

CLASS PROGRAMME

Type approval

DNVGL-CP-0072

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Thermoplastic 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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CHANGES – CURRENT

This is a new document.

CONTENTS

Changes – current.....	3
Section 1 GENERAL.....	5
1 Introduction.....	5
2 References.....	6
3 Documentation.....	6
Section 2 General requirements.....	9
1 Design requirements.....	9
2 Requirements for production and quality control arrangement.....	9
3 Requirements to material.....	9
4 Requirements for marking of product.....	16

SECTION 1 GENERAL

1 Introduction

1.1 Objective

The objective of this class programme (CP) is to give a description of the Society's type approval (TA) scheme for thermoplastic 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 type approval certificate based on requirements given in the Society's rules and standards, and the following documents, 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 regarding MED certification.

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1.2 Scope

This CP gives a description of the procedures and requirements related to documentation, design and type testing applicable for TA of thermoplastic piping systems.

This CP does not set the design requirements for the thermoplastic piping systems. TA is based on compliance with design requirements given in the Society's rules and/or other regulations and standards. The CP describes the applicable requirements 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.

Thermoplastic piping systems with different materials are considered as different grades, and different:.

- nominal pressures (both internal and external)
- joining methods
- diameters
- fire endurance level
- flame spread performance
- smoke generation and toxicity performance
- conductive or non-conductive, 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 upon 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 [RU SHIP Pt.4 Ch.6](#) require that thermoplastic piping systems are type approved in accordance with this CP for equipment to be installed on vessels classed with the Society.

A TA certificate in accordance with this CP will confirm compliance with the requirements given in the Society's rules 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 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 D2412-11, *Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading*
- 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*
- ISO 306:2013, *Plastics - Thermoplastic materials - Determination of Vicat softening temperature (VST)*
- ISO 2507-1:1995, *Thermoplastics pipes and fittings -- Vicat softening temperature - Part 1: General test method*
- ISO 8361-1:1991, *Thermoplastics pipes and fittings - Water absorption - Part 1: General test method*
- ISO 9854-1:1994, *Thermoplastics pipes for the transport of fluids - Determination of pendulum impact strength by the Charpy method - Part 1: General test method*
- ISO 9653:1998, *Adhesives - Test method for shear impact strength of adhesive bonds*
- ISO 15493:2003, *Plastics piping systems for industrial applications - Acrylonitrile-butadiene-styrene (ABS), unplasticized poly(vinyl chloride) (PVC-U) and chlorinated poly(vinyl chloride) (PVC-C) - Specifications for components and the system - Metric series*
- 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 thermoplastic 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 written 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
 - fittings, specification of all types and all diameters of each type
 - types of joining methods applicable, e.g. flange, gluing, welding 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:
 - materials
 - sectional assembly drawings (pipe, fittings, connections)
- 6) installation instructions, including:
 - joining 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
- 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 ²

¹ To be verified by a surveyor during type testing

² To be verified by initial assessment prior to issuance of type approval certificate

- 10) test results (from tests already carried out) with references to standards, methods etc.
- 11) information regarding marking of the product or packaging ², see [Sec.2 \[4\]](#)
- 12) in-service experience, reference list of ship installations (if available)
- 13) witnessed type test results (see [Sec.2 Table 3](#)) and initial assessment report by the Society's local office shall be submitted when completed.

SECTION 2 GENERAL REQUIREMENTS

1 Design requirements

The thermoplastic piping systems shall comply with the relevant requirements given in the rules and standards referred in [Sec.1 \[1.1\]](#).

2 Requirements for 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 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

<i>Control</i>	<i>Acceptance Criteria</i> ¹⁾	<i>Frequency of control</i>
Visual	According to a recognized standard	100% control
Dimensional	According to a recognized standard	
Weight	According to a recognized standard	
Short term burst	Safety Factor = 4.0 on Nominal Pressure	Sampling: Pipe: one pr. 500 m Fittings: one pr. 200
Vicat Softening Temperature (VST)	ISO 306, or ISO 2507	Sampling: Pipe: one pr. 500 m Fittings: one pr. 200
1) other standards and quality control arrangements may be agreed upon with the Society prior to testing		

3 Requirements to material

3.1 Extent of type tests applicable to all piping systems

See [Table 3](#) for test method, number and selection of test specimens, acceptance criteria, level of verification and frequency of verification.

For plastic piping systems made of thermoplastic materials intended for non-essential services, e.g. sanitary hot and cold water, sewage systems and similar piping systems, the test scope for type approval may be determined according to the recognized standard applicable. In addition the requirements given in [\[3.3.1\]](#) to [\[3.3.3\]](#) shall be observed.

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 be given access to verify that:

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

are according to manufacturer's specification (see 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 (see 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](#) (see also [RU SHIP Pt.4 Ch.6 Sec.9 Table 8](#) and [RU SHIP Pt.4 Ch.6 Sec.9 Table 9](#)).

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 Thermoplastic pipes. Permissible pressures and temperature limits

Material ¹⁾	Nominal pressure ²⁾ PN (bar)	Permissible working pressure (bar)						
		-20°C to 0°C	30°C	40°C	50°C	60°C	70°C	80°C
PVC	10		7.5	6				
	16		12	9	6			
PVC	10	7.5	7.5	7	6			
	ABS	12	12	10.5	9	7.5	6	

Material ¹⁾	Nominal pressure ²⁾ PN (bar)	Permissible working pressure (bar)						
		-20°C to 0°C	30°C	40°C	50°C	60°C	70°C	80°C
HDPE	10	7.5	6					
	16	12	9.5	6				
1) for other materials, the permissible working pressure to be in accordance with recognized standards								
2) according to recognized standards for water supply on shore								

For plastic piping systems intended for non-essential piping systems, results of long-term tests according to applicable standard may be accepted.

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 Vicat softening temperature (VST)

If more than one material is included in the type approval application, VST data shall be submitted for all materials.

Thermoplastic materials with an VST below 80°C shall not be used. However, lower VST may be accepted for non-essential systems based on recognised standard applicable for the plastic piping system.

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 mid-span 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 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.

Table 3 Extent of type tests applicable to all piping systems

No.	Property	Test method ¹⁾	Number and selection of test specimen ²⁾	Acceptance criteria	Minimum level of verification	Frequency of verification
1	Internal Pressure - Short-Term	ASTM D1599 Fixed end ASTM D 2992, ISO 15493 or equivalent	1 specimen, min., intermediate and max. diameter and fittings from each nominal pressure	Safety Factor = 4.0 on Nominal Pressure	Society to witness the test	Initial Renewal
2	Internal Pressure - Long-Term > 100 000h	ASTM D1598 ASTM D2992	1 specimen, one diameter	Safety Factor = 2.5 on Nominal Pressure	Manufacturer's QA department	Initial
3	External Pressure	Pressure test according to ASTM D2924, Ch. 6, Figure 2, hoop load only, ISO 15493 or equivalent, or calculations based on mechanical test data	1 specimen, 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.	Society to witness pressure test or mechanical test	Initial
4	Vicat Softening Temperature (VST)	ISO 306 or ISO 2507	Each material and according to test standard	> 20°C above max. operating temperature	Independent laboratory	Initial and at Change of granulate
5	External Load	100 kg at mid-span	Min. diameter above 100 mm	No visual damage nor reduction in short term pressure capacity	Society to witness the test	Initial
6	Impact Resistance	ASTM D2444, ISO 9854, ISO 9653, ISO 15493 or equivalent	1 specimen, min., intermediate and max. diameter, for lowest nominal pressure.	Impact followed by pressure testing to 2.5 x design pressure for at least 1 hour.	Society to witness the 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/nominal pressures, additional testing may be required

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 Dimensions and tolerances

The piping and fittings shall be according to a recognised standard with respect to dimensions and tolerances, in order to facilitate joining.

3.2.2 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.

3.2.3 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.

3.2.4 Erosion

Depending on the application, the pipe manufacturer shall consider whether the piping material is or is not subject to erosion at normal/design flow rates (up to 7 m/s) which may require increased wall thickness, special liners, change of materials etc.

Applicable service experience may be accepted as documentation.

3.2.5 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 3](#) 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, gluing, welding.

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, Annex 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 M Ω /m and less than 1 M Ω 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 M Ω /m and less than 1 M Ω 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

No.	Property	Test method ¹⁾	Number and selection of test specimen ²⁾	Acceptance criteria	Minimum level of verification	Frequency of verification
1a	Fire endurance	IMO Resolution A.753(18), Appendix 2	1 specimen, min. diameter and Min. diameter >152 mm and fittings, from the lowest nominal pressure.	L3	Independent laboratory	Initial, and change of granulate
1b	Fire endurance	IMO Resolution A.753(18), Appendix 1 IMO Resolution MSC.313(88)	1 specimen, min. diameter and fittings, from the lowest nominal pressure.	L1 or L2 / L1W or L2W	Independent laboratory	Initial, and change of granulate
2	Flame spread	IMO fire test procedures code (FTPC), Annex 1, Part 5 as modified according to IMO Resolution A.753(18), Appendix 3. Alternative standard: ASTM D635	1 specimen, one diameter	Low flame spread ASTM D635: acceptance criteria: average linear burning rate < 60 mm/min.	Independent laboratory ³⁾	Initial, and change of granulate
3a	Smoke generation	IMO fire test procedures code, (FTPC) Part 2 item 2.6.1.4 and 2.6.2	1 specimen, one diameter	Limited smoke generation	Independent laboratory ³⁾	Initial, and change of granulate
3b	Toxicity		1 specimen, one diameter	Limited toxicity	Independent laboratory ³⁾	Initial, and change of granulate
4	Electrical conductivity (For testing of both outside and inside conductivity)	ASTM D257	1 specimen, one diameter and one of each type of fitting with regard to type of construction.	< 0.1 MΩ/m and < 1 MΩ to earth	Society to witness the test	Initial, and change of conductive system
<p>1) other standard may be agreed upon with the Society prior to testing</p> <p>2) if design and construction method is not proportional for varying diameters/pressure classes, additional testing may be required</p> <p>3) fire tests according to FTP code shall be performed by a lab approved according IMO SSE.1/Circ.1/Rev.1</p> <p><i>Initial</i> = initial assessment</p> <p><i>Retention</i> = periodical assessment, carried out after two (2) years</p> <p><i>Renewal</i> = periodical assessment, carried out after five (5) years</p>						

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.

The marking shall be carried out in such a way that it is visible, legible and indelible. The product name shall be the same as stated in the Society's type approval certificate (see item 1 in [Sec.1 \[3\]](#)).

DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16 000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

SAFER, SMARTER, GREENER