Guideline No.: A-05(201510)

A-05 MARINE PLASTIC PIPES

Issued date: October 20,2015

Foreword:

This Guide is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

This Guide is published and updated by CCS and can be found through http://www.ccs.org.cn . Comments or suggestions can be sent by email to ps@ccs.org.cn .

Historical versions and release date :

Main changes and effective date:

CONTENTS

1 Application 4
2 Basis for approval and inspection 4
3 Terms and definitions 4
4 Design and technical requirements 5
5 Raw material 8
6 Drawings and documentation to be submitted 9
7 Bonding qualification approval test 10
8 Type test 11
9 Unit/batch inspection 17

Marine Plastic Pipes

1 Application

1.1 This Guideline applies to the approval and inspection of the marine plastic pipes and fittings installed and used on ships and offshore installations.

1.2 The piping systems that are constructed of thermoplastic materials such as polyethylene (PE, PE-RT), polypropylene (PP), polybutylene (PB), polyvinyl chloride (PVC) etc. and serve in non-essential systems are to comply with the relevant requirements of CCS rules and this Guideline.

1.3 This Guideline is not applicable to mechanical connecting flanges used in flexible piping, hosing and metallic piping systems.

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:

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

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

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

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

EU Mutual Recognition Technical Requirements

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: pipe connections by means of bonding, laminating and welding.

3.5 Nominal pressure: the maximum allowable working pressure required in 4.2.1 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: the capability of piping to maintain its strength and integrity for some predetermined period of time while exposed to fire.

4 Design and technical requirements

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

4.2 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:

4.2.1 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 recognized standard;

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

② External pressure

External pressure Pn ext ≤ Pcol /3

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

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

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

4.2.2 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 4.2.1 of this Guideline).

4.2.3 Impact resistance

(1) Plastic pipes and joints are to have the minimum impact resistance specified by the recognized 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.

4.2.4 Permissable working temperature

(1) In general, plastic pipes and fittings, if not verified by reliable data, are not to be used in piping systems having a medium temperature higher than 60 ℃ or lower than 0 ℃.

(2) The range of allowable working temperature is to be determined depending on the working pressure and in accordance with the manufacturer's recommendations.

(3) The maximum allowable working temperature is to be at least 20 ℃ lower than the minimum thermal deformation temperature of the pipe material and to be determined by ISO 75 Method A or equivalent standard.

(4) The minimum thermal deformation temperature is to be no less than 80 ℃. For thermoplastic piping systems, the minimum thermal deformation temperature is to be in compliance with the applicable standard.

(5) 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.

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

4.3.1 Fire endurance

(1) The fire endurance of plastic pipes and associated accessories serving in various systems and locations is to be in compliance with the relevant requirements of IMO Resolution A.753 (18) and Amendments to IMO Resolution MSC.313 (88).

(2) 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: pipes which have passed the fire endurance test of at least 1h period under the dry condition specified in Annex 1 of IMO Resolution A.753 (18) and of which the integrity has not been damaged during the test may be considered in compliance with grade 1 (L1) fire endurance.

② L1W grade: pipes which have passed the fire endurance test of at least 1h period under dry condition as specified in Annex 1 of IMO Resolution A.753 (18) and Amendments to IMO Resolution MSC.313(88) and of which the integrity has not been damaged during the test may be considered in compliance with grade 1W (L1W) fire endurance.

③ L2 grade: pipes which have passed the fire endurance test of at least 30min period under the dry condition

specified in Annex 1 of IMO Resolution A.753 (18) may be considered in compliance with grade 2 (L2) fire endurance.

④ L2W grade: pipes which have passed the fire endurance test of at least 30min period under dry condition as specified in Annex 1 of IMO Resolution A.753 (18) and Amendments to IMO Resolution MSC.313 (88) may be considered in compliance with grade 2W (L2W) fire endurance.

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

(3) The allowable service locations and systems determined depending on the fire endurance of pipes are given in Table 1.4.1, Appendix 1, Guide 2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships and IMO MSC.313 (88).

4.3.2 Flame spread

(1) The surface low flame spread of all plastic pipes other than those installed on open decks and in holds/tanks, cofferdams, pipe tunnels and ducts is not to exceed the average value specified in IMO 2010 FTP Code Part

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 is to be determined by the procedure specified in IMO 2010 FTP Code Part 5 and dressing of the surface of curved pipes is to be considered. See Annex 3 of IMO A.753 (18).

(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/s. Where other equivalent national standards are adopted, the relevant acceptance criteria are to be determined.

4.3.3 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 recommended that these properties be similar to those of the pipes;

④ The fire protection coating is to have sufficient impact resistance to maintain its integrity. It is

recommended that these properties be similar to those of the pipes.

4.3.4 Electrical conductivity

① Plastic pipes and fittings for delivery of liquids capable of generating electrostatic charges within the pipes and for services in hazardous areas are to be electrically conductive.

② To ensure proper electrical conductivity, the electric resistance of the pipes and fittings is not to exceed 1×105Ω/m.

③Firstly the pipes and accessories are to be homogeneously conductive. Where the pipes and accessories are not homogeneously conductive, an electrical conductive layer suitable for preventing electrical spark damage to pipe wall is to be provided.

④ Reliable earthing is to be provided.

⑤ 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.

4.4 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 IMO 2010 FTP Code Part 3.

(2) Where plastic pipes penetrate through watertight bulkheads or decks, the watertight integrity of such bulkheads or decks is to be maintained.

(3) The bulkheads or decks, which also serve as the fire divisions, are to be fitted with a metallic shut-off valve operable from the freeboard deck as the burned plastic pipes may give rise to the inflow of liquids contained in the tanks.

5 Materials and components

5.1 Materials approved by CCS are to be used as the main raw materials to manufacture plastic pipes and fittings.

5.2 Where other unapproved 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.

5.3 Technical requirements for main raw materials

5.3.1 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), melt flow index (GB/T3682), 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 or GB/T1040).

5.3.2 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/T7193.1), gel time (GB/T7193.6), acid value (GB/T2895), solid content (GB/T7193.3), temperature of thermal deformation of the casing body (GB/T1634) 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/T13657) and/or inorganic chlorine (GB/T4618).

5.3.3 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.

5.3.4 The measured values of the performance parameters of abovementioned polymers, resins and reinforcing materials are to comply with the provisions and requirements of the applicable standards or the manufacturer's technical specifications.

6 Drawings and documentation to be submitted

6.1 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 Dimensions of pipes and accessories

② Maximum internal and external working pressures

③ Range of allowable working temperatures

④ Intended locations of service and installation

⑤ Grade of fire endurance

⑥ Electrical conductivity

⑦ Fluid to be delivered

⑧ Flow velocity limit

⑨ Service life

⑩ Instructions for installation

⑪ Identification details.

(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

① Resin type

② The type and concentration of the catalyst and accelerator used in reinforced polyester resin pipes or curing agent used in epoxy resin pipes

③ Description of all reinforcing materials used; those coarse yarns used in winding process for which the mass per unit area or the reference Tex value of linear density has not been indicated are to be described in details

④ All information of the types of relevant gel layers or thermoplastic linings used in the manufacture, as applicable

⑤ Curing/post curing conditions. Curing and post curing temperatures and times

⑥ Proportion of resin/reinforcing materials

⑦ Angle and direction of winding

(4) Physical properties

①Strength 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

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

7 Bonding qualification approval test

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

①Materials used;

②Tools and positioning devices;

③Requirements for joint preparation;

④Curing temperature;

⑤Dimensional requirements and tolerances;

⑥Bonding steps and requirements;

⑦ Requirements for the qualification of operators;

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

7.2 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 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.

8 Type test

8.1 Selection of typical test specimens

Test Items and Methods, Specifications and Quantity of Test Specimens Table 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)	Pipes of maximum, medium and minimum diameters, matching elbows and tees	1 piece to be taken respectively to form a piping system for test

Continued table 1

No.	Test item	Test method	Specifications of test specimens	Quantity of test specimens
2	External pressure	② FRP piping system: ASTM D2924 ②Thermoplastic piping system: 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 diameters	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	4.2.4.2 (5), Section 2, Chapter 4, PART TWO of CCS Rules for Materials and Welding (2012)	Pipes of 100mm OD	1 piece
5	Electrical conductivity*	FRP piping system: Appendix X3.2 of ASTM F1173-2001(2006) or ASTM D257	Pipes of any specifications	3 pieces
6	Impact resistance	①FRP piping system: MIL-P-28584B-2001 ②Thermoplastic piping system: GB/T18743-2002 idt ISO 9854, ASTM D2444, GB/T 14152, ISO 3127	Pipes of any specifications	1 piece to be taken respectively to form a piping system for test
7	Temperature limit	①FRP piping system: thermal deformation temperature HDT: ISO 75-3-2004 Method A ② Thermoplastic piping system: thermal deformation temperature HDT: ISO 75-3-2004 Method A; Vicat softening temperature (VST): ISO306/ISO 2507-1/GB/T8802-2001	Standard test specimen	1 piece
8	Axial tensile strength	①FRP piping system: ASTM D2105-2001(2007)e1 ②Thermoplastic piping system: GB/T 8804-2003(ISO 6259)	Pipes of appropriate diameter	3 pieces
9	External load bearing property of parallel plate (load deformation)	①FRP:ASTM D2412-2011/GB/T5352-2005 ②Thermoplastic piping system: GB/T 9647-2003	Pipes of maximum, medium and minimum diameters	3 pieces respectively

Continued table 1

No.	Test item	Test method	Specifications of test specimens	Quantity of test specimens
10	①Barcol hardness ②Shore hardness	①FRP piping system: ASTM D2583-2007 or GB/T 3854-2005 ② Thermoplastic piping system: GB/T 2411-2008	Pipes of maximum, medium and minimum diameters	3 pieces respectively
11	Ageing	①FRP piping system: ISO 9142:1990 or manufacturer's standard ②Thermoplastic piping system: manufacturer's standard (after heating for 60min at 150 ℃, thermal deformation temperature changes ≤5 °C, to be measured as per GB/T 1634.2-2004)	Piping system of small dimensions	3 N/A
12	Fatigue	① FRP piping system: manufacturer's standard or service experience ② Thermoplastic piping system: ISO 10508:2006 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 1634.2-2004)	Piping system of small dimensions	3 N/A
13	Fluid absorption	①FRP piping system:ISO 8361:1991 ②Thermoplastic piping system: GB/T1034-2008 idt ISO 62 or GB/T9645	Piping system of any specifications	3 N/A
14	Material compatibility*	ASTM C581 or manufacturer's standard or service experience	660x838x0.25mm	3 N/A
15	Fire endurance*	Appendix 2 of IMO Resolution A.753 (18) and Amendments to MSC.313 (88)	Pipes of maximum and minimum diameters, matching couplings	1 piece to be taken respectively to form a piping system for test

Continued table 1

No.	Test item	Test method	Specifications of test specimens	Quantity of test specimens
16	Low flame spread*	①Appendix 3 of IMO Resolution A.753(18) IMO 2010 FTP Code Part 5 ③ASTM D635-10	①155mm×800mm ×maximum wall thickness ②127x13xmaximum thickness	①6 pieces ②3pieces
17	Smoke and toxicity*	IMO 2010 FTP Code Part 2	75mm x 75mm x maximum wall thickness	12 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.

8.2 Test conditions

8.2.1 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 ℃).

8.2.2 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.

8.2.3 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.

8.3 Approval test items

8.3.1 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.

8.3.2 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.

8.3.3 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 2.

Test Items, Technical Requirements and Test Methods Table 2

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
2	External pressure	Pn ext≤Pcol/3 Pcol≥0.3MPa	①FRP piping system: ASTM D2924 ②Thermoplastic piping system: 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)	Technical requirements for products	GB/T 2577 or ASTM D2584
4	External load test	DN100mm, 6m span, 100kg load/5min, no damage	4.2.4.2 (5), Section 2, Chapter 4, PART TWO of CCS Rules for Materials and Welding (2012)
5	Electrical conductivity*	≤0.1MΩ	Appendix X3.2 of ASTM F1173-2001 (2006) or ASTM D257

Continued table 2

No.	Test items	Technical requirements	Test method
6	Impact resistance	Technical requirements for products	① FRP piping system: MIL-P-28584B-2001 ②Thermoplastic piping system: GB/T18743-2002 idt ISO 9854, ASTM D2444, GB/T 14152, ISO 3127
7	Temperature limit	Technical requirements for products	① FRP piping system: thermal deformation temperature HDT: ISO 75-3-2004 Method A ②Thermoplastic piping system: thermal deformation temperature HDT: ISO 75-3-2004 Method A, Vicat softening temperature VST: ISO306/ISO 2507-1/GB/T8802-2001
8	Axial tensile strength	Technical requirements for products	①FRP piping system: ASTM D2105-2001 (2007)e1 ②Thermoplastic piping system: GB/T 8804-2003 (ISO 6259)
9	External load bearing property of Parallel plate (load deformation)	Technical requirements for products	① FRP:ASTM ASTMD2412 ②Thermoplastic piping system: GB/T 9647-2003
10	① Barcol hardness ②Shore hardness	Technical requirements for products	①FRP piping system: ASTM D2583-2007 or GB/T 3854-2005 ②Thermoplastic piping system: GB/T 2411-2008
11	Ageing	Technical requirements for products	①FRP piping system: ISO 9142:1990 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 1634.2-2004)
12	Fatigue	Technical requirements for products	① FRP piping system: manufacturer's standard or service experience ② Thermoplastic piping system: ISO 10508: 2006 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 1634.2-2004)
13	Fluid absorption	Technical requirements for products	① FRP piping system: ISO 8361:1991 ②Thermoplastic piping system: GB/T1034-2008 idt ISO 62 or GB/T9645
14	Material compatibility*	Technical requirements for products	ASTM C581or manufacturer's standard or service experience
15	Fire endurance*	L1, L1W, L2,L2W or L3	Appendix 2 of IMO Resolution A.753 (18) and Amendments to MSC.313 (88)
16	Flame spread*	Low flame spread	Appendix 3 of IMO Resolution A.753 (18) IMO 2010 FTP Code Part 5 or ASTM D635-10
17	Smoke and toxicity*	Qualified	IMO 2010 FTP Code Part 2

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.

8.3.4 Hydraulic test

(1) Each pipe is to be hydraulically tested to a pressure equal to 1.5 times of the design pressure. 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.

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

8.3.6 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 22262-1:2012 and other relevant standards.

9 Unit/batch inspection

9.1 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.

9.2 Manufacturer quality certification is to include the following details (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

— Ordering party, contract number (if applicable), project number

— Technical specifications or grade of materials

— Code of approval certificate

— Technical parameters of the product

—Inspection criteria for the product

— Inspection conclusion

— Name of authorized signatory, date of issuance, stamp

— Quality commitment

9.3 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)