

Fire Endurance Tests for Plastic Pipes

Amended Rules

Rules for the Survey and Construction of Steel Ships Part D

Reasons for Amendment

IACS adopted the requirements related to the application of plastic pipes on ships as Unified Requirement (UR) P4 in 1996. These requirements have been reviewed and revised at various times since then with recent revision being adopted as UR P4(Rev.6) in February 2021. UR P4(Rev.6) has already been incorporated into ClassNK's Rules for the Survey and Construction of Steel Ships Part D.

In recent years, due to the tightening of exhaust gas regulations, exhaust gas cleaning systems (EGCS) are being increasingly installed on ships, and this has, in turn, led to plastic pipes with larger diameters than before also being increasingly used on such ships for such systems. In response to this, it was found that in some cases it was difficult to conduct fire endurance tests for pipes with these larger diameters in existing test facilities. For this reason, IACS reviewed UR P4 regarding fire endurance test methods for such large diameter plastic pipes. During the review, IACS found that the meaning of "essential service" with respect to plastic pipes, which affects whether approval of use is required, was not clear. To address these issues, IACS adopted UR P4(Rev.7) in June 2022.

Accordingly, relevant requirements are amended based on the IACS UR P4(Rev.7).

Outline of Amendment

The main details of the amendment are as follows:

- (1) Specifies the diameters of test specimens of plastic pipes used for fire endurance tests.
- (2) Clarifies the uses of plastic pipes that require approval in accordance with 12.1.6, Part D of the Rules.
- (3) Specifies that, for open-ended pipes, leak tests under operational conditions may be substituted for onboard pressure tests after installation.

“Rules for the survey and construction of steel ships” has been partly amended as follows:

Part D MACHINERY INSTALLATIONS

Annex 12.1.6 PLASTIC PIPES

Section 1.1 has been amended as follows.

1.1 Scope

1 This annex is to apply to the materials, construction, strength, application, assembly and tests of piping systems on ships, including pipe joints and fittings, made predominately of materials other than metal.

2 ~~The annex is not applicable to use of mechanical joints and flexible couplings only approved for the use in metallic piping systems which are accepted for use in accordance with 12.3.3.1 or 12.3.4.2, Part D of the Rules is not permitted.~~

3 The specification of the pipes is to be in accordance with a recognised national or international standard acceptable to the Society and the following requirements. However, the requirements in **1.4** (except **1.4.1-2(2)**) and **1.5** (except **1.5.2**) need not apply to the pipes specified in **1.3-2**.

Section 1.2 has been amended as follows.

1.2 Terminology

Terms used in this annex are defined as follows:

- (1) “Plastic” means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as *PVC* and fibre reinforced plastics - FRP. Plastic includes synthetic rubber and materials of similar thermo /mechanical properties.
- (2) “Pipe/piping Systems” means those made of plastic(s) and include pipes, fittings, system joints, methods of joining and any internal or external liners, coverings and coatings required to comply with this annex.
- (3) “Joint” means the location at which two pieces of pipe or a pipe and a fitting are connected together. The joint may be made by adhesive bonding, laminating, welding, flanges ~~etc~~ and mechanical joints according to Fig. D12.1 in 12.3.3, Part D of the Rules.
- (4) “Fittings” means bends, elbows, fabricated branch pieces, etc. of plastic materials.
- (5) “Nominal pressure” means the maximum permissible working pressure which is to be determined in accordance with **1.4.1-2**.
- (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.
- (8) “Pipes and their associated fittings whose integrity is essential to the safety of ship” means piping systems specified in Table 1 and includes piping systems deemed by the Society that in event of failure will pose a threat to personnel and the ship.

- (9) “Essential services” are those services essential for propulsion and steering and safety of the ship as specified in 3.2.1-2, Part H of the Rules.
- (~~8~~10) “FTP Code” means as defined in 3.2.23, Part R of the Rules.

1.3 Materials

- 1 Plastic pipes are to be those approved by the Society in accordance with 12.1.6, Part D of the Rules and adequate for their service conditions.
- 2 Notwithstanding the requirement in -1 above, pipes which comply with recognised standards such as JIS or JWWA, comply with 1.4.1-2(2) and 1.5.2 and are adequate for their service conditions may be used for the following (1) and (2):
- (1) Drinking water pipes, domestic water pipes (including hot water pipes) and sanitary pipes located within accommodation spaces and engine rooms as well as deck scuppers located within spaces.
- (2) ~~Pipes used for the “Auxiliary machinery for specific use” and “Other auxiliary machinery” (except for selective catalytic reduction (SCR) systems, exhaust gas recirculation (EGR) systems, exhaust gas cleaning systems (EGCS), etc.) specified in 1.1.1-6, Part D of the Rules~~
Other pipes not used for essential services.

1.5 Requirements for Pipe/Piping Systems Depending On Service and/or Locations

Paragraph 1.5.1 has been amended as follows.

1.5.1 Fire Endurance

1 Pipes and their associated joints and 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)* (including any amendments due to *IMO Res. MSC.313(88)* and *IMO Res. MSC.399(95)*).

2 Unless instructed otherwise by the Administration, fire endurance tests are to be carried out with representative specimens for pipes, joints and fittings in accordance with the following (1) and (2). A test specimen incorporating several components of a piping system may be tested in a single test:

(1) Pipes

(a) For sizes with outer diameter less than 200 mm, the pipe with the minimum outer diameter and wall thickness is used.

(b) For sizes with outer diameter of 200 mm or more, the pipe with the minimum outer diameter is used for each category of t/D ratio (where “D” is the outer diameter and “t” is the structural wall thickness). A scattering of ±10 % for t/D is regarded as the same group.

If fire protective coatings, etc. are included in the pipe used in the fire test, the pipe with the minimum fire protective coatings, etc. are used regardless of the (t/D) ratio.

(2) Joints

Each type of joint applicable for applied fire endurance level on pipe to pipe specimen is to be tested.

3 Means are to be provided to ensure a constant media pressure inside the test specimen during the fire test as specified in *Appendix 1* or *2* of *IMO Res.A.753(18)*, as amended by *IMO Res. MSC.313(88)* and *MSC.399(95)*. During the test, it is not permitted to replace media drained by fresh water or nitrogen.

~~24~~ Permitted use of piping depending on fire endurance, location and piping system is given in **Table 1**.

1.7 Tests

Paragraph 1.7.2 has been amended as follows.

1.7.2 On-board Tests and Inspection

After installation on board, in addition to those tests and inspections specified in 2.1.4-1(8), **Part B of the Rules**, the following tests and inspections are to be carried out.

- (1) Hydrostatic tests at pressures 1.5 *times* design pressure or 0.4 MPa, whichever is greater, used for ~~“auxiliary machinery essential for main propulsion”, “auxiliary machinery for the manoeuvring and the safety” and “auxiliary machinery for cargo handling” specified in 1.1.6-1, Part D of the Rules~~ and for selective catalytic reduction (SCR) systems, exhaust gas recirculation (EGR) systems and exhaust gas cleaning systems (EGCS), etc essential services. Notwithstanding the requirement above, the following (2) may be applied to open ended pipes (drains, effluents, etc.).
- (2) Leakage tests at service conditions, used for other than auxiliary machinery specified in (1) above.
- (3) Sufficient earthing to hulls for those pipes required to be electrically conductive in accordance with 1.5.4 above.
- (4) Safe support of pipes and no harmful defects on their external surface.

Table 1 has been amended as follows.

Table 1 Fire Endurance Requirements Matrix

N	Piping Systems	Location										
		A	B	C	D	E	F	G	H	I	J	K
CARGO (FLAMMABLE CARGO f.p. ¹¹ ≤ 60°C)												
1	Cargo lines	—	—	L1	—	—	○	—	○ ¹⁰	○	—	L1 ²
2	Crude oil washing lines	—	—	L1	—	—	○	—	○ ¹⁰	○	—	L1 ²
3	Vent lines	—	—	—	—	—	○	—	○ ¹⁰	○	—	×
INERT GAS												
4	Water seal effluent lines	—	—	○ ¹	—	—	○ ¹	○ ¹	○ ¹	○ ¹	—	○
5	Scrubber effluent lines	○ ¹	○ ¹	—	—	—	—	—	○ ¹	○ ¹	—	○
6	Main lines	○	○	L1	—	—	—	—	—	○	—	L1 ⁶
7	Distribution lines	—	—	L1	—	—	○	—	—	○	—	L1 ²
FLAMMABLE LIQUIDS (f.p. ¹¹ > 60°C)												
8	Cargo lines	×	×	L1	×	×	— ³	○	○ ¹⁰	○	—	L1
9	Fuel oil	×	×	L1	×	×	— ³	○	○	○	L1	L1
10	Lubricating	×	×	L1	×	×	—	—	—	○	L1	L1
11	Hydraulic oil	×	×	L1	×	×	○	○	○	○	L1	L1
SEAWATER ¹												
12	Bilge mains & branches	L1 ⁷	L1 ⁷	L1	×	×	—	○	○	○	—	L1
13	Fire mains & water sprays	L1	L1	L1	×	—	—	—	○	○	×	L1
14	Foam systems	L1W	L1W	L1W	—	—	—	—	—	○	L1W	L1W
15	Sprinkler systems	L1W	L1W	L3	×	—	—	—	○	○	L3	L3
16	Ballast	L3	L3	L3	L3	×	○ ¹⁰	○	○	○	L2W	L2W
17	Cooling water, essential services ¹²	L3	L3	—	—	—	—	—	○	○	—	L2W
18	Tank cleaning services fixed machines	—	—	L3	—	—	○	—	○	○	—	L3 ²
19	Non-essential systems ¹³	○	○	○	○	○	—	○	○	○	○	○
FRESHWATER												
20	Cooling water essential services ¹²	L3	L3	—	—	—	—	○	○	○	L3	L3
21	Condensate returns	L3	L3	L3	○	○	—	—	—	○	○	○
22	Non-essential systems ¹³	○	○	○	○	○	—	○	○	○	○	○
SANITARY/DRAINS/SCUPPERS												
23	Deck drains (internal)	L1W ⁴	L1W ⁴	—	L1W ⁴	○	—	○	○	○	○	○
24	Sanitary drains (internal)	○	○	—	○	○	—	○	○	○	○	○
25	Scuppers and discharges (overboard)	○ ^{1,8}	○ ^{1,8}	○ ^{1,8}	○ ^{1,8}	○ ^{1,8}	○	○	○	○	○ ^{1,8}	○
SOUNDING/AIR												
26	Water tanks/dry spaces	○	○	○	○	○	○ ¹⁰	○	○	○	○	○
27	Oil tanks (f.p. ¹¹ > 60 °C)	×	×	×	×	×	×	○	○ ¹⁰	○	×	×

Table 1 Fire Endurance Requirements Matrix (continued)

N	Piping Systems	Location										
		A	B	C	D	E	F	G	H	I	J	K
MISCELLANEOUS												
28	Control air	L1 ⁵	L1 ⁵	L1 ⁵	L1 ⁵	L1 ⁵	—	○	○	○	L1 ⁵	L1 ⁵
29	Service air (non-essential) ¹³	○	○	○	○	○	—	○	○	○	○	○
30	Brine	○	○	—	○	○	—	—	—	○	○	○
31	Auxiliary low pressure steam (≤ 0.7MPa)	L2W	L2W	○ ⁹	○ ⁹	○ ⁹	○	○	○	○	○ ⁹	○ ⁹
32	Central vacuum cleaners	—	—	—	○	—	—	—	—	○	○	○
33	Exhaust gas cleaning system / Exhaust gas recirculation system effluent line	L3 ¹	L3 ¹	—	—	—	—	—	—	—○	L3 ^{1, 14} —	—○
34	Reductant agent transfer / supply system (SCR installations)	L1 ¹⁵	L1 ¹⁵	—	—	—	—	—	—	○	L3 ¹⁴ —	○

Notes:

(1) LOCATION

- A : “Machinery spaces of category A”: Machinery spaces of category A as defined in **2.1.32, Part A of the Rules**
- B : “Other machinery spaces and pump rooms”: Spaces, other than category A machinery spaces and cargo pump rooms, containing: propulsion machinery; boilers; fuel oil units; steam and internal combustion engines; generators and major electrical machinery; oil filling stations; refrigerating, stabilising, ventilation and air-conditioning machinery as well as similar spaces and trunks to such spaces.
- C : “Cargo pump rooms”: Spaces containing cargo pumps and entrances and trunks to such spaces.
- D : “Ro-ro cargo holds”: Ro-ro cargo holds are ro-ro cargo spaces and special category spaces as defined in **3.2.41, Part R of the Rules** and **2.1.38, Rules for High Speed Craft**
- 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 **2.1.36, 2.1.37, Part A of the Rules** and **9.2.3-2(1), Part R of the Rules**
- K : “Open decks”: Open deck spaces as defined in **9.2.4-2(10), Part R of the Rules** (excluding lifeboat and liferaft embarkation and lowering stations)

(2) ABBREVIATIONS

- L1 : Pipes without leakage during pressure tests as a result of fire endurance tests (for more than one hour) and pressure tests (for more than 15 minutes) in dry conditions in accordance with *IMO Res. A.753(18) Appendix 1* (including any amendments due to *IMO Res. MSC.313(88)* and *IMO Res. MSC.399(95)*)
- L1W : For piping systems which do not carry flammable fluid or any gas, pipes with negligible leakage (i.e. not exceeding 5 % flow loss) during pressure tests as a result of fire endurance tests (for more than one hour) and pressure tests (for more than 15 minutes) in dry conditions in accordance with *IMO Res. A.753(18) Appendix 1* (including any amendments due to *IMO Res. MSC.313(88)* and *IMO Res. MSC.399(95)*)
- L2 : Pipes without leakage during pressure tests as a result of fire endurance tests (for more than 30 minutes) and pressure tests (for more than 15 minutes) in dry conditions in accordance with *IMO Res. A.753(18) Appendix 1* (including any amendments due to *IMO Res. MSC.313(88)* and *IMO Res. MSC.399(95)*)
- L2W : Pipes with negligible leakage (i.e. not exceeding 5 % flow loss) during pressure tests as a result of fire endurance tests (for more than 30 minutes) and pressure tests (for more than 15 minutes) in dry conditions in accordance with *IMO Res. A.753(18) Appendix 1* (including any amendments due to *IMO Res. MSC.313(88)* and *IMO Res. MSC.399(95)*)
- L3 : Pipes without significant leakage (i.e. not exceeding 0.2 l/min) during pressure tests as a result of fire endurance tests (for more than 30 minutes) and pressure tests (for more than 15 minutes) in wet conditions in accordance with *IMO Res. A.753(18) Appendix 1* (including any amendments due to *IMO Res. MSC.313(88)* and *IMO Res. MSC.399(95)*)
- : No fire endurance test required

- : Not applicable
- × : Metallic materials having a melting point greater than 925 °C

(3) FOOTNOTES

- 1 : In cases where non-metallic piping is used, remotely controlled valves are to be provided at ship's side (such valves are to be controlled from outside spaces).
- 2 : Remote closing valves are to be provided at cargo tanks.
- 3 : When cargo tanks contain flammable liquids with a f.p. (to be determined by an approved closed cup method) > 60 °C, “○” may replace “–” or “×”.
- 4 : In the case of drains serving only the space concerned, “○” may replace “L1W”.
- 5 : When controlling functions are not required by statutory requirements or guidelines, “○” may replace “L1”.
- 6 : In the case of pipes between machinery spaces and deck water seals, “○” may replace “L1”.
- 7 : In the case of passenger vessels, “×” is to replace “L1”.
- 8 : Scuppers serving open decks in positions I and II, as defined in **20.1.2, Part C of the Rules**, ~~should~~ are to be “×” 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 : In the case of essential services, such as fuel oil tank heating and the ship’s whistle, “×” is to replace “○”.
- 10 : In the case of tankers where compliance with **3.2.4(1)(a)vi, Part 3 of the Rules for Marine Pollution Prevention Systems** is required, “–” is to replace “○”.
- 11 : To be determined by an approved closed cup method.
- 12 : Pipe-lines used for ~~the “auxiliary machinery essential for main propulsion”, “auxiliary machinery for the manoeuvring and safety” and “auxiliary machinery for cargo handling” specified in 1.1.1 6, Part D of the Rules essential services.~~
- 13 : Pipes specified in **1.3-2(1)** and **(2)**
- 14 : L3 in service spaces, NA in accommodation and control spaces.
- 15 : Type approved plastic piping without fire endurance test (○) is acceptable downstream of the tank valve, provided this valve is metal seated and arranged as fail-to-closed or with quick closing from a safe position outside the space in the event of fire.