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**Ships and marine technology — Standard  
specification for thermosetting resin  
fibreglass pipe and fittings to be used for  
marine applications**

*Navires et technologie maritime — Spécification normalisée pour les  
tuyaux et raccords en résine thermosettable avec renforcement en  
fibre de verre pour des applications maritimes*

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Published in Switzerland

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15840 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

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# Ships and marine technology — Standard specification for thermosetting resin fibreglass pipe and fittings to be used for marine applications

## 1 Scope

This International Standard applies to reinforced thermosetting resin pipe systems with nominal diameter (DN) 0 through 1 200 mm and nominal pipe sizes (NPS) 0 through 48, which are to be used in marine piping systems.

Values stated in SI units are to be regarded as the standard. Values given in English units are for information only.

The dimensionless designators DN and NPS have been substituted for traditional terms such as “nominal diameter”, “size”, and “nominal size”.

The following safety hazard caveat pertains to the test methods that are included in this International Standard. This standard does not purport to address all of the safety concerns associated with its use.

**SAFETY PRECAUTIONS — It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.**

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## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

American Society of Mechanical Engineers (ASME) B16.1:1998, *Cast Iron Pipe Flanges and Flanged Fittings*

American Society of Mechanical Engineers (ASME) B16.5:1996, *Pipe Flanges and Flanged Fittings*

American Society for Testing and Materials (ASTM) D883, *Standard Terminology Relating to Plastics*

ASTM D1598, *Standard Test Method for Time-To-Failure of Plastic Pipe Under Constant Internal Pressure*

ASTM D1599, *Standard Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings*

ASTM D2310, *Standard Classification for Machine-Made Fibreglass (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe*

ASTM D2583, *Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor*

ASTM D2584, *Standard Test Method for Ignition Loss of Cured Reinforced Resins*

ASTM D2924, *Standard Test Method for External Pressure Resistance of Fibreglass (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe*

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ASTM D2992: 2001, *Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for Fibreglass (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe and Fittings*

ASTM D3567, *Standard Practice for Determining Dimensions of Fibreglass (Glass-Fibre-Reinforced Thermosetting Resin) Pipe and Fittings*

ASTM E1529: 2000, *Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies*

ASTM F412, *Standard Terminology Relating to Plastic Piping Systems*

International Maritime Organisation (IMO), *International Convention for the Safety of Life at Sea (SOLAS)*

International Maritime Organisation (IMO) Resolution A.753 (18), *Guidelines for the Application of Plastic Pipes on Ships*

IMO Resolution MSC 61 (67), *International Code for Application of Fire Test Procedures*

ISO 75-1:—<sup>1)</sup>, *Plastics — Determination of temperature of deflection under load — Part 1: General test method*

ISO 75-2:—<sup>2)</sup>, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 4901, *Reinforced plastics based on unsaturated polyester resins — Determination of residual styrene monomer content*

ISO 9001:2000, *Quality management systems — Requirements*

ISO 11357-2 *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature*

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National Sanitation Foundation (NSF) International, Standard 61 *Drinking Water System Components — Health Effects*

United Kingdom Health and Safety Executive (HSE) Offshore Technology Report (OTI) 95 634, *Jet-Fire Resistance Test of Passive Fire Protection Materials*

United States Code of Federal Regulations (CFR), Title 21 — Food and Drugs, Sections 175.105, 177.2280, 177.2410 and 177.2420.

United States CFR, Title 46 — Shipping

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ASTM D883 and ASTM F412 and the following apply.

#### 3.1

##### **continuously conductive**

pipe and fittings made conductive using continuous conductive filaments, liners or layers

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1) To be published. Revision of ISO 75-1:1993.

2) To be published. Revision of ISO 75-2:1992.

**3.2****homogeneously conductive**

pipe and fittings made conductive using a resin additive so that conductivity is maintained between any two points on the pipe or fitting

NOTE For conveying non-conducting fluids (those having conductance less than 1 000 picosiemens per metre), pipe systems which are homogeneously conductive or have conductivity from the inside surface to the outside surface are recommended.

**3.3****maximum operating pressure**

highest pressure that can exist in a system or subsystem under normal operating conditions

**3.4****non-conducting fluid**

fluid having conductance less than 1 000 picosiemens per metre

**3.5****representative piping system**

system composed of a single manufacturer's pipes, fittings, joints and adhesives that would normally be used by a customer or installer

**4 Classification****4.1 General**

Pipe and fittings are to be classified using the system described in 4.2 through 4.6, which are similar to the requirements of ASTM D2310 for pipe.

**4.2 Types**

The following are pipe and fitting types:

- a) Type I — Filament wound
- b) Type II — Centrifugally cast
- c) Type III — Moulded (fittings only)

**4.3 Resin**

The following are examples of resin classifications:

- a) Resin 1 — Epoxy resin
- b) Resin 2 — Vinylester resin
- c) Resin 3 — Polyester resin
- d) Resin 4 — Phenolic resin
- e) Resin 5 — Customer-specified resin

**4.4 Class**

The following represent class types:

- a) Class A — No liner
- b) Class B — Reinforced liner
- c) Class C — Non-reinforced liner

#### 4.5 Pressure rating (see Annex A)

The following are examples of pressure test classifications:

- a) Rating Method 1 — Short-term test
- b) Rating Method 2 — Medium-term (1 000 h) test
- c) Rating Method 3 — Long-term (10 000 h) test
- d) Rating Method 4 — Long-term (10 000 h) regression test

#### 4.6 Fire endurance (see Annex B)

##### 4.6.1 Fluid

The following fluid types are specified for fire endurance testing:

- a) Fluid E — Empty
- b) Fluid EF — Initially empty for 5 min, followed by flowing water. [Fluid velocity of 1 m/s (3 ft/s) maximum during qualification test.]
- c) Fluid S — Stagnant water

##### 4.6.2 Fire type

The following represent types of fire test:

- a) Fire Type JF — Jet fire with heat flux between 300 kW/m<sup>2</sup> and 400 kW/m<sup>2</sup> (95 100 Btu/h/ft<sup>2</sup> and 126 800 Btu/h/ft<sup>2</sup>)
- b) Fire Type IF — Impinging flame with heat flux of 113,6 kW/m<sup>2</sup> (36 011 Btu/hr/ft<sup>2</sup>)
- c) Fire Type HF — Hydrocarbon furnace test at 1 100 °C (2 012 °F).

##### 4.6.3 Integrity

The following represent various classifications of piping integrity:

- a) Integrity A — No leakage during or after test
- b) Integrity B — No leakage during fire test except a slight weeping may be accepted. Capable of maintaining rated pressure for a minimum of 15 min with a leakage rate of 0,2 l/min (0,05 gal/min) after cooling.
- c) Integrity C — Minimal or no leakage [less than or equal to 0,5 l/min (0,13 gal/min)] during fire test. Capable of maintaining rated pressure with a customer-specified leakage rate after cooling.

##### 4.6.4 Duration

The duration of the test shall be expressed in minutes and shall be specified or approved by the authority having jurisdiction.

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## 5 Ordering information

### 5.1 General

When ordering pipe and fittings in accordance with this International Standard, the items described in 5.2 through 5.5 should be specified:

### 5.2 Service conditions

The following service conditions should be specified:

- a) Fluid being transported
- b) Design temperature (see 6.6)
- c) Internal design pressure
- d) External design pressure

### 5.3 General information

The following general information should be specified:

- a) Type (see 4.2)
- b) Resin (see 4.3)
- c) Class (see 4.4)

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### 5.4 Fire endurance

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The following information regarding fire endurance should be specified:

- a) Fluid (see 4.6.1)
- b) Fire type (see 4.6.2)
- c) Integrity (see 4.6.3)
- d) Flame-spread rating (see 6.4)
- e) Smoke and other toxic products of combustion (see 6.5)

### 5.5 Additional required information

The following additional required information should be specified:

- a) Pressure rating method (Internal only) (see 4.5)
- b) Size (DN and/or NPS)
- c) Manufacturer's identification (part number, product name, etc.)
- d) Specific job requirements (i.e. potable water usage, electrical conductivity)

## 6 Performance requirements

### 6.1 Internal pressure

All components included in the piping system shall have pressure ratings suitable for the intended service. Pressure ratings shall be determined in accordance with Annex A using the method specified by the customer or a longer-term method, if available. If, for example, a rating method 2 (medium-term test) is specified and data for rating method 3 (long-term test) is available, then the long-term test data are acceptable. Note that, for some components, particularly specialty fittings, long-term testing is not practical and ratings for these items will typically be determined using rating method 1.

### 6.2 External pressure

All pipe included in the piping system shall have external pressure ratings suitable for the intended service. External pressure ratings shall be determined by dividing the results of ASTM D2924 by a minimum safety factor of 3.

### 6.3 Fire endurance

The piping system shall have the fire endurance required by the authority having jurisdiction based on the intended location and service. Fire endurance shall be determined using the appropriate method in Annex B.

### 6.4 Flame spread

The authority having jurisdiction shall designate any flame spread requirements based on the location of the piping. For ships, mobile offshore drilling units (MODUs), and floating oil production platforms subject to the requirements of SOLAS or Title 46 of the U.S. Code of Federal Regulations, performance shall be determined by test procedures given in IMO Resolution MSC.61 (67), Annex 1, Part 5 — Test for Surface Flammability, as modified for pipes in Appendix 3 of IMO Resolution A.753 (18).

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### 6.5 Smoke and other toxic products of combustion

The authority having jurisdiction shall designate any smoke and toxicity requirements based on the location of the piping. For ships, mobile offshore drilling units (MODUs), and floating oil production platforms subject to the requirements of SOLAS or Title 46 of the U.S. Code of Federal Regulations, performance shall be determined by test procedures given in IMO Resolution MSC.61 (67), Annex 1, Part 2 — Smoke and Toxicity Test, as modified in Clause B.9.

### 6.6 Temperature

For epoxy resins, the maximum allowable design temperature shall be 30 °C less than the glass transition temperature ( $T_g$ ) of the resin used in the qualified component 8.1.4. For polyester and vinyl ester resins, the maximum allowable design temperature shall be 20 °C less than the heat distortion temperature (HDT) of the resin used in the qualified component determined in accordance with ISO 75-1 and ISO 75-2.

### 6.7 Material compatibility

The piping material shall be chemically compatible with the fluid being carried and any fluid in which it may be immersed.

### 6.8 Electrical resistance

Conductive piping systems shall have a resistance per unit length not exceeding  $1 \times 10^5 \Omega/\text{m}$  ( $3,05 \times 10^4 \Omega/\text{ft}$ ) when tested in accordance with Clause C.2. Resistance to earth at any location on an installed piping system shall be no greater than  $1 \times 10^6 \Omega$ .

## 6.9 Static charge shielding

Conductive piping systems shall have a maximum resulting voltage not exceeding 2 % of the supply voltage induced on the exterior surface of the pipe when tested in accordance with Clause C.1.

## 6.10 Potable water usage

The material, including pipe, fittings, adhesive, and any elastomeric gaskets required, shall have no adverse effect on the health of personnel when used for potable water service. Material shall conform to NSF International, Standard 61 or meet the requirements of FDA regulations 21 CFR 175.105 and 21 CFR 177.2280, 21 CFR 177.2410, or 21 CFR 177.2420.

## 7 Other requirements

Standard flanges shall have bolt patterns in accordance with ASME B16.5:1996, Class 150 for nominal pipe sizes 610 mm (24 inch) and smaller, and in accordance with ASME B16.1:1998, Class 125 for larger flanges. Consult the manufacturer's literature for bolt length, torque specifications and tightening sequence.

## 8 Inspection and sampling

### 8.1 Pipe

**8.1.1** Pressure tests: a minimum of 10 % of pipe joints shall be tested at a pressure of not less than 1,5 times the pipe-system pressure rating.

**8.1.2** Lot size: a lot of pipe shall consist of 150 joints, or fractions thereof, of one size, wall thickness, and grade in continuous production.

**8.1.3** Short-term hydrostatic burst tests shall be conducted in accordance with ASTM D1599 at a minimum frequency of one test per lot. If the measured value is less than 85 % of the published value, the lot is rejected or subject to retest.

**8.1.4** The degree of cure shall be determined by either measuring the glass transition temperature in accordance with ISO 11357-2, the residual styrene content in accordance with ISO 4901, or the barcol hardness in accordance with ASTM D2583. The minimum frequency shall be one test per production lot. The following shall apply, depending upon the method used to determine the degree of cure:

- If the glass transition temperature is 5,5 °C (10 °F) less than the value in the manufacturer's specifications, the lot shall be rejected or subject to retest.
- If the styrene content is more than 2 % of the resin content by weight, the lot shall be rejected or subject to retest.
- If the barcol hardness is less than 90 % of the value in the manufacturers specification, the lot shall be rejected or subject to retest.

**8.1.5** The glass content (mass fraction expressed as percentage) of at least one sample per production lot shall be determined in accordance with ASTM D2584. If the measured glass content is not within 5 % of the value in the manufacturer's specification, the lot is rejected or subject to retest.

**8.1.6** The total wall thickness and reinforced wall thickness shall be determined using ASTM D3567 once per every production lot. The total and reinforced wall thickness shall be as specified in Table 1. Any out-of-tolerance components shall be rejected and the remainder of the lot shall be subject to retest.

## 8.2 Fittings

**8.2.1** Pressure tests: a minimum of 10 % of each fitting lot shall be tested at a pressure of not less than 1,5 times the pipe-system pressure rating. All samples shall hold the test pressure for a minimum of 2 min.

**8.2.2** Lot size: a lot shall consist of 50 fittings or one day's production of a specific fitting.

**8.2.3** Short-term hydrostatic burst tests shall be conducted in accordance with ASTM D1599 at a minimum frequency of one test per lot. If the measured value is less than 85 % of the published value, the lot is rejected or subject to retest.

**8.2.4** The degree of cure shall be determined by either measuring the glass transition temperature in accordance with ISO 11357-2, the residual styrene content in accordance with ISO 4901, or the barcol hardness in accordance with ASTM D2583. The minimum frequency shall be one test per production lot. The following shall apply, depending upon the method used to determine the degree of cure:

- If the glass transition temperature is 5,5 °C (10 °F) less than the value in the manufacturer's specifications, the lot shall be rejected or subject to retest.
- If the styrene content is more than 2 % of the resin content by weight, the lot shall be rejected or subject to retest.
- If the barcol hardness is less than 90 % of the value in the manufacturer's specification, the lot shall be rejected or subject to retest.

**8.2.5** The glass content (mass fraction expressed as percentage) of at least one sample per production lot shall be determined in accordance with ASTM D2584. If the measured glass content is not within 5 % of the value in the manufacturer's specification, the lot is rejected or subject to retest.

**8.2.6** The total wall thickness and reinforced wall thickness shall be determined using ASTM D3567 once per every production lot. The total and reinforced wall thickness shall be as specified in Table 1. Any out-of-tolerance components shall be rejected and the remainder of the lot shall be subject to retest.

## 8.3 Flanges and mitred fittings

**8.3.1** Pressure tests: one mitred fitting from each lot shall be tested to a pressure equal to or greater than 1,5 times the pipe system rating. All samples shall hold the pressure for a minimum of 2 min.

**8.3.2** Lot size: a lot shall consist of 20 flanges or 10 mitred fittings of any given configuration.

**8.3.3** The degree of cure shall be determined by either measuring the glass transition temperature in accordance with ISO 11357-2, the residual styrene content in accordance with ISO 4901, or the barcol hardness in accordance with ASTM D2583. The minimum frequency shall be one test per production lot. The following shall apply, depending upon the method used to determine the degree of cure:

- If the glass transition temperature is 5,5 °C (10 °F) less than the value in the manufacturer's specifications, the lot shall be rejected or subject to retest.
- If the styrene content is more than 2 % of the resin content by weight, the lot shall be rejected or subject to retest.
- If the barcol hardness is less than 90 % of the value in the manufacturers specification, the lot shall be rejected or subject to retest.

**8.3.4** The glass content (mass fraction expressed as percentage) of at least one sample per production lot shall be determined in accordance with ASTM D2584. If the measured glass content is not within 5 % of the value in the manufacturer's specification the lot is rejected or subject to retest.

**8.3.5** The total wall thickness and reinforced wall thickness shall be determined using ASTM D3567 once per every production lot. The total and reinforced wall thickness shall be as specified in Table 1. Any out-of-tolerance components shall be rejected and the remainder of the lot shall be subject to retest.

**Table 1 — Wall thickness tolerances**

Dimension	Tolerance
Total wall thickness	+ 22,5 % <sup>a</sup> – 0 %
Reinforced wall thickness	+22,5 % <sup>a</sup> – 0 %
<sup>a</sup> The tolerance on total and reinforced wall thickness for fittings shall refer to the manufacturer's designated location on the body of the fitting.	

#### 8.4 Retest

If any test result in 8.1, 8.2 and/or 8.3 fails to conform to the specified requirements, the manufacturer may elect to reject the entire lot, or retest two additional samples from the same lot. If both of the retest specimens conform to the requirements, all items in the lot shall be accepted except the sample that initially failed. If one or both of the retest samples fails to conform to the specified requirements, the manufacturer may reject the entire lot or test individually for the remaining samples in the lot in accordance with 8.1.1, 8.2.1 or 8.3.1, as applicable. Note that, in the final case, all samples need only be subjected to the tests that the original samples failed.

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#### 8.5 Production quality documentation

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The manufacturer shall have manufacturing procedures for each component to be supplied, raw material test certificates for each component to be used in manufacturing, and production quality-control reports available for the procurement officer.

### 9 Appearance and workmanship

All pipe, fittings and spools shall be visually inspected for compliance with the requirements stated in Table 2, and, if appropriate, either repaired or rejected. After all minor repairs, a pressure test in accordance with 8.1.1, 8.2.1, or 8.3.1 shall be performed on the component.