Guideline No.: A-05(202407)

A-05

MARINE PLASTIC PIPES

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Foreword

China Classification Society (hereinafter referred to as CCS) Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn .

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Main changes:

The “Application, Normative reference documents, Terms and definitions, Technical requirements, Materials and components, Type test” is amended to coordinate with the rules.

CONTENTS

MARINE PLASTIC PIPES

1 Application

1.1 This Guideline applies to the approval and inspection of the marine plastic piping systems made predominately of other material than metal installed and used on ships and offshore installations.

1.2 The piping systems intended for non-essential services are to meet only the requirements of accepted standards and 5.2.1(3) ② external pressure, 5.3.2 flame spread of this Guidelines and items 1.5.2~1.5.7 and 1.6 of Appendix 1, Chapter 2, Part Three of CCS " Rules for Classification of Sea-Going Steel Ships".

1.3 This Guideline is not applicable for the use of mechanical joints approved for the use in metallic piping systems only are permitted.

2 Normative References

2.1 The approval and inspection of marine plastic pipes and fittings are to be performed in accordance with the following documents and their subsequent amendments:

(1) Appendix 1, Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships

(2) Chapter 4, PART TWO of CCS Rules for Materials and Welding

(3) IMO A.753(18) Guidelines for the Application of Plastic Pipes on Ships

(4) IMO MSC.313 (88) Amendments to the Guidelines for the Application of Plastic Pipes on Ships (Resolution A.753(18))

(5) IMO MSC.399(95) Amendments to the Guideline for the Application of Plastic Pipes on Ships (Resolution A.753(18)), as Amended by Resolution MSC.313(88)

(6) EU RO Mutual Recognition Technical Requirements Plastic Piping Systems (Components)

In case of any change to CCS Rules, IMO Conventions and the relevant standards of this Guideline, will follow the latest valid provisions.

3 Terms and definitions

3.1 Plastic material: reinforced or unreinforced thermoplastic and thermosetting materials, such as polyvinyl chloride (PVC) and fiber reinforced plastic (FRP or GRP), including synthetic rubber and the materials having similar thermal/mechanical properties.

3.2 Pipe/piping: pipe (also called tube), accessories (also called fittings), joints, connections, any internal/external lining, protective layer and coating in compliance with the performance standards, which are made of plastic materials.

3.3 Fittings: elbows, mandrel bends, branch pipes for assembly that are made of plastic materials.

3.4 Joint: 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 and welding, flanges etc and the mechnical joints listed in Table 1.4.1 of Appendix 1, Chapter 2, Part Three of CCS " Rules for Classification of Sea-Going Steel Ships".

3.5 Nominal pressure: the maximum allowable working pressure required in 5.2.1 of this Guideline.

3.6 Design pressure: 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.

3.7 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.

3.8 Essential to the safety of ship is all piping systems that in event of failure will pose a threat to personnel and the ship(essential piping to the safety of ship please see the Table 1.4.1 of Appendix 1, Chapter 2, Part Three of CCS " Rules for Classification of Sea-Going Steel Ships".

3.9 Essential services are those services essential for propulsion and steering and safety of the ship as specified essential devices in 1.1.2 of Chapter 1, Part Four of CCS " Rules for Classification of Sea-Going Steel Ships".

4 Drawings and documents

4.1 The following documents and information are to be submitted by the applicant to CCS for review.

(1) General information (product details), including the following information:

① Pipe and fitting dimensions

② Maximum internal and external working pressures

③ Range of allowable working temperatures

④ Intended services and installation locations

⑤ The level of fire endurance

⑥ Electrical conductivity

⑦ Intended fluids

⑧ Limits on flow rates

⑨ Service life

⑩ Instructions for installation

⑪ Details of marking

⑫ Bonding procedure (when bonding is foreseen by the manufacturer as a joining method).

(2) Plans and supporting documents

① Certificates and relevant test reports previously obtained

② Details of relevant standards

③ All relevant design drawings, catalogues, technical specifications, calculations and function descriptions

④ All detailed assembly drawings showing the pipes, accessories and joints

⑤ Details of any internal or external lining, protective layer and coating.

(3) Materials(if applicable)

① Resin type

② Catalyst and accelerator types, and concentration employed in the case of reinforced polyester resin pipes or hardeners where epoxide resins are employed

③ 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 shall be detailed

④ Full information regarding the type of gel-coat or thermoplastic liner employed during construction, as appropriate

⑤ Cure/post-cure conditions. Curing and post curing temperatures and times employ resin/reinforcement ratio

⑥ Winding angle and direction

⑦ Joint bonding procedures and qualification tests results, see 7.3.6.1 of this guideline

(4) Physical properties

① Strength of pipe against bending and twisting

② Strength of bonded section against abrasions by sand, sludge, etc.

③ Types of joints and relevant joint procedures (bonding procedure)

④ Data of bending strength and fatigue strength for standard types of bends and joints, if available.

(5) Other submitted documents : Company profile, list of production equipment, list of inspection equipment, list of main personnel, list of raw materials and components qualified supplier, product non-asbestos quality control plan, non-asbestos declaration, product quality certification etc.

5 Technical requirements

5.1 Plastic pipes and fittings are to comply with the requirements in 2.1 of this Guideline and not to contain any asbestos.

5.2 General requirements

The technical requirements of plastic pipes are to be in accordance with the national or international standards accepted by CCS. In addition, the following requirements are to be complied with:

5.2.1 Strength

(1) Pipe strength is to be determined by the bust pressure of the pipe specimen during hydraulic test carried out under standard conditions, at an atmospheric pressure equal to 0.1MPa, a relative humidity of 30% and an ambient and filling liquid temperature of 298K (25℃);

(2) The strength of pipe fittings and joints is to be no less than the strength of the pipe;

(3) The set pressure is to be determined based on the following conditions:

① Internal pressure

Internal pressure Pn int is to be of the smaller value of the following:

Pn int ≤ Psth /4*or Pn int ≤ Plth /2.5

Where, Psth——failure pressure of short-term hydraulic test, expressed in MPa;

Plth——failure pressure of long-term hydraulic test (>100000h)**, expressed in MPa;

Notes: *) the safety factor of thermosetting plastic piping is to be 4 and that of thermoplastic piping is to be determined in accordance with the adopted accepted standard;

**) the test may be carried out for a period beyond the shortened timeline specified in the adopted accepted standard such as ASTM D2837 and D1598.

② External pressure (for any installation which may be subject to vacuum conditions inside the pipe or a head of liquid acting on the outside of the pipe; and for any pipe installation required to remain operational in case of flooding damage, as per SOLAS II-1/8-1, or for any pipes that would allow progressive flooding to other compartments through damaged piping or through open ended pipes in the compartments)

External pressure Pn ext ≤ Pcol /3

Where, Pcol——pipe collapse pressure, expressed in MPa;

The collapse pressure is to be no less than 0.3 MPa;

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;

(4) Notwithstanding the requirements of (3) ① or (3) ② above as applicable, the pipe or pipe layer minimum wall thickness is to follow accepted standards. In the absence of standards for pipes not subject to external pressure, the requirements of (3) ② above are to be met.

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

5.2.2 Axial strength

(1) The total sum of the vertical stresses generated due to pressure, weight and other loads is not to exceed the allowable vertical stress.

(2) For fiber reinforced plastic pipes, the sum of the vertical stresses is not to exceed half of the set

circumferential stress generated under the effect of the set internal pressure (see 5.2.1 of this Guideline).

5.2.3 Impact resistance

(1) Plastic pipes and joints are to have the minimum impact resistance specified by the accepted national or international standards.

(2) After the test, the test specimens are to be hydraulically tested to 2.5 times design pressure for a period not less than 1h.

5.2.4 Permissable working temperature

(1) The permissible working temperature depending on the working pressure is to be in accordance with the manufacturer's recommendations, but in each case it is to be at least 20℃ lower than the minimum heat distortion/deflection temperature of the pipe material, determined according to ISO 75 Method A, or equivalent e.g. ASTM D648.

(2) The minimum heat distortion/deflection temperature is to be no less than 80℃. For thermoplastic piping systems, the minimum heat distortion/deflection temperature is to be in compliance with the applicable standard.

(3) Where plastic pipes are used in low temperature service areas, the design strength test is to be carried out at a temperature 10℃ lower than the minimum working temperature.

5.3 Requirements for pipe/piping depending on the intended purpose or service location

5.3.1 Fire endurance

(1) Pipes and their associated joints and fittings whose integrity is essential to the safety of ships, including plastic piping required by SOLAS II-2, Reg.21.4 to remain operational after a fire casualty, are required to meet the minimun fire endurance requirements of Appendix 1 or 2, as applicable, of IMO Res. A.753(18), as amended by IMO MSC. 313(88) and IMO MSC. 399(95).

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

① Pipes:

- for sizes with outer diameter < 200mm, the minimum outer diameter and wall thickness.

(Notes: Test conditions are most demanding for minimum wall thickness and thus larger wall thickness is covered. A key factor determining the fire performance of a pipe component variant is the thickness- to-diameter (t/D) ratio and whether it is larger or smaller than that of the variant which has been fire-tested. If fire-protective coatings or layers are included in the variant used in the fire test, only variants with the same or greater thickness of protection, regardless of the (t/D) ratio, shall be qualified by the fire test.)

- for sizes with outer diameter ≥200mm, one test specimen for each category of t/D (D=outer diameter, t=structural wall thickness). A scattering of ±10% for t/D is regarded as the same group. Minimum size approved is equal to the diameter of specimen successfully tested.

② Joints:

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

(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 the IMO Res.A753(18), as amended by IMO Resolution MSC.313(88) and MSC.399(95). During the test it is not permitted to replace media drained by fresh water or nitrogen.

(4) The fire endurance of piping systems is expressed in five grades depending on the systems' ability to maintain their strength and integrity:

① L1 grade: Piping having passed the fire endurance test specified in Appendix 1 of IMO A.753 (18), as amended by IMO MSC.313(88) and IMO MSC.399(95)for a duration of at least one hour period under the dry condition and of which the integrity has not been damaged after exposure may be considered in compliance with grade 1 (L1) fire endurance.

② L1W grade: Piping systems similar to grade 1 systems except these systems do not carry flammable fluid or any gas and a maximum 5% flow loss (Notes: The flow loss shall be considered in designing the sizes of pipes) in the system after exposure may be considered in compliance with grade L1W (L1W).

③ L2 grade: Piping having passed the fire endurance test specified in Appendix 1 of IMO A.753 (18), as amended by IMO MSC. 313(88) and IMO MSC.399(95) for a duration of at least 30min period under the dry condition may be considered in compliance with grade 2 (L2) fire endurance.

④ L2W grade: Piping systems similar to grade 2 systems except a maximum 5% flow loss (Notes: The flow loss shall be considered in designing the sizes of pipes) in the system after exposure may be considered in compliance with grade L2W (L2W).

⑤ L3 grade: pipes which have passed the fire endurance test of at least 30min period under the wet condition specified in Appendix 2 of IMO A.753 (18) may be considered in compliance with grade 3 (L3) fire endurance.

(5) The allowable service locations and systems determined depending on the fire endurance of pipes are given in Table 1.4.1, Appendix 1, Chapter 2, PART THREE of CCS Rules for Classification of Sea-Going Steel Ships and its Amendments.

(6) For Safe Return to Port purposes (SOLAS II-2, Reg.21.4), plastic piping can be considered to remain operational after a fire casualty if the plastic pipes and fittings have been tested to grade L1 standard.

5.3.2 Flame spread

(1) All pipes, exceptthose installed on open decks and within tanks, cofferdams, pipe tunnels and ducts if separated from accommodation, permanent manned areas and escape ways by means of an A class bulkhead are to have low surface flame spread characteristics not exceeding average values specified in Appendix 3 of IMO A.753(18), as amended by IMO MSC.313(88) and IMO MSC.399(95).

Item	Technical requirements
Critical heat flux at the time of extinction CFE (kW/m²)	≥20.0
Heat of sustaining burning Qsb(MJ/m²)	≥1.5
Total thermal release Qt(MJ)	≤0.7
Thermal release rate peak Qp(kW)	≤4.0
Falling combustion products	Not generated.

(2) The surface flame spread characteristics are to be determined by the procedure specified in IMO 2010 FTP Code Part 5 with regard to the modifications due to the curvilinear pipe surfaces as also listed in Appendix 3 of IMO A.753(18), as amended by IMO MSC.313(88) and IMO MSC.399(95).

(3) The surface flame spread may also be determined in accordance with ASTM D635 or other equivalent national standards. Where ASTM D635 is adopted, the maximum combustion rate is to be 60mm/min. Where other equivalent national standards are adopted, the relevant acceptance criteria are to be determined.

5.3.3 Fire protection coating

The fire protection coating of pipes and fittings is to comply with the following requirements in order to reach the required grade of fire endurance:

(1) Pipes are generally to be delivered by the manufacturer with protective coating;

(2) The fire endurance of the coating is not to be reduced by the action of salty water, oil or bilge water and the coating is to be resistant to the products with which the pipes may be in contact;

(3) For the fire protection coating, its thermal expansion, vibration resistance and flexibility are to be taken into account. It is advisable that these characteristics are close to the same characteristics of pipes;

(4) The fire protection coating is to have sufficient impact resistance to maintain its integrity. It is advisable that these characteristics are close to the same characteristics of pipes;

(5) Random samples shall be tested to determine the adhesion qualities of the coating to the pipe.

5.3.4 Electrical conductivity

(1) Piping systems conveying fluids capable of generating electrostatic charges, such as refined products and distillates, and in any case piping systems conveying fluids with a conductivity of less than 1000 pico-siemens per meter, shall be made of conductive pipes.

(2) Regardless of the fluid to be conveyed, plastic pipes passing through hazardous areas shall be electrically conductive.

(3) To ensure proper electrical conductivity, the electric resistance of the pipes and fittings shall not to exceed $1 \times 10^5 \Omega$/m.

(4) It is preferred that pipes and fittings are homogeneously conductive. Where the pipes and fittings are not homogeneously conductive, conductive layers shall be provided, suitably protected against the possibility of

spark damage to the pipe wall.

(5) Reliable earthing is to be provided.

(6) The pipe joints and accessories are to be earthed and their electrical continuity is to be maintained. The earth resistance at any point of the piping system is not to exceed 1MΩ.

5.3.5 Smoke and Toxicity

(1) All piping materials, exceptthose installed on open decks and within tanks, cofferdams, pipe tunnels and ducts if separated from accommodation, permanent manned areas and escape ways by means of an A class bulkhead are to comply with smoke and toxicity requirements.

(2) The piping materials shall be to meet the requirements of smoke and toxicity of IMO 2010 FTP Code, Annex 1, Part 2. With regard to the modifications due to the curvilinear pipe surfaces as also listed in Appendix 3 of IMO A.753(18), as amended by IMO MSC.399(95).

(3) Criteria

① Smoke : at each test condition, the Dm shall not exceed 400.

② Toxicity : the average value of the maximum value of the gas concentration measured at each test condition shall not exceed the following limits :

Category	Concentration (ppm)
CO	1450
HCl	600
HF	600
HBr	600
HCN	140
SO_2	120
NO_x	350

(4) Exempt test according to IMO 2010 FTP Code Part 2

With the both the total heat release (Qt) of not more than 0.2 MJ and the peak heat release rate (Qp) of not more than 1 kW (both values determined in accordance with Part 5 of Annex 1) are considered to comply with the requirements of Part 2 of Annex 1 without further testing (see IMO 2010 FTP Code, Annex 2, 2.2).

5.4 Penetration through fire divisions

(1) Where plastic pipes penetrate through class A or class B divisions, means are to be provided to protect the fire endurance from being damaged. These means are to be fire tested in accordance with Recommendations for fire resistance test procedures for “A”, “B” and “F” class divisions specified in Part 3 of Annex 1 to the IMO 2010 FTP Code.

(2) Where plastic pipes penetrate through watertight bulkheads or decks, the watertight integrity of such bulkheads or decks is to be maintained. For pipes not able to satisfy the requirements in 5.2.1(3)② of this Guidelines, a metallic shut-off valve operable from above the freeboard deck should be fitted at the bulkhead or deck.

(3) If the bulkhead or deck,is also a fire divisions 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..

6 Materials and components

6.1 The main raw materials (resins, reinforcement materials) firstly used for plastic pipes manufacturing shall be approved by CCS.

6.2 Where other unapproved by CCS main raw materials (e.g. resin, reinforcing materials) are intended to be used, the manufacturer of pipes and fittings is to provide sufficient evidence, prior to the use of such materials, to demonstrate that the performance and properties of these materials comply with the technical specifications for product manufacturing. The surveyor may, where necessary, require partial or full performances of the materials to be tested.

6.3 Technical requirements for main raw materials

6.3.1 For thermoplastic resins, including poly ethylene (PE, PE-RT), polypropylene (PP), polyvinyl chloride (PVC), Acrylonitrile-butadiene-styrene (ABS), etc., the manufacturer is to conduct the tests concerning the following applicable items (test methods): melting point (when applicable) (GB/T19466.3), Vicat softening temperature (GB/T1633) or thermal deformation temperature (GB/T1634.1, GB/T1634.2), melt flow index (GB/T3682.1), bulk density (GB/T1033.1), content of filling or coloring agent (if any) (GB/T 18251/GB/T 13021), Shore hardness (GB/T2411) or Rockwell hardness (GB/T3398.2), tensile strength and rate of elongation at break (GB/T8804.1,2,3 or GB/T1040.1).

6.3.2 Thermosetting resins, including unsaturated polyester resins (m-phenylene, phthalate, bisphenol A and vinyl ester resins), epoxy resins, etc.

(1) Unsaturated polyester resins: for unsaturated polyester resins (m-phenylene, phthalate, bisphenol A and vinyl ester resins), the manufacturer is to conduct the tests concerning the following applicable items: viscosity (GB/T7193), gel time (GB/T7193), acid value (GB/T2895), solid content (GB/T7193), temperature of thermal deformation of the casing body (GB/T1634.1) and Barcol harness (GB/T3854).

(2) Epoxy resins: the manufacturer is to conduct the tests concerning the following applicable items: viscosity (GB/T22314), epoxy value (GB/T4612), organic chlorine (GB/T4618.2) and/or inorganic chlorine (GB/T4618.1).

6.3.3 Glassfiber reinforced materials: alkali-free glassfiber, medium-alkali glassfiber, high-strength fibers and their fabrics or products, such as continuous coarse yarn, surface mat, chopped fiber mat and mesh, may be used. The manufacturer is to conduct the tests concerning the following applicable items: linear density of yarn or coarse yarn (Tex value) (GB/T7690.1), combustible matter content (GB/T9914.2), moisture content (moisture rate) (GB/T9914.1), mass per unit area (GB/T9914.3), tensile strength at break (GB/T7690.3) and other relevant items.

6.3.4 The measured values of the performance parameters of above-mentioned polymers, resins and reinforcing materials are to comply with the provisions and requirements of the applicable standards or the manufacturer’s technical specifications.

Notes: The test standards of raw materials may also as per other applicable standards.

7 Type test

7.1 Selection of typical test specimens

Test Items and Methods, Specifications and Quantity of Test Specimens Table 7.1

No.	Test item	Test method	Specifications of test specimens	Quantity of test specimens
1	Internal pressure	①FRP piping system: ASTM D1599 (short term), ASTM D2992 (long term), ASTM D1598 (long term) ②Thermoplastic piping system: GB/T 6111 idt ISO 1167(short term), GB/T18252 idt ISO 9080 (long term), ISO 15493 or equivalent standard	Pipes of maximum, medium and minimum diameters, matching fittings and joints	1 piece to be taken respectively to form a piping system for test
2	External pressure	① FRP piping system: ASTM D2924 ②Thermoplastic piping system: ISO 15493 or manufacturer standard【for instance, seal both ends of the pipe lengths to be tested (length≥1000mm) and place the same in the pipe of a larger size at room temperature(e.g. 23 ℃±2 ℃). Apply internal hydraulic pressure and apply 3 times nominal external pressure to the pipe of larger diameter. Vacuumize the pipe or increase 0.1MPa equivalent external pressure to the same serving as the test specimen, and maintain the pressure for 5~10min. The test specimens are to be free of fracture and leakage after the pressure test, or free from apparent change in the out-of-roundness after measurement.】	Pipes of maximum, medium and minimum diameter, of lowest pressure class, for straight pipes only	1 piece respectively
3	Resin content	FRP piping system: GB/T 2577 or ASTM D2584	Pipes and fittings of any specifications	1 piece
4	External load test	1.6.3, Appendix 1 of Chapter 2, PART Three of CCS Rules for Classification of Sea-Going Steel Ships	Pipes of ⩾100mm OD	1 piece
5	Electrical conductivity*	FRP piping system: Appendix X3.2 of ASTM F1173 or ASTM D257	Pipes of any specifications	1 pieces
6	Impact resistance	①FRP piping system: MIL-P-28584B ②Thermoplastic piping system: GB/T18743 idt ISO 9854, ASTM D2444, GB/T 14152, ISO 3127, ISO 15493	Pipes of typical specifications, of lowest pressure class	1 piece to be taken respectively to form a piping system or straight pipes for test
7	Temperature limit	①FRP piping system: thermal deformation temperature HDT: ISO 75-3 Method A ② Thermoplastic piping system: thermal deformation temperature HDT: ISO 75-3 Method A; Vicat softening temperature (VST): ISO306/ISO 2507-1/GB/T8802	Standard test specimen	1 piece
8	Axial tensile strength	①FRP piping system: ASTM D2105 ②Thermoplastic piping system: GB/T 8804.1,2,3, ISO 6259-1,2	Pipes of appropriate diameter, for straight pipes only	3 pieces
9	External load bearing property of parallel plate (load deformation)	①FRP:ASTM D2412/GB/T5352 ②Thermoplastic piping system: GB/T 9647	Pipes of maximum, medium and minimum diameters	3 pieces respectively
10	①Barcol hardness ②Shore hardness	①FRP piping system: ASTM D2583 or GB/T 3854 ② Thermoplastic piping system: GB/T 2411	Pipes of maximum, medium and minimum diameters	3 pieces respectively
11	Ageing	①FRP piping system: ISO 9142 or manufacturer's standard ② Thermoplastic piping system: manufacturer's standard (after heating for 60min at 150 ℃, thermal deformation temperature changes ≤5 ℃, to be measured as per GB/T 1634.2)	Piping system of small dimensions	3 pieces
12	Fatigue	① FRP piping system: manufacturer's standard or service experience ② Thermoplastic piping system: ISO 10508 or manufacturer's standard or service experience (at a temperature of 23 ℃±2 ℃ and a pressure ranging from 1.0MPa to 1.5MPa, with at least 30 alternate changes within each 1min, the thermal deformation temperature changes after 10000 consecutive alternate changes ≤5 ℃, to be measured as per GB/T 1634.2)	Piping system of small dimensions	3 pieces

Continued table 7.1

No.	Test item	Test method	Specifications of test specimens	Quantity of test specimens
13	Fluid absorption	①FRP piping system:ISO 8361.1,2 ②Thermoplastic piping system: GB/T1034 idt ISO 62 or GB/T9645	Piping system of any specifications	3 pieces
14	Material compatibility*	ASTM C581 or manufacturer's standard or service experience	660x838x0.25mm	3 pieces
15	Fire endurance*	Appendix 1, 2 of IMO A.753 (18) , as amended by IMO MSC.313(88) Appendix 1, Chapter 2, Part Three of CCS Rules for Classification of Sea-Going Steel Ships	Outer diameter : Φ＜200mm	1 piping system (pipe + joints) composed of minimum outer diameter and minimum wall thickness to be taken for test
			Outer diameter : Φ≥200mm	1 piping system (pipe + joints) composed of minimum t/D (D is outer diameter, t is structral wall thickness, a scattering of ±10% for t/D is regarded as the same group. Minimum size approved is equal to the diameter of specimen successfully tested) to be taken for test
16	Flame spread*	Appendix 3 of IMO Resolution A.753(18), as amended by IMO MSC.313(88), IMO MSC.399(95) ①IMO 2010 FTP Code Part 5 ②ASTM D635	①155mm×800mm×maximum wall thickness ② 127x13x(3mm, 13mm) thickness	① 6 pieces ②10 pieces each specifications
17	Smoke and toxicity*	IMO 2010 FTP Code Part 2 IMO MSC.399(95)	75mm x 75mm x maximum wall thickness (≤25mm)	12 pieces
18	Barcol hardness (FRP)	GB/T 3854 or ASTM D2583	Pipes and fittings of any specifications	3 pieces

Note: Items with "*" refer to the requirements for pipes/piping systems depending on the intended purpose or service locations of plastic pipes used on ships, and whether these requirements are to be complied with is to be indicated on the approval certificate. Where the approval test is not carried out or not applicable, the restrictions on the use of such products are to be indicated on the approval certificate.

7.2 Test conditions

7.2.1 The strength of plastic pipes is to be determined by the failure pressure of the pipe specimens measured during the hydraulic test carried out under the standard conditions, i.e. at an atmospheric pressure of 0.1MPa，a relative humidity of 30% and an ambient and filling medium temperature of 298 ℃ (25 ℃).

7.2.2 In any case, when the pressure is increased to the failure pressure during the static pressure test to determine the test pipe's strength, the pressure should be increased at the rate such that the bursting occurs after 60~70 seconds.

7.2.3 After impact test in specified procedure according to accepted standards, the test pipes are also to be hydraulically tested to 2.5 times design pressure for a period not less than 1h.

7.3 Approval test items

7.3.1 Visual inspection

(1) All pipes and fittings are to be visually inspected and free from any surface defect and flaw.

(2) The internal surface of pipes is to be smooth, even and free from any crack, lamination, pin hole, impurity, air void and bareness that affects the performance of the pipes.

(3) The pipe body is to be adequately level and straight, the socket is to be clear and neat and the grooves are to be smooth; and both end faces are to be vertical to the axis of the pipe and free from burrs.

7.3.2 Dimensions and tolerances

(1) The dimensions and tolerances of pipes and fittings are to comply with the manufacturer's technical specifications for products.

(2) The diameter, length, wall thickness and internal liner (if any) thickness of each pipe are to be measured.

(3) The wall thickness of pipes may be measured on the circumference of pipe end faces vertical to the pipe axis. Measure points are to be evenly distributed, measurements are to be taken at 7 points at least and the average value is to be taken.

Where an electric thickness gauge is used, the pipe wall thickness is to be measured once around the circumference vertical to the pipe axis at a regular interval along the length, and the quantity and distribution of measuring points are to be determined in accordance with accepted standards. The minimum thickness is to be greater than 90% of the nominal thickness and the average thickness not less than the nominal thickness. The nominal thickness of fiber reinforced plastic (FRP) pipes is to be equal to the thickness of internal liner plus the thickness of structural layer.

7.3.3 Pipe properties

(1) The temperature limits of pipes are to be in compliance with the manufacturer's technical specifications for products.

(2) The curing degree of fiber reinforced thermosetting plastic pipes is to be greater than 40 Barcol hardness; it is recommended that the resin content and glass fiber content of the structural layer be controlled within the ranges of 30±5% and 65%~75% respectively.

(3) The details of pipe properties are given in Table 7.3.3.

Test Items, Technical Requirements and Test Methods Table 7.3.3

No.	Test items	Technical requirements	Test method
1	Internal pressure	Pn int ≤Psth /4 or Pn int ≤Plth/2.5(whichever is smaller)	① FRP piping system: ASTM D1599 (short term), ASTM D2992 (long term), ASTM D1598 (long term) ② Thermoplastic piping system: GB/T 6111 idt ISO 1167 (short term), GB/T18252 idt ISO 9080, ISO 15493 or equivalent standard
2	External pressure	Pn ext≤Pcol/3 Pcol≥0.3MPa	①FRP piping system: ASTM D2924 ②Thermoplastic piping system: ISO 15493 or manufacturer's standard【for instance, seal both ends of the pipe lengths to be tested (length≥1000mm) and place the same in the pipe of a larger size at room temperature (e.g. 23℃±2℃). Apply internal hydraulic pressure and apply 3 times nominal external pressure to the pipe of larger diameter. Vacuumize the test pipe or increase 0.1MPa equivalent external pressure to the same serving, and maintain the pressure for 5~10min. The test pipes are to be free from fracture and leakage after pressure test, or free from any apparent change in the out-of-roundness after measurement.】
3	Resin content (FRP piping system)	30±5 %	GB/T 2577 or ASTM D2584
4	External load test	DN100mm, 6m span, 100kg load/5min, no damage	1.6.3, Appendix 1 of Chapter 2, PART Three of CCS Rules for Classification of Sea-Going Steel Ships
5	Electrical conductivity*	≤0.1MΩ	Appendix X3.2 of ASTM F1173 or ASTM D257

Continued table 7.3.3

No.	Test items	Technical requirements	Test method
6	Impact resistance	Technical requirements for products	① FRP piping system: MIL-P-28584B ②Thermoplastic piping system: GB/T18743 idt ISO 9854, ASTM D2444, GB/T 14152, ISO 3127, ISO 15493
7	Temperature limit	Technical requirements for products	① FRP piping system: thermal deformation temperature HDT: ISO 75-3 Method A ②Thermoplastic piping system: thermal deformation temperature HDT: ISO 75-3 Method A, Vicat softening temperature VST: ISO306/ISO 2507-1/GB/T8802
8	Axial tensile strength	Technical requirements for products	①FRP piping system: ASTM D2105 ②Thermoplastic piping system: GB/T 8804.1,2,3, ISO 6259-1,2
9	External load bearing property of Parallel plate (load deformation)	Technical requirements for products	① FRP: ASTMD2412/GB/T5352 ②Thermoplastic piping system: GB/T 9647
10	① Barcol hardness ②Shore hardness	Technical requirements for products	①FRP piping system: ASTM D2583 or GB/T 3854 ②Thermoplastic piping system: GB/T 2411
11	Ageing	Technical requirements for products	①FRP piping system: ISO 9142 or manufacturer's standard ②Thermoplastic piping system: manufacturer's standard (upon heating for 60min at 150 °C, thermal deformation temperature changes ≤5 °C, to be measured as per GB/T 1634.2)
12	Fatigue	Technical requirements for products	① FRP piping system: manufacturer's standard or service experience ② Thermoplastic piping system: ISO 10508 or manufacturer's standard or service experience (at a temperature of 23 ℃±2 ℃ and a pressure ranging from 1.0MPa to 1.5MPa, with at least 30 alternate changes within each 1min, the thermal deformation temperature changes after 10000 consecutive alternate changes ≤5 °C， to be measured as per GB/T 1634.2)
13	Fluid absorption	Technical requirements for products	① FRP piping system: ISO 8361-1,2 ②Thermoplastic piping system: GB/T1034 idt ISO 62 or GB/T9645
14	Material compatibility*	Technical requirements for products	ASTM C581or manufacturer's standard or service experience
15	Fire endurance*	L3	Appendix 2 of IMO Resolution A.753 (18) , as amended by IMO MSC.313 (88)
		L1, L1W, L2,L2W	Appendix 1 of IMO Resolution A.753 (18), as amended by IMO MSC.313 (88)
16	Flame spread*	Low flame spread	Appendix 3 of IMO Resolution A.753 (18), IMO MSC.313(88), IMO MSC.399(95) IMO 2010 FTP Code Part 5 or ASTM D635
17	Smoke and toxicity*	Qualified	IMO 2010 FTP Code Part 2 IMO MSC.399(95)
18	Barcol hardness (FRP)	≥40	GB/T 3854 or ASTM D2583

Notes:

(1) Items with "*" refer to the requirements for pipes/piping systems depending on the intended purpose or service locations of plastic pipes used on ships, and whether these requirements are to be complied with is to be indicated on the approval certificate. Where approval test is not carried out or not applicable, the restrictions on the use of such products are to be indicated on the approval certificate

(2)Where the flame spread test has been carried out, with total thermal release Qt≤0.2MJ and thermal release peak Qp≤1.0kW, the fume and toxicity test may be waived.

7.3.4 Hydraulic test

(1) Each pipe and fitting is to be hydraulically tested to a pressure not less than 1.5 times of the design pressure or 0.4MPa, take one of the big. The test pressure is to be maintained for at least 5min to allow inspection and verification.

(2) The hydraulically tested pipes are to be free from any dripping, leakage, expansion or crack.

7.3.5 For abovementioned tests, the sampling, measurement and results evaluation are to be carried out in the procedure specified by the accepted international or national standards.

7.3.6 Bonding qualification approval test

7.3.6.1 A documented work instruction of the bonding qualification procedure is to be developed and include the following details:

(1) Materials used;

(2) Tools and positioning devices;

(3) Requirements for joint preparation;

(4) Curing temperature;

(5) Dimensional requirements and tolerances;

(6) Bonding steps and requirements;

(7) Requirements for the qualification of operators;

(8) Acceptance criteria for tests to be conducted upon completion of assembly.

7.3.6.2 Where any change in bonding qualification procedure that will affect the physical and mechanical properties of the joint is intended, the involved procedure is to be re-approved.

7.3.6.3 Bonding procedure quality testing

(1) The test assemblies are to be assembled following the approved bonding qualification procedure and to consist of at least one pipe and pipe joint and one pipe and fitting joint.

(2) The cured test assemblies are to be hydraulically tested to 2.5 times design pressure for no less than 1h for the sake of safety. Leakage from or crack in the joint is not allowed. Both longitudinal force and circumferential force are to be applied to the joint in the test.

(3) The pipes used to prepare thetest assemblies are to comply with the following requirements:

① When the connected pipes have a maximum outer diameter equal to or less than 200mm, the pipes of maximum outer diameter are to be selected for preparing the test pieces.

② When the outer diameter of the largest connected pipe is more than 200mm, the pipe of 200mm in diameter or the pipe having a diameter equal to 25% of the maximum pipe diameter is to be selected for preparing the test pieces, whichever is greater.

(4) When the bonding procedure qualification test is carried out, the test pieces are to be assembled by each bonding machine and operator according to the dimensions and quantity specified above.

7.3.7 The products are to comply with the asbestos-free requirements. The company is to provide an Asbestos-freeDeclaration and carry out asbestos testing in accordance with ISO 22262-1 and other relevant standards.

8 Unit/batch inspection

8.1 According to the provisions in Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships, plastic pipes and fittings will not be subject to unit/batch inspection by CCS after approval and may be used on board with CCS approval certificate (copy) and manufacturer quality certification.

8.2 Manufacturer quality certification is to include the following details (if applicable) (in both Chinese and English):

— Name, address, contact information (Tel, Fax, E-mail address) and contact person of the manufacturer

— Designation, type, specifications and dimensions, batch number or code, pressure rating, permissable working temperature of the product

— Purchaser, contract number (if applicable), project number

— Technical specifications or grade of materials

— Approval certificate No.

— Technical parameters of the product

— Inspection criteria for the product

— Inspection conclusion

— Name of authorized signatory, date of issuance, stamp

— Quality commitment

8.3 Product identification is to include the following information:

— Type, specifications and dimensions, batch number or code, pressure rating, permissable working temperature of the product

— Name or trademark of the manufacturer

— Name or designation of the main materials used to manufacture the pipes

— Standard adopted

— CCS approval marks (by appropriate means such as jet printing)