemblies.

NOTE: Other standards may be accepted where agreed by the RBNA.

204. All flexible hose assemblies are to be satisfactorily prototype burst tested to na international standard* to demonstrate they are able to withstand a pressure not less than four times its design pressure without indication of failure or leakage.

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

206. Flexible hoses are to be permanently marked by the manufacturer with the following details:

a. Hose manufacturer’s name or trademark;

b. Date of manufacture (month/year);

c. Designation type reference;

d. Nominal diameter;

e. Pressure rating;

f. Temperature rating.

207. Where a flexible hose assembly is made up of items from different manufacturers, the components are to be

clearly identified and traceable to evidence of prototype testing.

T5. TESTING OF PLASTIC PIPES * [IACS UR P4.7]

* This UR addresses the provisions of IMO Res. A.753(18).

100. Testing After Installation on Board

101. Piping systems for essential services are to be subjected to a test pressure no less than 1.5 times the design pressure or 4 bar whichever is greater.

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

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

200. Test Specification For Plastic Pipes

201. **Scope**: the present subchapter T5 contains requirements for the Type Approval of plastic pipes. It is applicable to rigid pipes, pipe joints and fittings.

202. **Documentation**: the following information for the plastic pipes, fittings and joints is to be submitted for consideration and approval:

a. Pipe and fitting dimensions

b. Maximum internal and external working pressure

c. Working temperature range

d. Intended services and installation locations

e. The level of fire endurance

f. Electrically conductive

g. Intended fluids

h. Limits on flow rates

i. Serviceable life

j. Installation instructions

k. Details of marking

203. **Drawings and supporting documentation**:

a. Certificates and reports for relevant tests previously carried out.

b. Details of relevant standards.

c. All relevant design drawings, catalogues, data sheets, calculations and functional descriptions.

d. Fully detailed sectional assembly drawings showing pipe, fittings and pipe connections.

204. **Materials**

a. The resin type.

b. Catalyst and accelerator types, and concentration employed in the case of reinforced polyester resin pipes or hardeners where epoxide resins are employed.

c. A statement of all reinforcements employed where the reference number does not identify the mass per unit area or the tex number of a roving used in a filament winding process, these are to be detailed.

d. Full information regarding the type of gel-coat or thermoplastic liner employed during construction, as appropriate.

e. Cure/post-cure conditions. The cure and post cure temperatures and times employ resin/reinforcement ratio.

f. Winding angle and orientation

300. Testing

301. Testing is to demonstrate compliance of the pipes, fittings and joints for which Type Approval is sought with the requirements of this Part III, Title 62, Section 6, Chapter D.

302. Pipes, joints and fittings are to be tested for compliance with the requirements of standards* acceptable to RBNA.

* For the lists of standards refer to Part III, Tiutle 62, Chapter C **[IACS Rec 86.]**

T6. TYPE APPROVAL OF MECHANICAL JOINT [IACS UR P2.11]

100. General
[IACS UR P2.11]

101. This item T6.100 describes the type testing condition for type approval of mechanical joints intended for use in marine piping systems. Conditions outlined in these requirements are to be fulfilled before Type Approval Certificates are issued. RBNA may specify more severe testing conditions and additional tests if considered necessary to ensure the intended reliability and also accept alternative testing in accordance with national or international standards where applicable to the intended use and application.

102. **Scope**: This specification is applicable to mechanical joints defined in B5.200 including compression couplings and slip-on joints of different types for marine use.

103. **Documentation:** Following documents and information are to be submitted by Manufacturer for assessment and/or approval:

a. product quality assurance system implemented;

b. complete description of the product;

c. typical sectional drawings with all dimensions necessary for evaluation of joint design;

d. complete specification of materials used for all components of the assembly;

e. proposed test procedure as required in T6.107 and corresponding test reports or other previous relevant tests;

f. initial information:

f.1. maximum design pressures (pressure and vacuum);

f.2. maximum and minimum design temperatures;

f.3. conveyed media;

f.4. intended services;

f.5. maximum axial, lateral and angular deviation, allowed by manufacturer;

f.6. installation details.

105. **Materials**: the materials used for mechanical joints are to comply with the requirements of B5.206. The manufacturer has to submit evidence to substantiate that all components are adequately resistant to working the media at design pressure and temperature specified.

200. Testing, procedures and requirements.

201. The aim of tests is to demonstrate ability of the pipe joints to operate satisfactory under intended service conditions. The scope and type of tests to be conducted e.g. applicable tests, sequence of testing, and the number of specimen, is subject to approval and will depend on joint design and its intended service in accordance with the requirements of this Chapter

202. Unless otherwise specified, the water or oil as test fluid is to be used.

203. **Test program**: Testing requirements for mechanical joints are to be as indicated in Table T.T6.110.1.

204. **Selection of Test Specimen**

a. Test specimens are to be selected from production line or at random from stock.

b. Where there are various sizes from type of joints requiring approval, minimum of three separate sizes representative of the range, from each type of joints are to be subject to the tests listed in Table T.T6.204.1.

TABLE T.T6.204.1

Tests		Types of mechanical joints			Notes and references
		Compression coplings and pipe unions	Slip on Joints		
			Grip type & Machine grooved type	Slip type	
1	Tightness test	+	+	+	T6.400
2	Vibration (fatigue) test	+	+	-	T6.602
3	Pressure pulsation test[1]	+	+	-	T6.605
4	Burst pressure test	+	+	+	T6.606
5	Pull-out test	+	+	-	T6.607
6	Fire enduarance test	+	+	+	T6.608 If required by B4.208
7	Vacuum test	+[3]	+	+	T6.609 for suction lines only
8	Repeated assembly test	+[2]	+	-	T6.610

Notes:

Abbreviations:
+ test is required
- test is not required

1. for use in those systems where pressure pulsation other than water hammer is expected.
2. except press type.
3. except joints with metal-to-metal tightening surfaces.

300. Mechanical Joint Assembly [IACS UR P2.11.3]

301. Assembly of mechanical joints should consist of components selected in accordance with T6.204 and the pipe sizes appropriate to the design of the joints.

302. Where pipe material would affect the performance of mechnical joints, the selection of joints for testing is to take the pipe material into consideration.

303. Where not specified, the length of pipes to be connected by means of the joint to be tested is to be at least five times the pipe diameter. Before assembling the joint, conformity of components to the design requirements, is to be verified. In all cases the assembly of the joint shall be carried out only according to the manufacturer's instructions. No adjustment operations on the joint assembly, other than that specified by the manufacturer, are permitted during the test.

304. **Test Results Acceptance Criteria**: Where a mechanical joint assembly does not pass all or any part of the tests in Table T.T6.204.1, two assemblies of the same size and type that failed are to be tested and only those tests which mechanical joint assembly failed in the first instance, are to be repeated. In the event where one of the assemblies fails the second test, that size and type of assembly is to be considered unacceptable. The methods and results of each test are to be recorded and reproduced as and when required.

400. Methods of tests: Tightness test [P2.11.5.5.1]

401. In order to ensure correct assembly and tightness of the joints, all mechanical joints are to be subjected to a tightness test, as follows.

a. Mechanical joint assembly test specimen is to be connected to the pipe or tubing in accordance with the requirements of T6.300 and the manufacturers instructions, filled with test fluid and de-aerated.

a.1. Mechanical joints assemblies intended for use in rigid connections of pipe lengths, are not to be longitudinally restrained.

a.2. Pressure inside the joint assembly is to be slowly increased to 1.5 times of design pressure. This test pressure is to be retained for a minimum period of 5 minutes.

a.3. In the event where there is a drop in pressure or there is visual indication of leakage, the test (including fire test) shall be repeated for two test pieces.

a.4. If during the repeat test one test piece fails, the testing is regarded as having failed.

a.5. Other alternative tightness test procedure, such as pneumatic test, may be accepted.

b. For compression couplings a static gas pressure test is to be carried out to demonstrate the integrity of the mechanical joints assembly for tightness under the influence of gaseous media. The pressure is to be raised to maximum pressure or 70 bar whichever is less.

c. Where the tightness test is carried out using gaseous media as permitted in (a) above, then the static pressure test mentioned in (b) above need not be carried out.

500. Methods of tests: Vibration (fatigue) test [P2.11.5.5.2]

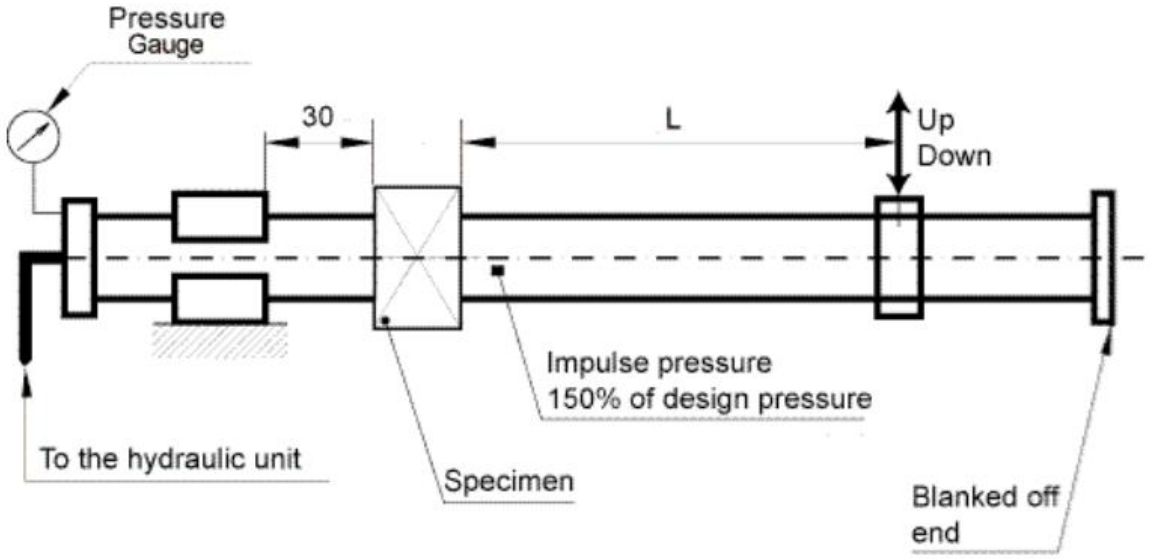
501. In order to establish the capability of the mechanical joint assembly to withstand fatigue, which is likely to occur due to vibrations under service conditions, mechanical joints assembly is to be subject to the following vibration test.

502. Conclusions of the vibration tests should show no leakage or damage, which could subsequently lead to a failure.

503. **Testing of compression couplings and pipe unions**

a. Compression couplings, pipe unions or other similar joints intended for use in rigid connections of pipe are to be tested in accordance with this method described as follows. Rigid connections are joints, connecting pip e length without free angular or axial movement. Two lengths of pipe are to be connected by means of the joint to be tested. One end of the pipe is to be rigidly fixed while the other end is to be fitted to the vibration rig. The test rig and the joint assembly specimen being tested are to be arranged as shown in Figure F.T6.5 03.1.

FIGURE F.T6.503.1 – TEST RIG



b. The joint assembly is to be filled with test fluid, de-aerated and pressurised to the design pressure of the joint.

c. Pressure during the test is to be monitored. In the event of drop in the pressure and visual signs of leakage the test is to be repeated as described in T6.304.

d. Visual examination of the joint assembly is to be carried out for signs of damage which may eventually lead to joint leakage.

e. Re-tightening may be accepted once during the first 1000 cycles.

f. Vibration amplitude is to be within 5% of the value calculated from the following formula: $A = \frac{2 \times S \times L^2}{3 \times E \times D}$

where:

A – single amplitude, mm

L – lenght of the pipe, mm

S – allowable bending stress in N/mm^2 based on 0.25 of the yield stress

E – modulus of elasticity of tube material (for mild steel, E=210 kN/mm^2)

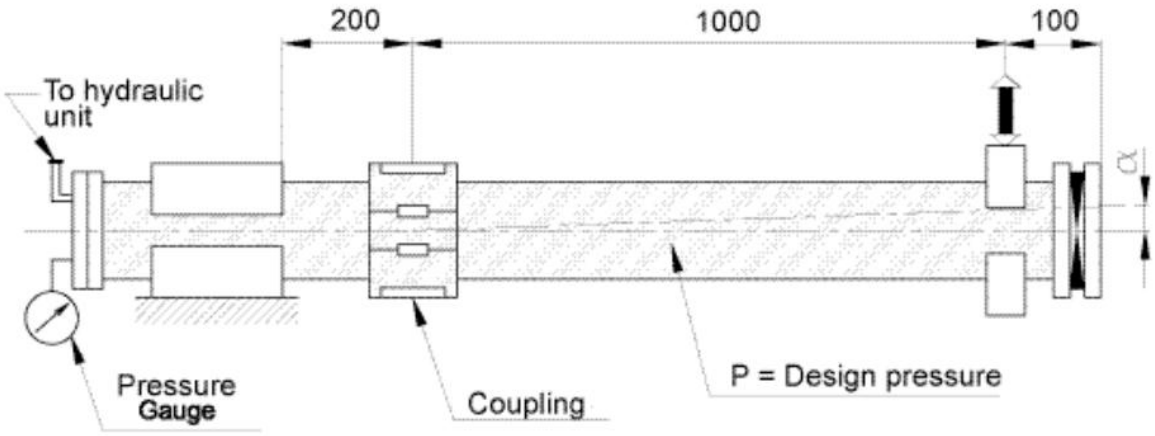
D – outside diameter of tube, mm

g. Test specimen is to withstand not less than 10 cycles with frequency 20 - 50 Hz without leakage or damage.

504. **Grip type and Machine grooved type joints**

a. Grip type joints and other similar joints containing elastic elements are to be tested in accordance with the following method. A test rig of cantilever type used for testing fatigue strength of components may be used. The test specimen being tested is to be arranged in the test rig as shown in FigureF.T6.504.1.

FIGUREF.T6.504.1 – TEST RIG



b. Two lengths of pipes are to be connected by means of joint assembly specimen to be tested.

c. One end of the pipe is to be rigidly fixed while the other end is to be fitted to the vibrating element on the rig. The length of pipe connected to the fixed end should be kept as short as possible and in no case exceed 200 mm.

d. Mechanical joint assemblies are not to be longitudinally restrained.

e. The assembly is to be filled with test fluid, de-aerated and pressurized to the design pressure of the joint. Preliminary angle of deflection of pipe axis is to be equal to the maximum angle of deflection, recommended by the manufacturer. The amplitude is to be measured at 1m distance from the center line of the joint assembly at free pipe end connected to the rotating element of the rig. (See Figure F.T6.504.1)

f. Parameters of testing are to be as indicated below and to be carried out on the same assembly:

TABLE T.T6.504.1 VIBRATION CYCLES

Number of cycles	Amplitude, mm	Frequency, Hz
$3 \cdot 10^6$	±0.06	100
$3 \cdot 10^6$	±0.5	45
$3 \cdot 10^6$	±1.5	10

g. Pressure during the test is to be monitored. In the event of a drop in the pressure and visual signs of leakage the test is to be repeated as described in T6.504.. Visual examination of the joint assembly is to be carried out for signs of damage which may eventually cause leakage.

600. Pressure pulsation test

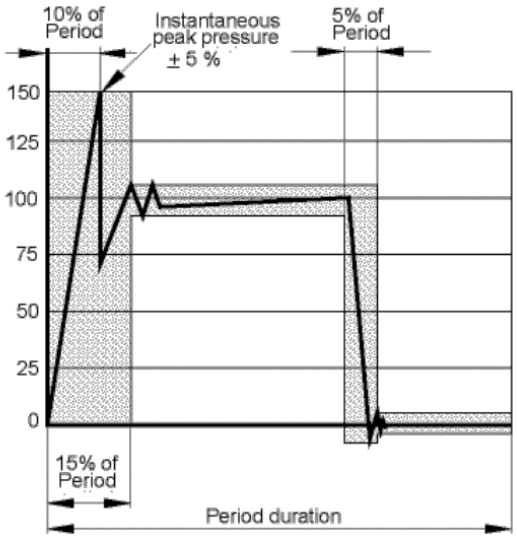
601. In order to determine capability of mechanical joint assembly to withstand pressure pulsation likely to occur during working conditions, joint assemblies intended for use in rigid connections of pipe lengths, are to be tested in accordance with the following method.

602. The mechanical joint test specimen for carrying out this test may be the same as that used in the test in T6.401.a provided it passed that test.

603. The vibration test in T6.500 and the pressure pulsation test are to be carried out simultaneously for compression couplings and pipe unions.

604. The mechanical joint test specimen is to be connected to a pressure source capable of generating pressure pulses of magnitude as shown in Figure F.T6.604.1.

FIGURE F.T6.604.1 – IMPULSE TEST DIAGRAM



605. Impulse pressure is to be raised from 0 to 1.5 times the design pressure of the joint with a frequency equal to 30-100 cycles per minute. The number of cycles is not to be less than $5 \cdot 10^5$

606. The mechanical joint is to be examined visually for sign of leakage or damage during the test.

700. Burst pressure test

a. In order to determine the capability of the mechanical joint assembly to withstand a pressure as stated by B5.207, the following burst test is to be carried out.

b. Mechanical joint test specimen is to be connected to the pipe or tubing in accordance with the requirements of, filled with test fluid, de-aerated and pressurized to test pressure with an increasing rate of 10% per minute of test pressure.

c. The mechanical joint assembly intended for use in rigid connections of pipe lengths is not to be longitudinally restrained.

d. Duration of this test is not to be less than 5 minutes at the maximum pressure. This pressure value will be annotated.

e. Where consider convenient, the mechanical joint test specimen used in tightness test in T6.601, same specimen may be used for the burst test provided it passed the tightness test.

f. The specimen may have small deformation whilst under test pressure, but no leakage or visible cracks are permitted.

800. Pull out test, fire endurance test and vacuum test

801 **Pull-out test**

a. In order to determine ability of a mechanical joint assembly to withstand axial load likely to be encountered in service without the connecting pipe from becoming detached, following pull-out test is to be carried out.

b. Pipe length of suitable size is to be fitted to each end of the mechanical joints assembly test specimen. The test specimen is to be pressurized to design pressure such that the axial loads imposed are of a value calculated by the following formula:

$$L = \frac{\pi}{4} D^2 p$$

where:

D – pipe outside diameter, mm

P – design pressure, N/mm^2

L – applied axial load, N

c. This axial load is to be maintained for a period of 5 minutes.

d. During the test, pressure is to be monitored and relative movement between the joint assembly and the pipe measured.

e. The mechanical joint assembly is to be visually examined for drop in pressure and signs of leakage or damage.

f. There are to be no movement between mechanical joint assembly and the connecting pipes.

802. **Fire endurance test**

a. In order to establish capability of the mechanical joints to withstand effects of fire which may be encountered in service, mechanical joints are to be subjected to a fire endurance test. The fire endurance test is to be conducted on the selected test specimens as per the following standards.

a.1. ISO 19921: 2005(E): Ships and marine technology – Fire resistance of metallic pipe components with resilient and elastomeric seals – Test methods

a.2. ISO 19922: 2005(E): Ships and marine technology – Fire resistance of metallic pipe components with resilient and elastomeric seals – Requirements imposed on the test bench.

b. Clarifications to the standard requirements:

b.1. If the fire test is conducted with circulating water at a pressure different from the design pressure of the joint (however of at least 5 bar) the subsequent pressure test is to be carried out to twice the design pressure.

b.2. A selection of representative nominal bores may be tested in order to evaluate the fire resistance of a series or range of mechanical joints of the same design.

b.3. When a mechanical joint of a given nominal bore (Dn) is so tested then other mechanical joints falling in the range Dn to 2xDn (both inclusive) are considered accepted.

803 **Vacuum test**

a. In order to establish capability of mechanical joint assembly to withstand internal pressures below atmosphere, similar to the conditions likely to be encountered under service conditions, following vacuum test is to be carried out.

b. Mechanical joint assembly is to be connected to a vacuum pump and subjected to a pressure 170 mbar absolute. Once this pressure is stabilized the mechanical joint assembly test specimen under test are to be isolated from the vacuum pump and this pressure is to be retained for a period of 5 minutes.

c. Pressure is to be monitored during the test.

d. No internal pressure rise is permitted.

804. **Repeated assembly test**

a. Mechanical joint test specimen are to be dismantled and reassembled 10 times in accordance with manufacturers instructions and then subjected to a tightness test as defined in T6.401 .

T8. TYPE TESTING OF AIR PIPE AUTOMATIC CLOSING DEVICES

100. Type Testing of Air Pipe Automatic Closing Devices [P3.4]

101. Each type and size of air pipe automatic closing device shall be surveyed and type tested at the manufacturer's works or other acceptable location according to the RBNA's practice. The minimum test requirements for an air pipe automatic closing device shall include the following:

200. Determination of the Flow Characteristics.

201. The flow characteristics of the air pipe closing device are to be determined. Measuring of the pressure drop versus rate of volume flow is to be carried out using water and with any intended flame or insect screens in place.

300. Tightness test during immersion/emerging in water.

301. An automatic closing device is to be subjected to a series of tightness tests involving not less than two (2) immersion cycles under each of the following conditions:

a. The automatic closing device is to be submerged slightly below the water surface at avelocity of approximately 4 m/min. and then returned to the original position immediately. The quantity of leakage shall be recorded.

b. The automatic closing device is to be submerged to a point slightly below the surface of the water. The submerging velocity is to be approximately 8 m/min and the air pipe vent head is to remain submerged for not less than 5 minutes. The quantity of leakage shall be recorded.

c. Each of the above tightness tests shall be carried out in the normal position as well as at an inclination of 40 degrees.

302. The maximum allowable leakage per cycle shall not exceed 2 ml/mm of nominal diameter of inlet pipe during any individual test.

400. Testing of non-metallic Floats [P3.4.2]

401. Impact and compression loading tests shall be carried out on the floats before and after pre-conditioning as follows:

Test temperature °C / Test condition	-25	20	85
Dry	+	+	+
After immerging in water	+	+	+
After immerging in fuel oil	-	+	-
Immerging in water and fuel oil is to be for at least 48 hours			

402. Impact Test: The test may be conducted on a pendulum type testing machine. The floats shall be subjected to 5 impacts of 2.5 Nm each and shall not suffer permanent deformation, cracking or surface deterioration at this impact loading.

403. Subsequently the floats shall be subjected to 5 impacts of 25 Nm each. At this impact energy level some localised surface damage at the impact point may occur. No permanent deformation or cracking of the floats shall appear.

404. Compression Loading Test: Compression tests shall be conducted with the floats mounted on a supporting ring of a diameter and bearing area corresponding to those of the float seating with which it is intended that float shall be used. For ball type float, loads shall be applied through a concave cap of the same internal radius as the test float and bearing on an area of the same diameter as the seating. For a disc type float, loads are to be applied through a disc of equal diameter as the float.

405. A load of 350 kg shall be applied over one minute and maintained for 60 minutes. The deflection shall be measured at intervals of 10 minutes after attachment of the full load. The record of deflection against time is to show no continuing increase in deflection and, after release of the load, there shall be no permanent deflection.

500. Testing of Metallic Floats

501. Tests shall be conducted in accordance with C1.401 the tests shall be carried out at room temperature and in the dry condition.

T9. PRESSURE VESSELS

100. Pressure vessels

101. Carbon steel or carbon-magnesium with recognized requirements are to be used in the construction of pressure vessels,

102. The steel is to be killed and, for certain applications such as use in low temperatures, fine-grained steel is to be employed.

103. The following tests shall be carried out and checked:

a. Mechanical tests and thickness measurements in the plating in three cross sections (neck, middle and bottom)

b. Removal of specimens for performing which follows:

b.1. Chemical analysis;

b.2. Tensile test;

b.3. Bending test taken from curved plating such as at the vessel’s bottom; and

b.4. Impact test if the material thickness is > 5 mm (at -20° C).

c. Hardness tests on vessels of killed or tempered steel, or in other cases at the discretion of the Surveyor.

d. Inside and outside visual inspection either directly or, in the case of very small aperture, with the aid of other resources, including:

d.1. Checking of dimensions

d.2. Tare determination

d.3. Capacity determination

d.4. Such inspections may be conducted by the manufacturer itself whom shall submit the report to the RBNA, being that the RBNA reserves the right to make partial checks.

e. Non-destructive tests such as ultrasound of the welds as determined on the occasion of the approval of plans.

f. Hydrostatic tests at 1.5 times the working pressure.

104. Additional tests may be required by the RBNA for vessels intended for specific applications.

105. In the case of mass production of cylinders, one sample will be chosed from each 200 manufactured.

106. The requirements for the tests are as follows:

a. In the tensile test, the values of yield strength, the ultimate strength and the elongation are to be measured. The minimum tensile value of yield strength, for thicknesses greater than or equal to 3 mm, is to be no less than the value calculated by the following formula, but in no case is to be less than 14%:

$\sigma_e \geq 2500 / (0{,}224 * \sigma_m)$

Where σ_m is the tensile value determined in the tensile test in N/mm^2.

b. For thicknesses less than 3 mm, the requirement for σe can be reduced of 15% to thicknesses up to 2 mm, and 30% for thicknesses less than 2 mm.

c. In the bending test, the angle to which the specimen is bent without showing defects is 180^0; ist should be used a mandrel with a diameter not exceeding "n" times the thickness of the specimen depends on the minimum tensile specified σ_m for steel, as specified in the table below:

TABLE T.T9.106.1 – BENDING TEST

σ_m N/mm^2	n
≤ 430	2
431-510	3
511-590	4
591-690	5
691-790	6
791-890	7
>890	8

d. In the impact test with notch in "V", the value of the absorbed energy, determined as the average of the three tests, is to not be less than the value indicated in the table below, in relation to specified ultimate tensile strength for the steel:

TABLE T.T9.106.2 – IMPACT TEST

	Ultimate Tensile Strength σ_m N/mm^2	Impact test With notch in "V" Energy absorbed J/cm
Steels C and C-Mn	≤ 510	34
Steel alloys killed or hardened	> 510	49

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