INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES

Requirements concerning PIPES AND PRESSURE VESSELS

IACS Req. 2000

CONTENTS

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P1 Rules for pipes

(Rev 2 1997) (Rev 3 May 1998) (Rev.4 June 2000)

P1.1 Scope

(1987)

This requirement is applicable to all piping systems covered by classification unless superseded by other UR and interpretation applicable to specific piping systems.
Chemical cargo and process piping are excluded from the scope of the present requirement.

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P1.2 Strength of pipes

(1972 Rev. 1 1987 Rev. 2 1997 Rev. 3 May, 1998)

P1.2.1 Required wall thickness

The minimum wall thickness of pipes is not to be less than the greater of the values obtained by P1.2.2, P1.2.3, as applicable, or the minimum wall thickness required by P1.2.4.

P1.2.2 Calculated wall thickness

The following requirements apply for pipes where the ratio outside-diameter to inside-diameter does not exceed the value 1.7.
The calculated wall thickness for straight or bent pressure pipes is not to be less than determined from the following formula, as applicable:

$$t = t_0 + b + c \quad (1)$$

where t = minimum calculated thickness(mm)
t_0 = thickness calculated by the following basic formula (mm)

$$t = \frac{PD}{20\,Ke + P} \quad (2)$$

P = design pressure (bar) (see P1.2.7)
D = outside diameter (mm)
K = permissible stress (N/mm^2) (from P1.2.5 and P1.2.6)
e = efficiency factor
(i) e = 1 for seamless pipes and for welded pipes delivered by manufacturers approved for making welding pipes which are considered as equivalent to seamless pipes.
(ii) for the other welded pipes the Classification Society will consider as efficiency factor value depending upon the service and the welded procedure.
b = allowance for bending
The value for this allowance is to be chosen in such a way that the calculated stress in the bend, due to the internal pressure only, does not exceed the permissible stress.
When this allowance is not determined by a more accurate procedure, it is to be taken as not less than:

$$b = \frac{1}{2{,}5}\,\frac{D}{R}\,t_0 \quad (3)$$

where R = mean radius of the bend (mm)
c = corrosion allowance (mm) (from Tables 1 and 2).

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P1.2.3 Manufacturing tolerance

The value of *t*, calculated above, does not account for any negative manufacturing tolerance; therefore the said thickness shall be increased considering the negative manufacturing tolerance by means of the following formula:

$$t_1 = \frac{t}{1 - a/100} \quad (4)$$

where t_1 = minimum thickness in the case of negative tolerance(mm)
t = minimum thickness calculated by formula (1) (mm)
a = percentage negative manufacturing tolerance.

P1.2.4 Minimum wall thickness

In all cases the minimum thickness of pipes shall not be less than that indicated in Tables 3-6. For pipes subject also to Load Line Regulations see LL36.

Table 1 Corrosion allowance *c* for steel pipes

Piping service	c (mm)
Superheated steam systems	0,3
Saturated steam systems	0,8
Steam coil systems in cargo tanks	2
Feed water for boilers in open circuit systems	1,5
Feed water for boilers in closed circuit systems	0,5
Blow down (for boilers) systems	1,5
Compressed air systems	1
Hydraulic oil systems	0,3
Lubricating oil systems	0,3
Fuel oil systems	1
Cargo oil systems	2
Refrigerating plants	0,3
Fresh water systems	0,8
Sea water systems in general	3

NOTE
1. For pipes passing through tanks an additional corrosion allowance is to be considered according to the figures given in the Table, and depending on the external medium, in order to account for the external corrosion.
2. For pipes efficiency protected, at the discretion of the Classification Society, the corrosion allowance may be reduced by not more than 50%.
3. In the case of use of special alloy steel with sufficient corrosion resistance, the corrosion allowance may be reduced to zero.

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Table 2 Corrosion allowance *c* for non-ferrous metal pipes

Piping material	c (mm)
Copper, brass and similar alloys, copper-tin alloys except those with lead contents	0,8
Copper-nickel alloys (with Ni ≥ 10%)	0,5
NOTE For media without corrosive action in respect of the material employed and in the case of special alloys with sufficient corrosion resistance the corrosion allowance may be reduced to zero.	

P1
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Table 3 Minimum wall thickness for steel pipes (All dimensions in mm)

Nominal size	Outside diameter	Wall thickness			
		A	B	C	D
6	10,2	1,6			
	12	1,6			
8	13,5	1,8			
10	17,2	1,8			
	19,3	1,8			
	20	2			
15	21,3	2		3,2	
	25	2		3,2	
20	26,9	2		3,2	
25	33,7	2		3,2	
	38	2	4,5	3,6	6,3
32	42,4	2	4,5	3,6	6,3
	44,5	2	4,5	3,6	6,3
40	48,3	2,3	4,5	3,6	6,3
	51	2,3	4,5	4	6,3
50	60,3	2,3	4,5	4	6,3
	63,5	2,3	4,5	4	6,3
	70	2,6	4,5	4	6,3
65	76,1	2,6	4,5	4,5	6,3
	82,5	2,6	4,5	4,5	6,3
80	88,9	2,9	4,5	4,5	7,1
90	101,6	2,9	4,5	4,5	7,1
	108	2,9	4,5	4,5	7,1
100	114,3	3,2	4,5	4,5	8
	127	3,2	4,5	4,5	8
	133	3,6	4,5	4,5	8
125	139,7	3,6	4,5	4,5	8
	152,4	4	4,5	4,5	8,8
150	168,3	4	4,5	4,5	8,8
	177,8	4,5	5	5	8,8
175	193,7	4,5	5,4	5,4	8,8
200	219,1	4,5	5,9	5,9	8,8
225	244,5	5	6,3	6,3	8,8
250	273	5	6,3	6,3	8,8
	298,5	5,6	6,3	6,3	8,8
300	323,9	5,6	6,3	6,3	8,8
350	355,6	5,6	6,3	6,3	8,8
	368	5,6	6,3	6,3	8,8
400	406,4	6,3	6,3	6,3	8,8
450	457,2	6,3	6,3	6,3	8,8

P1 cont'd

Notes of Table 3

Columns A, B, C and D in the table apply to the following services:

A Pipes in general

B Vent, overflow and sounding pipes for integral tanks

C Bilge, ballast and sea water pipes

D Bilge, ballast, vent, overflow and sounding pipes passing through fuel tank Bilge, vent, overflow, sounding and fuel pipes passing through ballast tanks.

Notes:

1. The nominal sizes, pipe diameters and wall thicknesses given in the table are many of the common sizes based on international standards. Diameter and thickness according to other national or international standards may be accepted.

2. For pipes efficiently protected against corrosion, at the discretion of the Classification Society, the thickness may be reduced by not more than 1 mm.

3. For sounding pipes, except those for flammable cargoes, the minimum wall thickness in column B is intended to apply only to the part outside the tank.

4. The minimum thicknesses listed in this table are the nominal wall thickness. No allowance needs to be made for negative tolerance or for reduction in thickness due to bending.

5. For threaded pipes, where allowed, the minimum wall thickness is to be measured at the bottom of the thread.

6. The minimum wall thickness for bilge lines and ballast lines through deep tanks will be subject to special consideration by the Classification Society. The minimum wall thickness for ballast lines through oil cargo tanks is not to be less than that specified by UR F15.

7. For larger diameters, the minimum wall thickness will be subject to special consideration by the Classification Society.

8. The minimum internal diameter for bilge, sounding, venting and overflow pipes shall be:

Bilge	50 mm bore
Sounding	32 mm bore
Venting and overflow	50 mm bore

9. Exhaust gas pipe minimum wall thickness will be subject to special consideration by the Classification Society.

10. The minimum wall thickness for cargo oil lines will be subject to special consideration by the Classification Society.

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Table 4 Minimum wall thickness for austenitic stainless steel pipes

External diameter D (mm)	Minimum wall thickness (mm)	External diameter D (mm)	Minimum wall thickness (mm)
10.2 to 17.2	1.0	219.1	2.6
21.3 to 48.3	1.6	273.0	2.9
60.3 to 88.9	2.0	323.9 to 406.4	3.6
114.3 to 168.3	2.3	over 406.4	4.0

Note: The external diameters and thicknesses have been selected from ISO-Standard 1127:1980. Diameters and thicknesses according to other national or international standards may be accepted.

P1
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Table 5 Minimum wall thickness for steel pipes for CO_2 fire extinguishing

External diameter D (mm)	From bottles to distribution station	From distribution station to nozzles
21,3 - 26,9	3,2	2,6
30 - 48,3	4	3,2
51 - 60,3	4,5	3,6
63,5 - 76,1	5	3,6
82,5 - 88,9	5,6	4
101,6	6,3	4
108 - 114,3	7,1	4,5
127	8	4,5
133 - 139,7	8	5
152,4 - 168,3	8,8	5,6

NOTES
1. Pipes are to be galvanized at least inside,except those fitted in the engine room where galvanizing may not be required at the discretion of the Classification Society.
2. For threaded pipes, where allowed, the minimum wall thickness is to be measured at the bottom of the thread.
3. The external diameters and thicknesses have been selected from ISO Recommendations R336 for smooth welded and seamless steel pipes. Diameter and thickness according to other national or international standards may be accepted.
4. For larger diameters the minimum wall thickness will be subject to special consideration by the Classification Society.
5. In general the minimum thickness is the natural wall thickness and no allowance need be made for negative tolerance and reduction in thickness due to bending.

P1
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Table 6 Minimum wall thickness for copper and copper alloy pipes

External diameter D (mm)	Minimum wall thickness (mm)	
	Copper	Copper alloy
8 - 10	1	0,8
12 - 20	1,2	1
25 - 44,5	1,5	1,2
50 - 76,1	2	1,5
88,9 - 108	2,5	2
133 - 159	3	2,5
193,7 - 267	3,5	3
273 - 457,2	4	3,5
(470)	4	3,5
508	4,5	4

NOTE
The external diameters and the thicknesses have been selected from ISO Standards.
Diamter and thickness according to other national or international standards may be accepted.

P1.2.5 Permissible stress k for carbon steel and alloy steel pipes

The permissible stress for carbon steel and alloy steel pipes to be considered in formula (2) of P1.2.2 is to be chosen as the lowest of the following values:

$R_{20}/2,7$
$E_T/1,6$ up to $E_T/1,8$
$\sigma_{R/100\,000}/1,6$ up to $\sigma_{R/10\,000}/1,8$
$\sigma_{R/100\,000}/1$

where R_{20} = specified minimum tensile strength (N/mm^2) at room temperature, i.e. 20°C
E_T = specified minimum yield stress or 0,2% proof stress (N/mm^2) at the design temperature (see P1.2.8)
$\sigma_{R/100\,000}$ = average stress (N/mm^2) to produce rupture in 100 000 hours at the design temperature (see P1.2.8)
$\sigma_{1/100\,000}$ = average stress (N/mm^2) to produce 1% creep in 100 000 hours at the design temperature (see P1.2.8)

NOTES
1. As an interim measure it is recommended that the values of yield stress or 0,2% proof stress given by ISO 2604/II or III for steel tubes be adopted.
2. As an interim measure the values in the range between 1,6 and 1,8 are to be chosen at the discretion of the Classification Society.
3. The value of $\sigma_{1/100\,000}/1$ may be used at discretion of the Classification Society on the basis of its reliability, and if deemed necessary.

P1.2.6 Permissible stress K for copper and copper alloys

The permissible stress for copper and copper alloy pipes to be considered in formula (2) of P1.2.2 is to be taken from Table 6, depending upon design temperature (see P1.2.8).

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Table 7 Permissible stress limits *K* for copper and copper alloys

Pipe material		Copper	Aluminium brass	Copper nickel Cu Ni 5 Fe 1 Mn Cu Ni 10 Fe 1 Mn	Copper nickel Cu Ni 30
Material condition		Annealed	Annealed	Annealed	Annealed
Minimum tensile strength (N/mm^2)		215	325	275	365
Permissible stress K (N/mm^2)	50°C	41	78	68	81
	75°C	41	78	68	79
	100°C	40	78	67	77
	125°C	40	78	65,5	75
	150°C	34	78	64	73
	175°C	27,5	51	62	71
	200°C	18,5	24,5	59	69
	225°C	–	–	56	67
	250°C	–	–	52	65,5
	275°C	–	–	48	64
	300°C	–	–	44	62

NOTES
1. Intermediate values may be determined by linear interpolation.
2. For materials not included in the Table, the permissible stress shall be specially considered by the Classification Society.

P.1.2.7 Design pressure

The design pressure P to be considered in formula (2) of P1.2.2 is the maximum working pressure and it is not to be less than the highest set pressure of any safety valve relief valve. For special cases, the design pressure will be specially considered. For pipes containing fuel oil heated above 60°C, the design pressure is to be taken not less than 14 bar.

P1.2.8 Design temperature

The design temperature to be considered for determining the permissible stress in P1.2.5 and P1.2.6 is in general the maximum temperature of the medium inside the pipes. For special cases, the design temperature will be specially considered.

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P1.3 Flanges

(1972 (Rev. 1 1987)

The dimensions of flanges and relative bolts are to be chosen in accordance with the national standards. For special application the dimensions of flanges and relative bolts will be subject to special consideration*.

*For special applications, when the temperature, the pressure and the size of the flange have values above certain limits, to be fixed, the complete calculation of bolts and flanges is to be carried out.

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P2 Rules for piping design, construction and testing

P2.1 Foreword
(1981)
(Rev. 1
1987)

The present requirements are related to piping-systems made of carbon, carbon-manganese, alloy steels or non-ferrous material intended for essential services and normally installed on board ships and for the other services considered in Table 1.

These requirements cover the following services:

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 open end exhaust lines from internal combustion engines and gas turbines, and pipes forming integral part of a boiler.

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

Piping systems intended for liquefied gases (cargo and process) are dealt with in U.R. G3 and W1.

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

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P2.2 Classes of pipes
(1974)
(Rev. 1
1975
Rev. 2
1987)
(Rev. 3
May
2000)

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 1 and Table 1.

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P2
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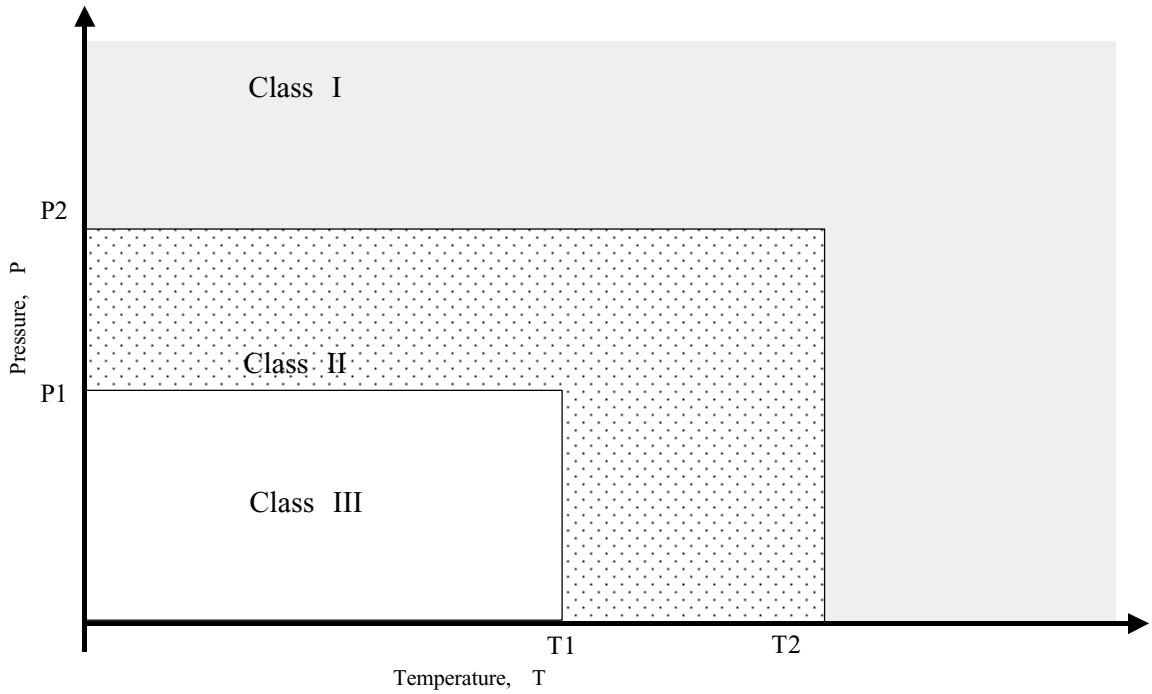

Figure 1

Table 1

Piping System for	Class I P> or T>		Class II	Class III P≤ & T≤	
Toxic or corrosive media	Without special safeguards		With special safeguards (1,2)	Not applicable	
Flammable media heated above flash point or with flash point below 60°C Liquefied Gas	Without special safeguards		With special safeguards (1)	Not Applicable	
Steam	16	300	Any pressure-temperature combination not belong to Class I or III	7	170
Thermal Oil	16	300		7	150
Fuel Oil Lubricating Oil Flammable Hydraulic Oil	16	150		7	60
Other Media (5,6)	40	300		16	200

Notes:
1) Safeguards for reducing leakage possibility and limiting its consequences to the Classification Societies satisfaction
2) Class II pipes are not to be used for toxic media
3) Cargo oil pipes belong to Class III
4) P = Design pressure (bar), as defined in P1.2.7 T = Design temperature (°C), as defined in P1.2.8
5) Including water, air, gases, non-flammable hydraulic oil
6) Open ended pipes (drains, overflows, vents, exhaust gas lines, boiler escape pipes) irrespecitve of T, belong to Class III

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P2.3 Materials
(1974)
(Rev. 1,1987)

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 P2.3.1 to P2.3.4)

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

P2.3.1 Steel pipes, valves and other fittings

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

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 Classification Society.

P2.3.2 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 Society.

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

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

.1 Copper and aluminium brass	200°C
.2 Copper nickel (see Table 6 of P1).	300°C

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

P2.3.3 Nodular cast iron pipes, valves and other fittings

Nodular cast iron of the ferritic type according to the material rules of the Classification Society may be accepted for bilge, ballast and cargo oil piping within double bottom or cargo tanks, or other locations to the Classification Society's satisfaction.

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

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

P2.3.4 Ordinary cast iron pipes, valves and fittings

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

Ordinary cast iron piping may be accepted for cargo oil and ballast lines within cargo tanks of tankers, except for clean ballast lines to forward tanks through cargo oil tanks.

Ordinary cast iron is not to be used for pipes, valves and other fittings handling media having temperature rature above 220°C and for piping subject to pressure shock, excessive strains and vibrations.

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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.

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.

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

P2.4 Testing of Materials
(1974)

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 in accordance with applicable Rules of the individual Classification Society.

The individual Classification Society may require internal workshop certificates for pipes, valves and fittings belonging to Class III.

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P2.5 Welding
(1974)
(Rev. 1
1987)

P2.5.1 General

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 Classification Society's Rules.

Joint preparations and tolerance shall be appropriate to the welding process, in accordance with the Classification Society's Rules or recognized standards.

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 P2.6

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:

.1 carbon and carbon-manganese steels having minimum tensile strength (Rm) 320, 360, 410, 460 and 490 N/mm^2.

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

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

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

P2.5.2 Edge preparation for welded joints

Edge preparation is to be in accordance with recognized standards and/or approved drawings.

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.

P2.5.3 Alignment and assembling

P2.5.3.1 Unless otherwise agreed by the Society, the tolerances on the alignment of the pipes to be welded are to be as follows:

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

.2 Pipes welded without fitted backing ring:

.2.1 inside diameter less than 150 mm, thickness up to 6 mm included - 1 mm or $\frac{1}{4}$ whichever is less;

.2.2 inside diameter less than 300 mm, thickness up to 9,5 mm included - 1,5 mm or $\frac{1}{4}$ whichever is less;

.2.3 inside diameter 300 mm and over, or over thickness 9,5 mm included - 2,0 mm or $\frac{1}{4}$ whichever is less.

NOTE:
For Class III piping systems,the requirements for alignment tolerances may be waived at the discretion of the Society.

P2.5.3.2 Assembling for welding is to be appropriate and within the prescribed tolerances.

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.

When welding materials requiring preheating, the same preheating should be applied during tack welding. ▶

P2 cont'd

P2.5.4 Preheating

Preheating of the different types of steels will be dependent upon thier thickness and chemical composition as indicated in Table 2.

In any case, dryness is to be ensured using, if necessary, suitable preheating.

Table 2 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.

Table 2

Type of steel		Thickness of thicker part (mm)	Minimum preheating temperature (°C)
C and C/Mn steels	$C + \frac{Mn}{6} \leq 0{,}40$	≥ 20 (2)	50
	$C + \frac{Mn}{6} > 0{,}40$	≥ 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 Society.
2. For welding in ambient temperature below 0°C, the minimum preheating temperature is required independent of the thickness unless specifically approved by the Classification Society.

P2.5.5 Heat-treatment after forming and welding

P2.5.5.1 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.

P2.5.5.2 Hot forming is to be generally carried out in the temperature range 1000° - 850°C for all grades; however, the temperature may decrease to 750°C during the forming process.

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

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.1.1 for C, C-Mn and C-Mo steels, no subsequent heat treatment is required:
.1.2 for Cr-Mo and C-Mo-V steels, a subsequent stress relieving heat treatment accordance with Table 3 is required.

2. When the hot forming is carried outside the above temperature range, a subsequent new heat treatment in accordance with Table 4 is generally required for all grades.

P2.5.5.3 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 Table 4; in any case, a stress relieving heat treatment in accordance with Table 3 is required for all grades other than carbon and carbon-manganese steels with Rm 320, 360 and 410.

P2.5.5.4 Stress relieving heat treatment after welding for other than the oxy-acetylene welding process is required as indicated in Table 3 depending on the type of steel and thickness.

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 Society.

The 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 on 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.

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

Table 3

Type of steel	Thickness of thicker part (mm)	Stress relief heat treatment temperature (°C)
C and C-Mn	≥ 15 (1) (3)	550 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 Society
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 Society.

P2.5.5.5 Unless otherwise specified, for oxyacetylene welding, the heat treatment indicated in Table 4 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 Society. ▶

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Table 4

Type of steel	Heat treatment and temperature (°C)
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

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P2.6 Non destructive testing of welds and acceptance criteria
(1987)

P2.6.1 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.

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

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

.1.2 pipes of Class II:at least 10% random radiography when the outside diameter is greater than 100 mm.
More stringent requirements may be applied at the Society's discretion depending on the kind of materials, welding procedure and controls during the fabrication.
An approved ultrasonic testing procedure may be accepted, at the Society's discretion, in lieu of radiographic testing when the conditions are such that a comparable level of weld quality is assured.

.2 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.

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

P2.6.2 Radiographic and ultrasonic examination is to be performed with an appropriate technique by trained operators.

At the request of the Society, complete details of the radiographic or ultrasonic technique is to be submitted for approval.

P2.6.3 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.

P2.6.4 The welds are to meet the acceptable standard level as required by the individual Society. Unacceptable defects are to be removed and repaired according to the satisfaction of the Society.

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P2
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2.7 Types of connections
(1974)
(Rev. 1
1987)

P2.7.1 Direct connection of pipe lengths

P2.7.1.1 Direct connection of pipe lengths may be obtained by: welded butt-joints, slip-on sleeve welded joints or sleeve threaded joints.

.1 Welded butt-joints shall be of full penetration type with or without special provisions for a high quality of root side.
.2 Slip-on sleeve joints shall have sleeves and relative welding of adequate dimensions conforming to Classification Society's Rules or a recognised Standard.
.3 Sleeve threaded joints are to be of approved type for the service conditions.

P2.7.1.2 Dependent on piping class, the three aforesaid types of connections may be used as follows:
.1 Welded butt-joints with special provisions for root side - Any Class, any outside diameter.
.2 Welded butt-joints without special provisions for root side - Classes II and III, any outside diameter.
.3 Slip-on welded joints - Class III, any outside diameter.
.4 Sleeve threaded joints with the exclusion of combustible media - Class III, outside diameter not more then 57 mm.

Slip -on joints, sleeve threaded joints and other types of direct connection of pipe lengths (e.g. bell and spigot joints) may be allowed by the Classification Society in each particular case for small diameter and depending upon the service conditions.

P2.7.2 Flange connections

Acceptable flange pipe connections are indicated in Figure 1.

Typical applications of these different types of connections are indicated in Table 5 depending upon the class of piping, media, sizes, pressure and temperature. The standard is to be selected so as to cover the range of pressure and temperature conditions.

Other types of flange pipe connections may be considered by the Classification Society in each particular case.

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P2
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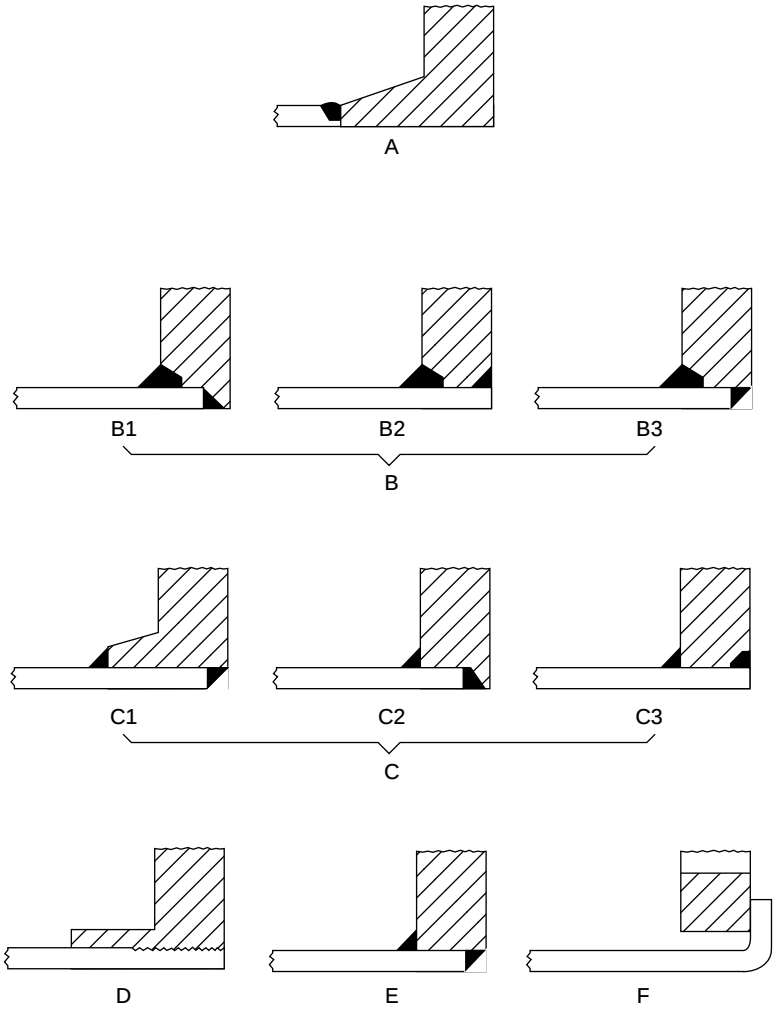

Fig. 1 Types of flange connections (typical)

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.

Table 5

Class of piping	Toxic or corrosive media, (4) flammable media, (4) LG	Lubricating and fuel oil	Steam (3) and thermal oil	Other media (1 - 3)
I	A, B (6)	A, B	A, B (6)	A, B
II	A, B, C	A, B, C, E (7)	A, B, C, D (5), E (5)	
III		A, B, C, E	A, B, C, D, E	A, B, C, D, E, F (2)

P2
cont'd

NOTES:
1. Including water, air, gases, hydraulic oil.
2. Type F for water pipes and open ended lines only.
3. Only type A when design temperature exceeds 400°C.
4. Only type A when design pressure exceeds 10 bar.
5. Types D and E are not to be used when design temperature exceeds 250°C.
6. Type B for outside diameter < 150 mm only.
7. Type E for oil piping when design temperature < 150°C and design pressure < 16 bar only.

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P2.8 Hydrostatic tests of piping
(1974)
(Rev. 1
1987)

P2.8.1 All Classes I and II pipes are 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 if 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 P1.2.7.

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:

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

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

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

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

P2.8.2 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 Classification Society for testing the closing lengths of piping, particularly in respect to the closing seams.

P2.8.3 When the hydrostatic test of piping is carried out on board, these tests may be carried out in conjunction with the test required under P2.9.

P2.8.4 Pressure testing of small bore pipes (less than about 15 mm) may be waived at the discretion of the Classification Society depending on the application.

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P2
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P2.9 Pressure tests of piping after assembly on board
(1974)
(Rev. 1
1975
Rev. 2
1987)

After assembly on board, the following tightness tests are to be carried out in the presence of the Surveyor.

In general, all the piping systems covered by these requirements are to be checked for leakage under operational conditions and, if necessary, using special techniques other than hydrostatic testing. In particular, heating coils in tanks and liquid or gas fuel lines are to be tested to not less than 1,5 P but in no case less than 4 bar.

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P2.10 Hydrostatic tests of valves and fittings
(1975)
(Rev. 1
1987)

Valves and fittings non-integral with the piping system, intended for Classes I and II, are to be tested in accordance with recognized standards, but to not less than 1,5 times the design pressure.

Valves, cocks and distance pieces intended to be fitted on the ship side below the load waterline are to be tested by hydraulic pressure not less than 5 bar.

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P3 Air Pipe Closing Devices

P3 (1991) (Corr. 1 May 1998) (Rev.1 May 2001)

P3.1 General requirements

Where air pipes are required by the Rules or Load Line Convention, 1966 to be fitted with automatic closing devices, they are to comply with the following:

P3.2 Design

P3.2.1 Air pipe automatic closing devices shall be so designed that they will withstand both ambient and working conditions, and be suitable for use at inclinations up to and including $\pm 40^{o}$.

P3.2.2 Air pipe automatic closing devices shall be constructed to allow inspection of the closure and the inside of the casing as well as changing the seals.

P3.2.3 Efficient seating arrangements are to be provided for the closures.

P3.2.4 Air pipe automatic closing devices are to be self-draining.

P3.2.5 The clear area through an air pipe closing device in the open position shall be at least equal to the area of the inlet.

P3.2.6 An automatic closing device is to:

a) Prevent the free entry of water into the tanks,
b)Allow the passage of air or liquid to prevent excessive pressure or vacuum coming on the tank.

P3.2.7 In the case of air pipe closing devices of the float type, suitable guides are to be provided to ensure unobstructed operation under all working conditions of heel and trim.

P3.2.8 The maximum allowable tolerances for wall thickness of floats should not exceed ± 10% of thickness.

P3.3 Materials

P3.3.1 Casings of air pipe closing devices are to be of approved metallic materials adequately protected against corrosion.

P3.3.2 Closures and seats made of non-metallic materials are to be compatible with the media intended to be carried in the tank and to seawater and suitable for operating at ambient temperatures between -25 ^{o}C and 85 ^{o}C.

P3.4 Type Testing

P3.4.1 Testing of Air Pipe Automatic Closing Devices

Each type and size of air pipe automatic closing device shall be surveyed and type

P3
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tested at the manufacturer's works or other acceptable location according to the Classification Society's practice. The minimum test requirements for an air pipe automatic closing device shall include the following:

a) 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.

b) Tightness test during immersion/emerging in water.
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:

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

ii) 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.

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

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

P3.4.2 Testing of non-metallic Floats

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			

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a) 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. 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.

b) 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.

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.

P3.4.3 Testing of Metallic Floats

Tests shall be conducted in accordance with 3.4.2 a). The tests shall be carried out at room temperature and in the dry condition.

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P4 Production and Application of Plastic Pipes on Ships *

(1996) (Corr. 1 1997) (Rev.1 May 1998) (Rev. 2 July 1999)

P4.1 Terms and Definitions

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

2. "Pipes/piping systems" means the pipes, fittings, system joints, method of joining and any internal or external liners, coverings and coatings required to comply with the performance criteria.

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

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

.5 "Nominal pressure" means the maximum permissable working pressure which should be determined in accordance with the requirements in P 4.3.1.

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

.7 "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.

P4.2 Scope

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

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

P4.3 General Requirements

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

4.3.1 Strength

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

.2 The strength of fittings and joints is to be not less than that of the pipes.

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

(i) Internal Pressure

For an internal pressure the following is to be taken whichever is smaller:

$$Pn\ int \leq Psth/4 \text{ or } Pn\ int \leq Plth/2.5$$

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

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where Psth = short-term hydrostatic test failure pressure;

Plth = long-term hydrostatic test failure pressure (> 100,000 h)

(ii) External Pressure

For an external pressure:

Pn ext ≤ Pcol/3

where Pcol - pipe collapse pressure.

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

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

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

4.3.2 Axial Strength

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

.2 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 P 4.3.1).

4.3.3 Impact Resistance

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

.2 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.

4.3.4 Temperature

.1 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.

.2 The minimum heat distortion temperature is to be not less than 80ºC.

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P4.4 Requirements for Pipes/Piping Systems Depending on Service and/or Locations

4.4.1 Fire Endurance

.1 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).

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

(i) 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).

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

(iii) 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).

.3 Permitted use of piping depending on fire endurance, location and piping system is given in Table 1 "Fire Endurance Requirements Matrix".

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Table 1 Fire Endurance Requirements Matrix

N	Piping Systems	Location										
		A	B	C	D	E	F	G	H	I	J	K
		Machinery spaces of category A	Other machinery spaces & pump rooms	Cargo pump rooms	Ro/Ro cargo holds	Other dry cargo holds	Cargo tanks	Fuel oil tanks	Ballast water tanks	Cofferdams void spaces pipe tunnel & ducts	Accomodation service & control spaces	Open decks
1	2	3	4	5	6	7	8	9	10	11	12	13
CARGO (FLAMMABLE CARGOES f.p. ≤ 60°C)												
1.	Cargo 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]
3.	Vent lines	NA	NA	NA	NA	NA	O	NA	O[10]	O	NA	X
INERT GAS												
4.	Water seal effluent line	NA	NA	O[1]	NA	NA	O[1]	O[1]	O[1]	O[1]	NA	O
5.	Scrubber effluent 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 (f.p. > 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	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 [1]												
12.	Bilge main & branches	L1[7]	L1[7]	L1	X	X	NA	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

P4
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18. Tank cleaning services fixed machines	NA	NA	L3	NA	NA	O	NA	O	O	NA	L3[2]
19. Non-essential systems	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 drains (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 (fp. > 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 (non-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 low pressure steam (≤ 7 bar)	L2	L2	O[9]	O[9]	O[9]	O	O	O	O	O[9]	O[9]

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ABBREVIATIONS:

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

0 No fire endurance test required

NA Not applicable

X Metallic materials having a melting point greater than 925^{o}C

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 liquids with f.p. > 60^{o}C, "0" may replace "NA" or "X".

4. For drains serving only the space concerned, "0" may replace "L1".

5. When controlling functions are not required by statutory requirements or guidelines, "0" may replace "L1".

6. For pipe between machinery space and deck water seal, "0" may replace "L1".

7. For passenger vessels, "X" 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 ship's 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".

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.

P4
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C -	Cargo pump rooms	Spaces containing cargo pumps and entrances and trunks to such spaces.
D -	Ro-ro cargo holds	Ro-ro cargo holds are ro-ro cargo spaces and special category spaces as defined in SOLAS* 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, service	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).

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

4.4.2 Flame Spread

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

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

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

4.4.3 Fire Protection Coatings

.1 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:

(i) The pipes are generally to be delivered from the manufacturer with the protective coating on.

(ii) 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.

(iii) In considering fire protection coatings, such characteristics as thermal expansion, resistance against vibrations, and elasticity are to be taken into account. ▶

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(iv) The fire protection coatings are to have sufficient resistance to impact to retain their integrity.

4.4.4 Electrical Conductivity

Where electrical conductivity is to be ensured, the resistance of the pipes and fittings is not to exceed 1×10^5 Ohm/m.

P4.5 Material approval and Quality Control During Manufacture

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

.2 For prototype testing representative samples of pipes and fittings are to be selected to the satisfaction of the Classification Society.

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

.4 Each pipe and fitting is to be tested by the Manufacturer at a hydrostatic pressure not less than 1.5 times the nominal pressure.

.5 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.

.6 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 UR to the satisfaction of the Classification Society's surveyors for every batch of pipes.

P4.6 Installation

4.6.1 Supports

.1 Selection and spacing of pipe supports in shipboard systems are to be determined as a function of allowable stresses and maximum deflection criteria. Support spacing is not to be greater than the pipe Manufacturer's recommended spacing. The selection and spacing of pipe supports are to take into account pipe dimensions, mechanical and physical properties of the pipe material, mass of pipe and contained fluid, external pressure, operating temperature, thermal expansion effects, loads due to external forces, thrust forces, water hammer, vibrations, maximum accelerations to which the system may be subjected. Combination of loads is to be considered.

.2 Each support is to evenly distribute the load of the pipe and its contents over the full width of the support. Measures are to be taken to minimise wear of the pipes where they contact the supports.

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

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4.6.2 Expansion

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

(i) the difference in the coefficients of thermal expansion;
(ii) deformations of the ship's hull and its structure.

.2 When calculating the thermal expansions, account is to be taken of the system working temperature and the temperature at which assembly is performed.

4.6.3 External Loads

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

.2 Besides for providing adequate robustness for all piping including open-ended piping a minimum wall thickness, complying with 4.3.1., may be increased upon the demand of the Classification society taking into account the conditions encountered during service on board ships.

.3 Pipes are to be protected from mechanical damage where necessary.

4.6.4 Strength of Connections

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

.2 Pipes may be assembled using adhesive-bonded, welded, flanged or other joints.

.3 Adhesives, when used for joint assembly, are to be suitable for providing a permanent seal between the pipes and fittings throughout the temperature and pressure range of the intended application.

.4 Tightening of joints is to be performed in accordance with Manufacturer's instructions.

4.6.5 Installation of Conductive Pipes

.1 In piping systems for fluids with conductivity less than 1000 pico siemens per metre (pS/m) such as refined products and distillates use is to be made of conductive pipes.

.2 Regardless of the fluid being conveyed, plastic piping is to be electrically conductive if the piping passes through a hazardous area. The resistance to earth from any point in the piping system is not to exceed 1×10^6 Ohm. It is preferred that pipes and fittings be homogeneously conductive. Pipes and fittings having conductive layers are to be protected against a possibility of spark damage to the pipe wall. Satisfactory earthing is to be provided.

.3 After completion of the installation, the resistance to earth is to be verified. Earthing wires are to be accessible for inspection.

4.6.6 Application of Fire Protection Coatings

.1 Fire protection coatings are to be applied on the joints, where necessary for meeting the required fire endurance as for 4.4.3, after performing hydrostatic pressure tests of the piping system.

.2 The fire protection coatings are to be applied in accordance with Manufacturer's recommendations, using a procedure approved in each particular case.

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4.6.7 Penetration of Divisions

.1 Where plastic pipes pass through "A" or "B" class divisions, arrangements are to be made to ensure that the fire endurance is not impaired. These arrangements are to be tested in accordance with Recommendations for fire test procedures for "A", "B" and "F" bulkheads (Resolution A754 (18) as amended).

.2 When plastic pipes pass through watertight bulkheads or decks, the watertight integrity of the bulkhead or deck is to be maintained.

.3 If the bulkhead or deck is also a fire division and destruction by fire of plastic pipes may cause the inflow of liquid from tanks, a metallic shut-off valve operable from above the freeboard deck should be fitted at the bulkhead or deck.

4.6.8 Control During Installation

.1 Installation is to be in accordance with the Manufacturer's guidelines.

.2 Prior to commencing the work, joining techniques are to be approved by the Classification Society.

.3 The tests and examinations specified in this UR are to be completed before shipboard piping installation commences.

.4 The personnel performing this work are to be properly qualified and certified to the satisfaction of the Classification Society.

.5 The procedure of making bonds is to include:

(i) materials used,
(ii) tools and fixtures,
(iii) joint preparation requirements,
(iv) cure temperature,
(v) dimensional requirements and tolerances, and
(vi) tests acceptance criteria upon completion of the assembly.

6. Any change in the bonding procedure which will affect the physical and mechanical properties of the joint is to require the procedure to be requalified.

4.6.9 Bonding Procedure Quality Testing

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

.2 When the test assembly has been cured, it is to be subjected to a hydrostatic test pressure at a safety factor 2.5 times the design pressure of the test assembly, for not less than one hour. No leakage or separation of joints is allowed. The test is to be conducted so that the joint is loaded in both longitudinal and circumferential directions.

.3 Selection of the pipes used for test assembly, is to be in accordance with the following:

(i) When the largest size to be joined is 200 mm nominal outside diameter, or smaller, the test assembly is to be the largest piping size to be joined.

(ii) When the largest size to be joined is greater than 200 mm nominal outside diameter, the size of the test assembly is to be either 200 mm or 25% of the largest piping size to be joined, whichever is greater.

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.4 When conducting performance qualifications, each bonder and each bonding operator are to make up test assemblies, the size and number of which are to be as required above.

4.6.10 Testing After Installation on Board

.1 Piping systems for essential services are to be subjected to a test pressure not less than 1.5 times the design pressure or 4 bar whichever is greater.

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

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