



# STANDARD FOR CERTIFICATION

No. 2.9

Type Approval Programme No. 1-501.1

## FIBRE REINFORCED THERMOSETTING PLASTIC PIPES

MAY 2011

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# FOREWORD

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The Society reserves the exclusive right to interpret, decide equivalence or make exemptions to this Standard for Certification.

## ***Main changes:***

This document replaces the October 2009 issue.

- Aligned with IACS UR P4, latest revisions
- Aligned with IACS Recommendations No. 86, latest revision
- As a consequence of the two above, an increased test programme has been made
- More details on which documentation submittal requirements
- Evaluation of smoke generation and toxicity is now included
- Specific requirements on external pressure capacity, text and table updated
- Editorial changes.

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## 1. Scope of services

Det Norske Veritas (DNV) Type Approval is based on the ISO/IEC Guide 2 (1991) definition:

*“Approval of conformity with specified requirements on the basis of systematic examination of one or more specimens of a product representative of the production”.*

The requirements are specified in Rules and/or standards referred to in this Type Approval programme.

This Type Approval programme outlines the procedure and conditions for obtaining, maintaining and renewing a Type Approval. DNV Standards for Certification No. 1.2 (2009) describes the Type Approval in general.

Type Approved products will be listed in DNV's Register of Type Approved Products available on the DNV Internet site at <http://exchange.dnv.com/>.

## 2. Procedure

The Type Approval procedure normally consists of the following steps:

- application for Type Approval
- quotation
- assessment of Type Approval documentation
- Initial Survey of product and production facilities including witnessing of Type Tests
- assessment of survey report and Type Test results
- issuance of Type Approval Certificates
- Certificate Retention Survey after two (2) years
- application for renewal after four (4) years

Explained in detail:

### 2.1 Application for Type Approval

The Type Approval should be applied for in writing to DNV's local office. The application shall include Type Approval documentation as specified in section 3.

### 2.2 Quotation

A quotation will be given by DNV Responsible Approval Centre, to be confirmed by the client.

### 2.3 Assessment of Type Approval documentation

The Type Approval documentation is assessed by DNV Responsible Approval Centre to verify that it is in conformity with the specified requirements.

### 2.4 Initial Survey of product and production facilities including witnessing of Type Tests

The objective of Initial Survey is to verify that the production, quality control arrangement, product design, material composition and the product marking is according to the Type Approval documentation.

The main elements of a DNV Initial Survey are to:

- ensure that production and quality control arrangements are according to requirements as specified in section 4.3 and as stated in Type Approval documentation submitted by manufacturer
- witness Type Tests, as specified in section 4.4.1 and 4.4.3 when applicable
- ensure traceability between manufacturer's product marking and the type designation as stated in the application for Type Approval, ref. section 4.5.

The objective of Type Tests is to verify the ability of the product to meet specified requirements by subjecting the test sample to physical, chemical, environmental or operational stresses.

Type Tests are to be carried out and verified in one of the following ways:

- at a DNV laboratory
- at a recognised and independent laboratory accepted by DNV
- at the manufacturer's premises in the presence of a DNV surveyor.

The Initial Survey report and Type Test results are to be submitted to DNV Responsible Approval Centre for evaluation.

## **2.5 Assessment of Survey report and Type Test results**

The Initial Survey report and Type Test results are assessed in order to verify compliance with the requirements.

## **2.6 Issuance of Type Approval Certificates**

When the assessment of Type Approval documentation, Type Testing and survey of production and quality control arrangement is successfully completed a Type Approval Certificate will be issued to the manufacturer of the product. The certificate is normally given a validity period of four (4) years, with a Certificate Retention Survey after two (2) years.

## **2.7 Certificate Retention Survey after two (2) years**

The objective of the Certificate Retention Survey is to verify that the product design, material composition and the product marking are not altered since issuance of the Type Approval Certificate.

Certificate Retention Survey is to be carried out two (2) years after issuance of Type Approval Certificate.

The main elements of the Certificate Retention Survey are to:

- ensure that Type Approval documentation is available
- review design, materials, performance and production process (as specified in section 4.3) with respect to possible changes, in order to ensure compliance with Type Approval documentation and/or referenced material specifications
- ensure traceability between manufacturer's product marking and the DNV Type Approval Certificate as stated in section 4.5.
- witness tests/inspection on factory samples, selected at random from the production line (where practicable), or storage, if specified in section 4.4.

The Certificate Retention Survey report shall conclude that either:

- a) the Type Approval Certificate shall be retained,  
or
- b) the Type Approval Certificate shall be modified/recalled due to the changes in the basis for approval

The Certificate Retention Survey report shall be submitted to the manufacturer and to DNV Responsible Approval Centre.

## **2.8 Application for renewal after four (4) years**

Application for renewal should be submitted to DNV not later than three (3) months before expiry date of the Type Approval Certificate.

The application shall include updated Type Approval documentation as specified in section 3, item 1-6. Items 7-12 shall be submitted if changes have been implemented since last issuance of the Type Approval.

Upon receipt of the application, DNV will perform a Renewal Survey with objective to verify that the product design, material composition and the product marking are not altered since issuance of the Type Approval Certificate.

Renewal Survey is to be carried out not later than four (4) years after issuance of the Type Approval Certificate.

The main elements of a Renewal Survey are the same as specified for the Certificate Retention Survey in section 2.7.

If there, since last issuance of the Type Approval Certificate, has been any change in the relevant standards or in DNV Rules, new assessment of product and Type Tests may be required.

The Renewal Survey report will constitute part of the basis for renewal of the Type Approval Certificate.

## **3. Documents to be submitted**

The following Type Approval documentation is to be submitted by the manufacturer at Initial Type Approval and updated, at renewal. The documentation shall be in duplicate, one (1) copy for the DNV local office's surveyor and one (1) copy to be submitted by the DNV local office to DNV Responsible Approval Centre. The manufacturer shall keep one (1) copy of Type Approval documentation in their own file. The documentation shall be in English, 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:
  - Manufacturer's name
  - mailing address
  - contact person
  - phone and fax number
  - E-mail and Web address (if applicable).
- 3) product description, including:
  - pressure classes (internal pressure)
  - pressure capacity (external pressure)
  - diameters, specification of all
  - wall thicknesses, for each diameter
  - fittings, specification of all types and all diameters of each type
  - max. service temperature
  - liner thickness and type
  - Fire Endurance level (if applicable)
  - Low Flame Spread (if applicable)
  - Smoke Generation and Toxicity (if applicable)
  - conductive or non-conductive grade.
- 4) Field of Application and special limitations of the product, such as:
  - intended service
  - installation locations
  - intended fluids
  - limitations w.r.t. flow rates.
- 5) Product specification/data sheet/drawings for:
  - thermosetting resins used
  - catalyst and accelerator types, and their concentrations
  - fibre reinforcements used
  - sectional assembly drawings (pipe, fittings, connections)
  - relevant calculations.
- 6) Installation guide, including:
  - lamination procedure for joints <sup>1)</sup>
  - torque tables for bolted flanges <sup>1)</sup>
  - support span for clamping <sup>1)</sup>.
- 7) Description of production processes <sup>2)</sup>
  - production steps
  - winding angle and orientation
  - cure- and post-cure conditions.
- 8) Description of quality control arrangement <sup>2)</sup>
- 9) Test results (from tests already carried out) with references to standards, methods etc.
- 10) Information regarding marking of the product or packaging <sup>2)</sup>
- 11) In-service experience, if available  
Witnessed Type Test results (ref. Section 4) and Survey report by DNV local office is to be submitted when completed.
  - 1) To be verified by survey during Type Testing.
  - 2) To be verified by Initial Survey prior to issuance of Type Approval Certificate.

## 4. Requirements

### 4.1 Basis for Type Approval

The Type Approval of Fibre Reinforced Thermosetting Plastic Pipes is based on the requirements given in:

- DNV Rules for Classification of Ships, Pt.4 Ch.6
- DNV Rules for Classification of High Speed, Light Craft and Naval Surface Craft, Pt.4 Ch.6
- DNV Offshore Codes, DNV-OS-D101, “Marine and Machinery Systems and Equipment”, Ch.2 Sec.2
- 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 FTP Code: International Code for Application of Fire Test Procedures.

### 4.2 Scope of Type Approval

One DNV Type Approval Certificate will cover one grade of the actual product with the possibility to include variants.

Fibre Reinforced Plastic (FRP) piping systems with different:

- resin system
- temperature limit
- Fire Endurance level
- Flame Spread performance
- conductive or non-conductive performance

are considered as different grades.

Different pressure classes (both internal and external), diameters, as well as a defined range of fittings (including flanges) are considered variants of the same grade.

One DNV Type Approval Certificate is limited to one manufacturer at one production site.

### 4.3 Requirements to production and quality control arrangement

The manufacturer shall have a quality system that meets ISO 9001 standards, or equivalent. If this quality standard is not fulfilled, the extent of testing and surveys will be specially considered.

The extent of the manufacturer's quality control during production shall as a minimum be according to Table 4-1.

<i>Control</i>	<i>Acceptance Criteria</i>	<i>Frequency of control</i>
Visual	According to BS 7159:1989, Table 11.1 <sup>1)</sup>	
Dimensional	According to a recognized standard	100% control
Leakage control of spools	No leaks at 1.5 × Design Pressure <sup>2)</sup>	
Hardness	> 35 Barcol	
Glass Transition temperature, T <sub>g</sub>	According to a recognized standard	Sampling:
Glass content	According to specification	Pipe: one pr. 500 m
Short-term burst	Safety Factor = 4.0 on Nominal Pressure	Fittings: one pr. 200
Electric conductance <sup>3)</sup>	< 0.1M Ω/m	

1) Other standards and quality control arrangements may be agreed upon with the Society prior to testing.  
 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 of 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.

## 4.4 Requirements to material

### 4.4.1 Extent of Type Test applicable to all piping systems

See Table 4-2 below for Test Method, Number and Selection of Parallels, Acceptance Criteria, Level of Verification and Frequency of Verification.

#### 4.4.1.1 Internal Pressure - Short-Term

The pressure test shall include:

- one pipe of min. diameter
- one pipe of an intermediate diameter

- one pipe of max. diameter
- one of each type of fitting, including flanges, with regard to both function, i.e. T/bend/flange/etc. and method of construction from each pressure class.

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

The pipe shall be flanged 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 Section 3).

If bolted flanges are to 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 Section 3)
- according to manufacturer's torque table +25% over torque.

If winding angle is not constant, pipe diameters to be tested shall be agreed with DNV 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.

#### 4.4.1.2 Internal Pressure – Long-Term

If long-term testing is carried out at room temperature, the allowable operational pressure will be reduced as listed in DNV Rules for Classification of Ships / High Speed, Light Craft and Naval Surface Craft, Pt.4 Ch.6 Sec.6.

If long-term 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.

#### 4.4.1.3 External Pressure

The capacity 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. 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 D2924-01, Ch. 6, Figure 2, hoop load only (introduction of axial loads shall be avoided).

The nominal external pressure rating equals the collapse pressure divided by a safety factor of 3.

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

The pressure testing shall include:

- one pipe of min. diameter
- one pipe of an intermediate diameter
- one pipe of max. diameter

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. This means; 30 meter external pressure head (3.0 bar), plus 1.0 bar inside the pipe (full vacuum), will require an external pressure rating for the piping system of 4.0 bar.

#### 4.4.1.4 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.

#### 4.4.1.5 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 is to be taken as the maximum recommended span length in the manufacturer's pipe installation guide. The pipe shall be pressure tested after loading.

#### 4.4.1.6 Impact resistance

In order to assure a minimum impact resistance the minimum nominal pressure rating for pipe and fittings to be Type Approved is set to 10 bar for conventional thermo-set resins (e.g. polyester, vinyl ester and epoxy).

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

#### 4.4.1.7 Axial strength

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

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

<b>Table 4-2 Extent of Type Tests applicable to all piping systems</b>						
	<i>Property</i>	<i>Test method</i> <sup>1)</sup>	<i>Number and selection of parallels</i> <sup>2)</sup>	<i>Acceptance criteria</i>	<i>Minimum level of verification</i>	<i>Frequency of verification</i>
1	Internal Pressure - Short-Term	ASTM D1599-99 Fixed end	1 parallel, min., intermediate and max. diameter and fittings from each pressure class	Safety Factor = 4.0 on Nominal Pressure	DNV witness of test	Initial and Renewal
2	Internal Pressure - Long-Term >100 000h	ASTM D1598-02 ASTM D2992-06	1 parallel, one diameter	Safety Factor = 2.5 on Nominal Pressure	Manufacturer's QA department	Initial
3	External Pressure	Pressure test according to ASTM D2924-01, Ch. 6, Figure 2, hoop load only, or calculations based on mechanical test data	1 parallel, min., intermediate and max. diameter, of lowest pressure class	Safety Factor = 3.0 on specified external pressure capacity, min. 1 bar (vacuum). The collapse pressure not to be less than 3 bar.	DNV witness of pressure test or mechanical test	Initial
4	Heat Distortion Temperature	ISO 75-3:2004, Method A	Each resin system and according to ISO 75-3:2004	> 20°C above max. operating temperature and > 80°C	Independent laboratory	Initial and at Change of resin system
5	External Load	100 kg at midspan	Min. diameter above 100 mm	No visual damage nor reduction in short term pressure capacity	DNV witness of test	Initial
6	Impact Resistance <sup>3)</sup>	ASTM D2444-99	1 parallel, min., intermediate and max. diameter, of lowest pressure class.	Equal to or better than a 10 bar construction with conventional thermo-set resin	DNV witness of test	Initial
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/pressure classes, additional testing may be required. 3) Only relevant if other resins than polyester, vinyl ester and epoxy are used.  Initial = Initial Type Approval Survey Retention = Certificate Retention Survey, carried out after two (2) years Renewal = Renewal Survey, carried out after four (4) years						

### 4.4.2 General requirements to material applicable to all piping systems

#### 4.4.2.1 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 to the piping system as specified.

Applicable service experience may be accepted as documentation.

#### 4.4.2.2 Fatigue

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.

#### 4.4.2.3 Erosion

The pipe manufacturer shall demonstrate that the piping material is not subject to erosion at normal/design flow rates (up to 7 m/s).

Applicable service experience may be accepted as documentation.

#### 4.4.2.4 Material Compatibility and Fluid Absorption

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 to the piping system as specified.

Applicable service experience may be accepted as documentation.

### 4.4.3 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 4-3 for Test Method, Acceptance Criteria, Level of Verification, Frequency of Verification etc.

#### 4.4.3.1 Fire Endurance

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 test shall include one parallel of:

- minimum diameter pipe
- minimum diameter pipe greater than 152 mm
- one of each type of fitting w.r.t. construction.

If the Type Approval shall include several pressure classes 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.

#### 4.4.3.2 Flame Spread

The Flame Spread test shall include one parallel 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.

#### 4.4.3.3 Smoke Generation and Toxicity

The Smoke Generation and Toxicity testing shall include one parallel 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.

#### 4.4.3.4 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 parallel 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 is to 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 parallel 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 is to be connected to the outer conductive layer, or to be prepared for attachment of earthing cables.

	<i>Property</i>	<i>Test method <sup>1)</sup></i>	<i>Number and selection of parallels <sup>2)</sup></i>	<i>Acceptance criteria</i>	<i>Minimum level of verification</i>	<i>Frequency of verification</i>
1	Fire Endurance	IMO Resolution A.753(18)	1 parallel, Min. diameter and Min. diameter >152 mm and fittings, from the lowest pressure class.	L1, L2, or L3	Independent laboratory	Initial, and Change of resin system
2	Flame Spread	IMO Resolution A.653(16) modified according to IMO Resolution A.753(18), or ASTM D635-06	1 parallel, one diameter	Low Flame Spread ASTM D635-06: Average linear burning rate < 60 mm/min.	Independent laboratory	Initial, and Change of resin system
3a	Smoke Generation	IMO Fire Test Procedures Code, Part 2	1 parallel, one diameter	Limited smoke generation	Independent laboratory	Initial, and Change of resin system
3b	Toxicity	item 2.6.1.4 and 2.6.2	1 parallel, one diameter	Limited toxicity	Independent laboratory	Initial, and Change of resin system
4	Electrical Conductivity (For testing of both outside and inside conductivity)	ASTM D257-07	1 parallel, one diameter and one of each type of fitting with regard to type of construction.	< 0.1 MΩ/m and < 1 MΩ to earth	DNV witness of test	Initial, and Change of conductive system
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  Initial = Initial Type Approval Survey Retention = Certificate Retention Survey, carried out after two (2) years Renewal = Renewal Survey, carried out after four (4) years						

#### 4.5 Requirements to marking of product

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

- manufacturer's name
- production plant
- product name (grade)
- pressure rating - nominal
- design pressure - if different from nominal
- temperature rating

The marking is to be carried out in such a way that it is visible, legible and indelible. The product name shall be the same as stated on the DNV Type Approval Certificate (ref. item 1 in Section 3).

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

“APPLY BOLTING TORQUE ACCORDING TO MANUFACTURER'S RECOMMENDATION”.

## **5. Suspension and Withdrawal of Type Approval Certificates**

A Type Approval Certificate may be suspended or withdrawn if the Society finds it justified. Directions for suspension and withdrawal of a Type Approval Certificate are given by the DNV Standards for Certification No. 1.2 (2009).

## **6. Standards referred to in this document**

- ISO 9001:2008, Quality management systems - Requirements
- BS 7159:1989, Code of practice for design and construction of glass-reinforced plastics (GRP) piping systems for individual plants or sites
- ASTM D1599-99(2005), Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
- 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 D 2924-01(2006), Standard Test Method for External Pressure Resistance of “Fiberglass” (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe
- ISO 75-3:2004, Plastics - Determination of temperature of deflection under load - Part 3: High-strength thermosetting laminates and long-fibre-reinforced plastics
- 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)