CLASS PROGRAMME

Type approval

DNVGL-CP-0070 Edition December 2015

Fibre reinforced thermosetting plastic piping systems - Non-metallic materials
FOREWORD

DNV GL class programmes contain procedural and technical requirements including acceptance criteria for obtaining and retaining certificates for objects and organisations related to classification.

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Any comments may be sent by e-mail to rules@dnvgl.com

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CHANGES - CURRENT

This is a new document.
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SECTION 1 GENERAL

1 Introduction

1.1 Objective
The objective of this class programme is to describe the type approval (TA) scheme for fibre reinforced thermosetting plastic piping systems.

The general requirements for obtaining DNV GL type approval certificate is given in class programme DNVGL CP 0338 Type approval scheme.

The procedures and requirements described in this CP are applicable for obtaining TA certificate based on requirements given by the Society’s rules and standards, including other standards as listed below, e.g.:

— RU SHIP Pt.4 Ch.6
— DNV GL offshore standard, DNVGL OS D101 Ch.2 Sec.2
— IACS Recommendations No. 86, Applicable Standards for UR P4.7 Requirements for Type Approval of Plastic Pipes
— IMO Resolution A.753(18) Guidelines for the Application of Plastic Pipes on Ships
— IMO Resolution MSC.313(88) Amendments to the Guidelines for the Application of Plastic Pipes on Ships (Resolution A.753(18))
— IMO FTP Code: International Code for Application of Fire Test Procedures

Guidance note:
This class programme is not applicable for obtaining EU Marine Equipment Directive (MED) certificates. Visit www.dnvgl.com for information on MED certification.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

1.2 Scope
This CP gives a description of the procedures and requirements related to documentation, design and type testing applicable for TA of fibre reinforced thermosetting plastic piping systems.

This CP does not set the design requirements for the fibre reinforced thermosetting plastic piping systems. TA is based on compliance with design requirements given in the rules and/or other regulations and standards referred in Sec.2 [1]. The CP describes how to document compliance with the requirements in order to obtain a TA certificate for the equipment. This includes, where relevant, technical requirements for how the type tests shall be performed.

The Society’s type approval certificate will cover one grade of the actual product with the possibility to include variants.

Fibre reinforced thermosetting plastic piping systems with different resin systems are considered as different grades.

Different:
— nominal pressures (both internal and external),
— joining methods,
— diameters,
— fire endurance level,
— flame spread performance,
— conductive or non-conductive performance, as well as a
— defined range of fittings (including flanges)

are considered variants of the same grade.
The Society's type approval certificate is normally limited to one manufacturer at one production site, however, other arrangements may be agreed with the Society. Type tests as specified in Sec.2 [3], shall be carried out and verified in one of the following ways:
— at a DNV GL laboratory
— at an accredited and recognized testing laboratory or a laboratory accepted by the Society
— at the manufacturer's premises in the presence of a surveyor.

The type test results shall be submitted to the Society in form of a test report according to ISO 17025 and the additional requirements for the relevant test standard for evaluation.

1.3 Application

DNV GL rules for classification - Ships RU SHIP Pt.4 Ch.6 require that fibre reinforced thermosetting plastic piping systems are type approved in accordance with this CP for equipment to be installed on classed vessels. A TA certificate in accordance with this CP will confirm compliance with the requirements given in the rules and standards as specified in [1.1]. The TA certificate will not confirm compliance with requirements given in other parts of the rules. In case additional requirements given in other parts of the rules shall be covered by the TA certificate, this shall be specified in the application for TA and will be stated in the TA certificate.

2 References

Standards referred to in this document:
— ISO 9001:2008, Quality management systems - Requirements
— ASTM D1598-02(2009), Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
— ASTM D2992-06, Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe and Fittings
— ASTM D635-10, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
— ASTM D257-07, Standard Test Methods for DC Resistance or Conductance of Insulating Materials
— IMO FTPC, International Code for Application of Fire Test Procedures (FTP Code)

3 Documentation

For TA of fibre reinforced thermosetting plastic piping systems the following documentation shall be submitted by the manufacturer at initial type approval, and updated at renewal. The documentation shall, to the extent possible, be submitted as electronic files. The manufacturer shall keep one (1) copy of type approval documentation in their own file. The documentation that forms the basis for the TA shall be easily available for surveyors at the TA applicant’s premises. When documentation is submitted in paper format, normally two copies of the documentation shall be submitted to the Society. No documentation will be returned to the company applying for TA. The documentation shall be in the English language, if not otherwise agreed. (Please number documentation according to below list to facilitate review):
1) type designation, i.e. product name (grade) with list of variants to be included in and stated on the type approval certificate

2) name and address of the manufacturer, to be listed on type approval certificate. The following shall be specified:
   — details for all relevant production places
   — manufacturer's name
   — mailing address
   — contact person
   — phone and fax number
   — e-mail and Web address (if applicable).

3) product description, including:
   — nominal pressure (internal and external)
   — nominal diameters
   — wall thicknesses, for each diameter
   — liner and outer layer, thickness and type
   — fittings, specification of all types and all diameters of each type
   — type of pipe connections applicable, e.g. flange, bell & spigot, taper joint etc.
   — temperature range.

4) field of application and special limitations of the product, such as:
   — intended range of applications
   — installation locations, medium outside
   — fire endurance Level (if applicable)
   — low flame spread (if applicable)
   — smoke generation and toxicity (if applicable)
   — intended fluids, medium inside
   — conductive or non-conductive
   — limitations w.r.t. flow rates
   — serviceable life.

5) product specification/data sheet/drawings for:
   — thermosetting resin type used
   — catalyst and accelerator types, and their concentrations, where polyesters or vinyl esters are used
   — hardeners, where epoxies are used
   — fibre reinforcements used (type of fibre; rovings, fabrics; tex number, mass per unit area)
   — sectional assembly drawings (pipe, fittings, connections).

6) installation instructions, including:
   — lamination procedure for joints \(^1\)
   — torque tables for bolted flanges \(^1\)
   — design of supports and support span for clamping \(^1\)

7) description of production processes \(^2\)
   — production steps
   — winding angle and orientation
   — resin/reinforcement ratio
   — cure- and post-cure conditions (times and temperatures).

\(^1\) Will be verified by surveyor during type testing
\(^2\) Will be verified by initial assessment prior to issuance of type approval certificate.
8) description of quality assurance system or copy of ISO 9001 certificate
9) quality plan for plastic piping systems intended to be installed on board ships
10) test results (from tests already carried out) with references to standards, methods etc.
11) information regarding marking of the product or packaging
12) in-service experience, if available
13) witnessed type test results and initial assessment report by the Society's local office shall be submitted when completed.

\[3\] Will verified by initial assessment prior to issuance of type approval certificate.
SECTION 2 GENERAL REQUIREMENTS

1 Design requirements
The fibre reinforced thermosetting plastic piping systems shall comply with the relevant requirements given in the following publications:

- DNV GL rules and standards as defined in Sec. 1 [1.1]
- IACS UR P4, *Production and Application of Plastic Pipes on Ships*
- IACS Recommendations No. 86, *Applicable Standards for UR P4.7 Requirements for Type Approval of Plastic Pipes*
- IMO Resolution A.753(18) *Guidelines for the Application of Plastic Pipes on Ships*
- IMO Resolution MSC.313(88) *Amendments to the Guidelines for the Application of Plastic Pipes on Ships* (Resolution A.753(18))
- IMO FTP Code: *International Code for Application of Fire Test Procedures*

2 Requirements for production and quality control arrangement
The manufacturer should have a quality system that meets ISO 9001 standards, or equivalent. If this quality standard is not fulfilled, the extent of type testing and assessments will be specially considered.

The quality control arrangement in production shall be checked with respect to:

- control of incoming materials
- scope of quality control, i.e. proof that test methods, test quantity and test equipment complies to the applicable standard EN or ISO
- traceability and marking system
- production records
- storage condition and procedure.

The extent of the manufacturer's quality control during production shall as a minimum be according to Table 1.
Table 1 Requirements for manufacturer’s quality control 1)

<table>
<thead>
<tr>
<th>Control</th>
<th>Acceptance Criteria</th>
<th>Frequency of control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>According to a recognized standard</td>
<td>100%</td>
</tr>
<tr>
<td>Dimensional</td>
<td>According to a recognized standard</td>
<td></td>
</tr>
<tr>
<td>Leakage control of spools</td>
<td>No leaks at 1.5 × design pressure 1)</td>
<td></td>
</tr>
<tr>
<td>Barcol hardness</td>
<td>&gt; 35</td>
<td>10%</td>
</tr>
<tr>
<td>Glass transition temperature, Tg</td>
<td>According to a recognized standard</td>
<td></td>
</tr>
<tr>
<td>Glass content</td>
<td>According to manufacturer’s specification</td>
<td></td>
</tr>
<tr>
<td>Short-term burst</td>
<td>Safety factor = 4.0 on nominal pressure</td>
<td></td>
</tr>
<tr>
<td>Electric conductivity 2)</td>
<td>&lt; 0.1 MΩ/m</td>
<td>According to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>manufacturer’s standard</td>
</tr>
</tbody>
</table>

1) Other quality control arrangement may be agreed upon with the Society.
2) For pipes and fittings not employing hand lay-up techniques, the hydrostatic pressure testing may be carried out in accordance with the hydrostatic test requirements for the recognised national or international standard to which the pipes and fittings are manufactured – provided an effective quality system is in place.
3) For conductive type only.

3 Requirements for material

3.1 Extent of type tests applicable to all piping systems

See Table 3 below for test method, number and selection of test specimens, acceptance criteria, level of verification and frequency of verification.

3.1.1 Internal pressure - short-term

Tests shall be carried out at least on three pipe spools for each nominal pressure, as follows:

The pressure testing shall include:

— one pipe spool made of bottom range of diameters
— one pipe spool made of middle range of diameters
— one pipe spool made of top range of diameters
— the pipe spools shall also include:
  — joining methods applicable
  — one of each type of fitting e.g. elbows/tees/reducers/ flanges and pipe couplings (if applicable),
  — method of construction.

The pressure test shall be carried out with flanges or grip type pipe couplings fixed to the pipe, such that the pipe is subject to axial load due to pressure.

The pipe shall be connected according to the manufacturer's specifications.

The surveyor shall verify that:

— marking
— dimensions, including diameter and wall thickness
— laminations (construction)
— materials

are according to manufacturer's specification (ref. items 1, 3, 5, and 6 in Sec.1 [3]).
If bolted flanges shall be included in the type approval, the test spool shall be pressure tested with the bolts torqued:

— according to manufacturer’s torque table (ref. item 6 in Sec.1 [3])
— according to manufacturer’s torque table +25% over torque.

In case of pipe couplings the mounting instructions of the manufacturer shall be observed.

If winding angle is not constant, pipe diameters to be tested shall be agreed with the Society prior to testing. The pipe shall be flanged according to the manufacturer’s specifications.

For leakages in o-ring joints, a safety factor of 3.0 may be accepted.

### 3.1.2 Internal pressure – long-term

If long-term internal pressure testing is carried out at room temperature, the allowable operational pressure will be reduced as listed in Table 2.

If long-term internal pressure testing is carried out at max. operating temperature for the piping system, there will be no reduction of allowable operational pressure, or the allowable operational pressure will be adjusted accordingly.

#### Table 2 Glassfibre reinforced epoxy, vinylester and polyester pipes (GRE/GRV/GRP). Permissible pressures and temperature limits

| Minimum heat distortion temperature (HDT) of resin 1) (ISO 75 Method A) | Nominal pressure 2) PN (bar) | Permissible working pressure (bar) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | -50°C to 30°C | 40°C | 50°C | 60°C | 70°C | 80°C | 90°C | 95°C |
| 80°C (typically polyester) | 10 | 10 | 9 | 7.5 | 6 | | | | |
| | 16 | 16 | 14 | 12 | 9.5 | | | | |
| | 25 | 16 | 16 | 16 | 15 | | | | |
| 100°C (typically vinyl ester) | 10 | 10 | 10 | 9.5 | 8.5 | 7 | 6 | | |
| | 16 | 16 | 16 | 15 | 13.5 | 11 | 9.5 | | |
| | 25 | 16 | 16 | 16 | 16 | 16 | 16 | | |
| 135°C (typically epoxy) | 10 | 10 | 10 | 10 | 9.5 | 8.5 | 7 | 6 | |
| | 16 | 16 | 16 | 16 | 15 | 13.5 | 11 | 9.5 | |
| | 25 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | |

1) For other resins, the permissible working pressure to be in accordance with recognized standards.
2) According to recognized standards for marine use.

### 3.1.3 External pressure

The section is applicable to plastic pipes subject to vacuum conditions inside the pipe or a head of liquid acting on the outside of the pipe.

The nominal external pressure of pipe shall be verified either by pressure test on piping, or by calculations based on mechanical data obtained from testing of pipe material.

Evaluation of vacuum and external pressure resistance is necessary for plastic piping systems arranged in tanks. Due to low modulus of elasticity the buckling stability may be critical in piping systems where vacuum and/or external pressures are to be expected.

Pressure testing is to be carried out in accordance with ASTM D2924, Ch. 6, Figure 2, hoop load only (introduction of axial loads shall be avoided). Other standards may be accepted.

**Nominal external pressure:**

The nominal external pressure rating equals the collapse pressure divided by a safety factor of 3.
The pressure testing shall include:
— one pipe of min. diameter
— one pipe of an intermediate diameter
— one pipe of max. diameter.

For plastic piping systems designed to take external pressure, the collapse pressure shall not be less than 3.0 bar.

**Maximum external working pressure:**
The maximum external working pressure shall consider a maximum external pressure head acting on the outside of the pipe plus full vacuum inside the pipe. As an example; 20 meter external pressure head (2.0 bar), plus 1.0 bar inside the pipe (full vacuum), will require an external pressure rating for the piping system of 3.0 bar.

### 3.1.4 Heat distortion temperature (HDT)
If more than one resin system is included in the type approval application, HDT data shall be submitted for all resin systems.

Resins with an HDT below 80°C should not be used.

### 3.1.5 External load
Capacity with respect to external load shall be tested on smallest diameter above or equal to 100 mm.
The pipe shall be able to withstand a load of 100 kg applied over 100 mm at midspan without reduction to short term pressure capacity. The span shall be taken as the maximum recommended span length in the manufacturer’s pipe installation guide. The pipe shall be pressure tested after loading.

### 3.1.6 Robustness of pipe
In order to adequate robustness for all piping including open-ended piping the minimum nominal pressure rating for pipe and fittings to be type approved shall be set to 10 bar. In case the manufacturer would challenge this, load deformation tests to ASTM D2412 shall be carried out to support that performance is equal to or better than a 10 bar construction with conventional thermoset resin.

### 3.1.7 Impact resistance
Plastic pipes and joints shall have a minimum resistance to impact in accordance with recognized national or international standards.

After the test the specimen shall be subjected to hydrostatic pressure equal to 2.5 times the design pressure for at least 1 hour for conventional thermoset resins (e.g. polyester, vinyl ester and epoxy).

For other resin systems, the manufacturer shall demonstrate equivalent or better impact resistance.

### 3.1.8 Axial strength
The sum of the longitudinal stresses due to pressure, weight and other dynamic and sustained loads shall not exceed the allowable stress in the longitudinal direction.

In the case of fibre reinforced plastic pipes, the sum of the longitudinal stresses shall not exceed half of the nominal circumferential stress derived from the nominal internal pressure condition.

### Table 3 Extent of type tests applicable to all piping systems

<table>
<thead>
<tr>
<th>Property</th>
<th>Test method ¹)</th>
<th>Number and selection of test specimen ²)</th>
<th>Acceptance criteria</th>
<th>Minimum level of verification</th>
<th>Frequency of verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 INTERNAL PRESSURE - SHORT-TERM</td>
<td>ASTM D1599 Fixed end</td>
<td>1 specimen, min., intermediate and max. diameter and fittings from each nominal pressure</td>
<td>Safety factor = 4.0 on Nominal Pressure</td>
<td>The Society will witness the test</td>
<td>Initial Renewal</td>
</tr>
<tr>
<td>Property</td>
<td>Test method 1)</td>
<td>Number and selection of test specimen 2)</td>
<td>Acceptance criteria</td>
<td>Minimum level of verification</td>
<td>Frequency of verification</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Internal pressure - long-term &gt;100 000h</td>
<td>ASTM D1598, ASTM D2992</td>
<td>1 specimen, one diameter</td>
<td>Safety factor = 2.5 on nominal pressure</td>
<td>Manufacturer’s QA department</td>
<td>Initial</td>
</tr>
<tr>
<td>External pressure</td>
<td>Pressure test according to ASTM D2924, Ch.6, Figure 2, hoop load only, or calculations based on mechanical test data</td>
<td>1 specimen, min., intermediate and max. diameter, of lowest pressure class</td>
<td>Safety Factor = 3.0 on specified external pressure capacity, min. 1 bar (vacuum). The collapse pressure not to be less than 3 bar.</td>
<td>The Society will witness the pressure test or mechanical test</td>
<td>Initial</td>
</tr>
<tr>
<td>Heat distortion temperature (HDT)</td>
<td>ISO 75-3, Method A</td>
<td>Each resin system and according to test standard</td>
<td>&gt; 20°C above max. operating temperature and &gt; 80°C</td>
<td>Independent laboratory</td>
<td>Initial and at change of resin system</td>
</tr>
<tr>
<td>External load</td>
<td>100 kg at midspan</td>
<td>Min. diameter above 100 mm</td>
<td>No visual damage nor reduction in short term pressure capacity</td>
<td>The Society will witness the test</td>
<td>Initial</td>
</tr>
<tr>
<td>Robustness</td>
<td>-</td>
<td>Min. 10 bar nominal pressure</td>
<td>The Society will witness the test</td>
<td></td>
<td>Initial</td>
</tr>
<tr>
<td>Load deformation</td>
<td>ASTM D2412 Robustness in case manufacturer argues 10 bar is too strict</td>
<td>1 specimen, min., intermediate and max. diameter, for lowest nominal pressure</td>
<td>Equal to or better than a 10 bar construction with conventional thermoset resin</td>
<td>The Society will witness the test</td>
<td>Initial</td>
</tr>
<tr>
<td>Impact resistance 3)</td>
<td>ASTM D2444</td>
<td>1 specimen, min., intermediate and max. diameter, for lowest nominal pressure.</td>
<td>Impact followed by pressure testing to 2.5x design pressure for at least 1 hour.</td>
<td>The Society will witness the test</td>
<td>Initial</td>
</tr>
<tr>
<td>Axial strength</td>
<td>-</td>
<td>-</td>
<td>Within allowable stress</td>
<td>The Society will witness the test</td>
<td>Initial</td>
</tr>
</tbody>
</table>

1) Other standards may be agreed upon with the Society prior to type testing.
2) If design and construction method is not proportional for varying diameters/nominal pressures, additional testing may be required.
3) Only relevant if other resins than polyester, vinyl ester and epoxy are used.

initial = initial assessment
retention = periodical assessment, carried out after two (2) years
renewal = periodical assessment, carried out after five (5) years
3.2 General requirements for material applicable to all piping systems

3.2.1 Ageing
The pipe manufacturer shall demonstrate that environmental effects will not degrade the properties of the piping material to a level below the values necessary to meet the requirements for the piping system as specified.
Applicable service experience may be accepted as documentation.

3.2.2 Fatigue
In cases where design loads incorporate a significant cyclic or fluctuating component, fatigue shall be considered in material selection and installation design.
The pipe manufacturer shall demonstrate that the piping material is not susceptible to fatigue failure (rupture, leakage, or excessive creep) at the operating stress levels.
Applicable service experience may be accepted as documentation.

3.2.3 Erosion
The pipe manufacturer shall consider whether, depending on the application, the piping material is subject to erosion which may require increased wall thickness, special liners, change of materials etc.
Applicable service experience may be accepted as documentation.

3.2.4 Material compatibility and fluid absorption
Piping materials' compatibility with the fluid to be carried or in which it will be immersed, shall be ensured (e.g. for other liquids/gases than the normal such as water and common hydrocarbons).
The pipe manufacturer shall demonstrate that the piping material is compatible and does not absorb the medium conveyed in the pipe to the extent that it degrades to a level below the values necessary to meet the requirements for the piping system as specified.
Applicable service experience may be accepted as documentation.

3.3 Extent of type tests applicable to piping system dependent on application
The applicant can elect to test any of the below listed properties. If testing is carried out, the results will be stated on the Type Approval Certificate, and if testing is not carried out, this will be stated on the certificate.
See Table 4 for test method, acceptance criteria, level of verification, frequency of verification etc.

3.3.1 Fire endurance level 3
Pipes and fittings whose functions or integrity are essential to the safety of ships are required to meet minimum fire endurance requirements.
The fire endurance testing shall include:
— one test specimen of minimum diameter pipe
— one test specimen of minimum diameter pipe greater than 152 mm
— one of each type of fitting w.r.t. joining methods, e.g. flange, pipe couplings, taper joint.
If the type approval shall include several nominal pressures of the same design, only the lowest pressure class need to be tested.
If the pipe is tested with a fire-protective coating, this will be specially considered.
The fire protective coating shall be specified w.r.t.:
— thickness
— formulation
— procedure for terminating insulation at fittings
and the following shall be documented:

— resistance to oils, salt water, and other applicable fluids
— resistance to impact
— resistance to degradation over time.
— For plastic piping systems that shall meet fire endurance level 2 or level 1, a special fire-protective coating will always be needed. The piping systems shall be tested in accordance with Appendix 1 of IMO Resolution A.753(18). A test programme will be subject to agreement with the Society in each separate case.
— Reference is made to IMO Resolution MSC.313(88) Amendments to the Guidelines for the Application of Plastic Pipes on Ships (Resolution A.753(18)) for information regarding fire endurance level 1W and fire endurance level 2W.

3.3.2 Flame spread

All pipes, except those fitted on open decks and within tanks, cofferdams, pipe tunnels and ducts shall have low flame spread characteristics not exceeding average values listed in IMO FTP code, App.1, Part 5.
Surface flame spread characteristics may also be determined using the test procedures given in ASTM D635, or in other national or international equivalent standards.

The flame spread test shall include one test specimen taken from of one diameter.
If the pipe is tested with a fire-protective coating, this will be specially considered. The following shall be documented:

— resistance to oils, salt water, and other applicable fluids
— resistance to impact
— resistance to degradation over time.

3.3.3 Smoke generation and toxicity

The smoke generation and toxicity testing shall include one test specimen taken from of one diameter.
If the pipe is tested with a fire-protective coating, this will be specially considered. The following shall be documented:

— resistance to oils, salt water, and other applicable fluids
— resistance to impact
— resistance to degradation over time.

3.3.4 Electrical conductivity

a) Electrical conductivity - outside

Piping which satisfies the criteria for electrical conductivity - outside, will be approved for conveying conductive fluids in hazardous areas.

The electrical conductivity test shall include one test specimen of one diameter, and one of each type of fitting w.r.t. both function, i.e. T/bend/flange/etc. and method of construction.

The resistance shall be less than 0.1 MΩ/m and less than 1 MΩ to earth. The test shall include measuring resistance over the connections of flanges and fittings carried out as per manufacturer's specification.

The piping shall be prepared for attachment of earthing cables.

b) Electrical conductivity - inside and outside

Piping which satisfies the criteria for electrical conductivity - inside and outside, will be approved for conveying non-conductive fluids (refined oil products and distillates) in hazardous areas.

The electrical conductivity test shall include one test specimen of one diameter, and one of each type of fitting w.r.t. both function, i.e. T/bend/flange/etc. and method of construction.

The resistance shall be less than 0.1 MΩ/m and less than 1 MΩ to earth. The test shall include measuring resistance over the connections of flanges and fittings carried out as per manufacturer's specification.

The inner conductive liner shall be connected to the outer conductive layer, or to be prepared for attachment of earthing cables.
### Table 4 Extent of Type Tests applicable to piping system dependent on application

<table>
<thead>
<tr>
<th>Property</th>
<th>Test method</th>
<th>Number and selection of test specimen</th>
<th>Acceptance criteria</th>
<th>Minimum level of verification</th>
<th>Frequency of verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a Fire endurance</td>
<td>IMO resolution A.753(18), Appendix 2, IMO resolution MSC.313(88)</td>
<td>1 specimen, Min. diameter and Min. diameter &gt;152 mm and fittings, from the lowest nominal pressure.</td>
<td>L3</td>
<td>Independent laboratory</td>
<td>Initial, and change of resin system</td>
</tr>
<tr>
<td>1b Fire endurance</td>
<td>IMO resolution A.753(18), Appendix 1, IMO resolution A.753(18), Appendix 3. Alternative standard: ASTM D635</td>
<td>1 specimen, Min. diameter and fittings, from the lowest nominal pressure.</td>
<td>L1 or L2 / L1W or L2W</td>
<td>Independent laboratory</td>
<td>Initial, and change of resin system</td>
</tr>
<tr>
<td>2 Flame spread</td>
<td>IMO fire test procedures code (FTPC), App.1, Part 5 as modified according to IMO resolution A.753(18), Appendix 3. Alternative standard: ASTM D635</td>
<td>1 specimen, one diameter</td>
<td>Low Flame Spread ASTM D635: Acceptance criteria: Average linear burning rate &lt; 60 mm/min.</td>
<td>Independent laboratory 3)</td>
<td>Initial, and change of resin system</td>
</tr>
<tr>
<td>3a Smoke generation</td>
<td>IMO fire test procedures code, (FTPC), part 2 item 2.6.1.4 and 2.6.2</td>
<td>1 specimen, one diameter</td>
<td>Limited smoke generation</td>
<td>Independent laboratory 2)</td>
<td>Initial, and change of resin system</td>
</tr>
<tr>
<td>3b Toxicity</td>
<td></td>
<td>1 specimen, one diameter</td>
<td>Limited toxicity</td>
<td>Independent laboratory 3)</td>
<td>Initial, and change of resin system</td>
</tr>
<tr>
<td>4 Electrical conductivity (For testing of both outside and inside conductivity)</td>
<td>ASTM D257</td>
<td>1 specimen, one diameter and one of each type of fitting with regard to type of construction.</td>
<td>&lt; 0.1 MΩ/m and &lt; 1 MΩ to earth</td>
<td>The Society will witness the test</td>
<td>Initial, and change of conductive system</td>
</tr>
</tbody>
</table>

1) Other standard may be agreed upon with the Society prior to testing.
2) If design and construction method is not proportional for varying diameters/pressure classes, additional testing may be required.
3) Fire tests according to FTP code shall be performed by a lab approved according IMO SSE.1/Circ.1/Rev.1

- *initial* = initial assessment
- *retention* = periodical assessment, carried out after two (2) years
- *renewal* = periodical assessment, carried out after five (5) years
4 Requirements for marking of product

The pipes and fittings shall be marked. The marking shall at least include the following information:

— manufacturer’s name and/or logo
— type designation
— the design standards that the pipe or fitting is manufactured in accordance with
— material of which the pipe or fitting is made
— size/dimensions
— pressure ratings (internal and external) - nominal
— design pressure (internal and external) - if different from nominal
— temperature rating
— conductive/non-conductive
— date of fabrication and/or serial number

Labels with the following text shall be attached to flanges which shall be joined by bolting:

"APPLY BOLTING TORQUE ACCORDING TO MANUFACTURER'S RECOMMENDATION".

The marking shall be carried out in such a way that it is visible, legible and indelible. The marking of product shall enable traceability to the type approval certificate.
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