Polski Rejestr Statków

RULES

PUBLICATION NO. 40/P

NON-METALLIC MATERIALS

2007

Publications P (Additional Rule Requirements), issued by Polski Rejestr Statków, complete or extend the Rules and are mandatory where applicable.

GDAŃSK

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1 GENERAL

1.1 Application

1.1.1 *Publication No. 40/P – Non-metallic materials* applies to organic origin materials and plastics which are subject to PRS survey according to the provisions of the *Rules for Classification and Construction of Sea-going Ships* and other *PRS Rules*.

1.1.2 The following materials and products are subject to PRS survey during the manufacture:

.1 reinforced plastics,
.2 coated textiles,
.3 ropes.

1.2 Definitions

Definitions and explanations concerning the general terminology applied in PRS *Rules* are contained in the *Rules*. For the purpose of this Publication, the following additional definition has been adopted:

S p e c i m e n – a section of the material of the defined shape and dimensions, taken from the sample, to be subjected to the required tests.

1.3 Scope of Survey

1.3.1 General

1.3.1.1 General provisions determining the scope and procedure of survey are given in *General Survey Regulations* issued by PRS.

1.3.1.2 The survey of the manufacture of materials covers the following:

.1 consideration of technical documentation,
.2 approval of material manufacturers,
.3 material type approval,
.4 examinations and testing of materials,
.5 the issue of appropriate PRS documents following the survey.

1.3.2 Approval of Material Manufacturers

1.3.2.1 Manufacturers of materials specified in 1.1.2 shall be approved by PRS.

1.3.2.2 The manufacturer seeking an approval is to submit a written request/application to PRS, containing the following data:

– characteristics of the material,
– destination of the material,
– description of the manufacturing procedure and information on the quality management system,

– proposed scope of approval,
– proposed acceptance tests programme.

The request/application shall also contain information on the previous experience of the manufacturer in production of the materials being subject to the approval.

1.3.2.3 After consideration of the data provided in the request/application, PRS agrees, with the manufacturer, the programme of the material acceptance tests and carries out the inspection of the manufacturer. Acceptance tests shall be carried out under the survey of PRS.

The approval granted to the manufacturer must not be transferred to other manufacturers and PRS shall be notified of any alterations introduced to the material manufacturing procedure.

1.3.2.4 The approval procedure mentioned above also applies to the already approved manufacturers wishing to extend the existing scope of approval or manufacturers introducing new methods of material production.

1.3.3 Approval of Materials (indirect survey)

1.3.3.1 PRS may approve the series production of certain types of materials, whose workmanship complies with the quality requirements specified for materials used in shipbuilding, and may issue *Type Approval Certificate*.

1.3.3.2 The manufacturer seeking an approval of its materials shall submit a written request/application to PRS, containing the following data:
– characteristics of the material,
– destination of the material,
– description of the manufacturing procedure and information on the quality management system,
– proposed scope of approval,
– proposed acceptance tests programme.

1.3.3.3 After consideration of the data provided in the request/application, PRS agrees, with the manufacturer, the programme of the material acceptance tests and carries out the inspection of the manufacturer. Acceptance tests shall be carried out under the survey of PRS.

The approval granted to the manufacturer must not be transferred to other manufacturers and PRS shall be notified of any alterations introduced to the material manufacturing procedure.

1.3.3.4 The approval procedure mentioned above also applies to the manufacturers wishing to extend the existing scope of approval to other materials.

1.3.4 Certification of Materials

1.3.4.1 PRS may certify a series production or piece production of certain types of materials, whose workmanship complies with the quality requirements of relevant EU directives concerning the materials used in shipbuilding as well as for other purposes and may issue appropriate certificates.

1.3.4.2 The manufacturer seeking certification of its materials shall submit a written request for PRS certification.

1.3.4.3 After consideration of the data provided in the request, PRS agrees, with the manufacturer, the programme of the material acceptance tests. Acceptance tests shall be carried under the survey of PRS.

The issued certificate relating to the particular place of material manufacturing must not be transferred to other manufacturers and PRS shall be notified of any alterations introduced to the material manufacturing procedure.

1.3.4.4 The procedure mentioned above, also applies to the manufacturers wishing to extend the existing scope of certification.

1.3.5 Testing

1.3.5.1 Tests shall be performed in the laboratories approved by PRS. The criteria for approval of laboratories are specified in *Publication No. 56/P – Procedural Requirements for Laboratories*.

1.3.5.2 If the obtained test results are unsatisfactory, the tests may be repeated subject to the following:

.1 if the unsatisfactory results are due to the local defects in the specimen material, the tests shall be repeated on the same number of specimens;

.2 if the unsatisfactory results are due to the inappropriate quality of the material, the tests shall be repeated on a double number of the specimens taken from the same material. If satisfactory results are obtained from the repeated test, the material from which additional specimens were cut, as well as the remaining materials belonging to the same batch, may be accepted. If, during a repeated test, at least one of the specimens proves unsatisfactory, the material shall be rejected.

1.3.5.3 PRS reserves the right to repeat the tests if confusion of specimens or test results occured or the test results do not allow to determine the material quality with the required accuracy.

1.3.5.4 If the properties of the material slightly differ from those required by this *Publication*, such material may be approved for further use only when special consideration by PRS Head Office for this purpose at the manufacturer’s request.

1.4 Marking

1.4.1 Materials shall be marked in accordance with the relevant standards.

1.4.2 If the products are supplied in single pieces, each of them shall be marked.

1.4.3 In the case of supplying small-size products, their marking shall be agreed with PRS.

1.4.4 In each case, the marks on the products shall contain at least the following particulars:

.1 grade of the material,

.2 number of batch or other marking allowing to ascertain that the product belongs to the batch for which the appropriate certificate has been issued,

.3 manufacturer's name or brand,

.4 manufacturer's control stamp,

.5 PRS' oval stamp.

1.5 General Requirements

Unless otherwise stated in this *Publication*, all plastics and organic origin materials shall comply with the following requirements:

.1 they shall neither be flammable nor produce excessive amounts of smoke nor bring a hazard of poisoning nor a hazard of explosion at elevated temperatures;

.2 unless other service temperature limits need to be specified due to service conditions, the materials are to ensure reliable operation of structures and products in the following temperature ranges:
- on weather deck: from –40 °C to +70 °C,
- in the ship internal compartments: from –10 °C to +70 °C;

.3 during the service they are to neither release any harmful substances, nor become brittle, and their mechanical properties shall not reduce by more than 30% of the initial state;

.4 they shall be rot-proof and mould-proof and shall not have adverse effect on other materials being in contact with them.

2 TESTING METHODS FOR NON-METALLIC MATERIALS

2.1 Testing Conditions

2.1.1 The specimens shall be conditioned at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 5% for at least 16 hours before testing.

The tests shall be performed immediately after the conditioning.

2.1.2 Test specimens of fabric-reinforced plastics shall be cut with their axes parallel with the reinforcement weft or warp.

The specimens for testing of anisotropic materials shall have their main axes parallel with or perpendicular to the expected anisotropy directions.

2.1.3 In justified cases, subject to the agreement with PRS, the tests may be performed on specimens with shapes or dimensions different from those required by this Chapter.

2.1.4 The tests are to be performed in accordance with the relevant standards agreed with PRS. Testing conditions and procedures not covered by this Chapter shall be agreed with PRS.

2.2 Determination of Tensile Strength

2.2.1 The tensile strength of non-reinforced plastics shall be determined using a testing machine ensuring both maintaining of the required gripping jaw travelling speed and measurement of the specimen tensile stress. The extensometer shall enable measurement of tensile strain of the specimen gauge length with the accuracy of at least 1%. When determining the tensile strength, it is necessary to record the strain increase as a function of the specimen load. Modulus of elasticity in tension shall also be determined.

The testing shall be performed at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 5% on 5 conditioned specimens in accordance with ISO Standards 527-1[1)] and 527-2[2)].

The measurement shall be carried out with a gauge speed specified in relevant standards concerning the tested material and corresponding to one of the speeds given in Table 2.2.1.

Table 2.2.1

Speed [mm/min]
1 ± 0.5
5 ± 1.0
50 ± 5.0
100 ± 10.0
500 ± 50.0

2.2.2 Tensile strength of reinforced plastics shall be tested by determining the stress at break and the modulus of elasticity in tension. The testing shall be performed at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 5% on 5 conditioned specimens in accordance with ISO Standards 527-4[3)] and ISO 527-5[4)].

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1) ISO Standard 527-1:1993 Plastics – Determination of tensile properties – Part 1: General principles.

2) ISO Standard 527-2:1993 Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics.

3) ISO Standard 527-4:1997 Plastics – Determination of tensile properties – Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites.

4) ISO Standard 527-5:1997 Plastics – Determination of tensile properties – Part 5: Test conditions for unidirectional fibre-reinforced plastic composites.

2.3 Determination of Compressive Strength

2.3.1 Determining the compressive strength of plastics consists in loading the tested specimen with an increasing compressive load at specified testing speed, and measuring resulting specimen compressive strain.

The test shall be carried out on 5 conditioned specimens in the form of rectangular prism of dimensions specified in relevant standards. In case of anisotropic materials, at least 5 test specimens for each axis of anisotropy, shall be prepared.

Test temperature shall be 23 ± 2 °C and a relative humidity of 50 ± 5% in accordance with ISO Standard 604[1)].

The test speed shall not exceed 1.5 mm/min.

2.3.2 Compressive strength of rigid cellular plastics shall be determined by applying a compressive force to the specimen in the form of rectangular prism.

The test shall be carried out on 5 conditioned specimens in accordance with ISO Standard 844:2001[2)].

The test shall continue, if possible until a relative displacement of at least 10% is reached. Then, the maximum compressive stress shall be calculated. If the value of maximum compressive stress corresponds to a relative displacement of less than 10%, it shall be noted as the "compressive strength". However, if the value of the maximum compressive stress corresponds to a relative displacement of more than 10%, the compressive stress at 10% relative displacement shall be calculated and this value shall be noted as the "compressive stress at 10% relative displacement".

2.4 Determination of Flexural Strength

2.4.1 Determination of flexural strength of reinforced plastics consists in applying of a momentary static flexural load to a specimen in the form of beam of rectangular cross-section, supported freely at two points on the testing machine, until the conventional deflection is achieved or the specimen is broken.

The test shall be carried out at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 5%, on 5 conditioned specimens, in accordance with ISO Standard 14125[3)]. The edge radius of the supports shall be 2 ± 0.2 mm where the specimen thickness is equal or less than 3 mm, or 5 ± 0.2 mm where the specimen thickness is more than 3 mm. In the case applying of one loading member of edge radius equal 5 ± 0.2 mm, the load shall be applied at the mid-span of the specimen. However, if two loading members of the edge radius equal to 2 ± 0.2 mm (for specimens equal or less than 3 mm in thickness) or 5 ± 0.2 mm (for specimens of more than 3 mm in thickness) are used, the load shall be applied in two points whose spacing is one third of the specimen's span between the testing machine supports.

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1) ISO Standard 604:2002 Plastics – Determination of compressive properties.

2) ISO Standard 844:2004 Rigid cellular plastics – determination of compression properties.

3) ISO Standard 14125:1998 Fibre-reinforced plastic composites – Determination of flexural properties.

2.4.2 For determining the flexural strength of rigid cellular plastics, a force shall be applied acting continuously at mid-span of the test specimen two supports spaced 300 mm apart.

The flexural load and deflection shall be recorded during the test.

The flexural test shall be carried out on 5 conditioned specimens according to ISO 1209-2[1)]. If the test specimens rupture before the deflection reaches 5%, breaking load and strain shall be recorded and the test shall be finished.

2.5 Determination of Shear Strength

Determination of shear strength of cellular plastics consists in applying shearing stress to a specimen in the form of a rectangular prism using metal bars stuck to the specimen.

The shearing test shall be carried out at a temperature of 23 ± 2 °C on 5 conditioned specimens in accordance with ISO Standard 1922[2)] by pulling a movable grip off the fixed one with the speed of 1 ± 0.5 mm per minute and deflection not exceeding 10%. The force – displacement relation shall be recorded during the test.

An adhesive used to fasten the test specimen to metal bars shall be such as to ensure that the shear strength and the modulus of elasticity of adhesive joint be far greater than those of the tested cellular plastic. The cellular plastic shall be damaged during testing, not the adhesive joint. The adhesive shall not affect the structure of the tested cellular material.

2.6 Impact Test

Determination of impact strength consists in breaking the test specimen in the form of a horizontal beam supported at both ends, by a single pendulum machine hit the centre specimen between supports, and in the case of notched specimens – directly opposite the single notch. The striking edge shall hit the centre, perpendicularly to the specimen longitudinal axis with a tolerance of ± 2°. The impact energy shall be within the range 0.5 ÷ 50 J.

The impact test shall be carried out on 10 conditioned specimens in accordance with ISO Standard 179-1[3)]. In the case of notched specimens, the shape and dimensions of the notch shall be determined in accordance with the relevant standards. For sheet or plate materials which have anisotropic characteristics of impact properties, two groups of test specimens shall be cut with their major axes respectively parallel with and perpendicular to the reinforcement direction.

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1) ISO Standard 1209-2:2004 Rigid cellular plastics – Determination of flexural properties – Part 2: Determination of flexural strength and apparent flexural modulus of elasticity.

2) ISO Standard 1922:2001 Rigid cellular plastics – Determination of shear strength.

3) ISO Standard 179-1:2000 Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test.

2.7 Determination of Water Absorption

2.7.1 Determination of water absorption by plastics consists in determining the change of mass of the specimen immersed in cold or boiling water for a strictly specified time and at a constant temperature. The test is to be performed on 3 specimens dried in the vacuum drying oven at a temperature of 50 ± 2 °C within 24 ± 1 hours and cooled in an desiccator at a temperature of 23 ± 2 °C. The test shall be performed in accordance with ISO Standard 62[1)].

Test specimens cut from thermoplastic, thermosetting and other moulding compounds shall be disc-shaped with a diameter of 50 ± 1 mm and thickness of 3 ± 0.2 mm. Specimens cut from sheets or plates shall be square with a side of 50 ±1 mm and thickness equal to the sheet thickness, however not more than 25 mm. Specimens from sections, bars and pipes shall be prepared as segments of 50 ± 1 mm in length. Sections' thickness shall be below 3 ± 0.2 mm whereas bar and pipe diameter and wall thickness shall be below 50 mm.

Water absorption is defined as a mass of water absorbed by the specimen either as the mass of water absorbed by the specimen surface unit, or as the absorbed water mass to the specimen initial mass percentage ratio.

2.7.2 Determination of water absorption for rigid cellular plastics consists in measuring of the change of the buoyancy force of a specimen immersed 50 mm deep in an treated water (deaerated, distilled water, used at least 48 hours after distillation) for 96 ± 1 h.

The test shall be carried out at the temperature of 23 ± 2 °C and the relative humidity of 50 ±5% on 3 conditioned specimens of 150 ± 1 mm in length, 150 ± 1 mm in width, not exceeding 75 mm in thickness, and of a volume at least 500 cm^3 in accordance with ISO Standard 2896[2)]. For materials manufactured and used with natural or laminated skin, the specimen thickness shall be such as that of the product.

The water absorption means the percentage proportion of absorbed water volume to initial specimen volume. Swelling and open pores on the specimen surface shall be taken into account.

2.8 Ageing Test

2.8.1 Determination of seawater resistance shall be carried out on the specimens whose number and sizes are subject to specification depending on the scope of testing. The specimens shall be immersed in the seawater of a temperature of 23 ± 2 °C for 28 days. After this period, the specimens shall be subjected to the agreed tests.

2.8.2 Determination of oil resistance shall be carried out on the specimens whose number and sizes are subject to specification depending on the scope of testing.

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1) ISO Standard 62:1999 Plastics – Determination of water absorption.

2) ISO Standard 2896:2001 Rigid cellular plastics – Determination of water absorption.

The specimens shall be immersed in diesel oil of a temperature of 23 ± 2 °C for 28 days. After this period, the specimens shall be subjected to the agreed tests.

2.9 Dimensional Stability Test

The dimensional stability test of rigid cellular plastics consists in determining the changes of linear dimensions of conditioned specimens exposed to specified conditions within specified time and subjected to conditioning again after the exposure.

The test shall be performed on 3 specimens of the following dimensions:

length	100 ±1 mm,
width	100 ±1 mm,
thickness	25 ±0.5 mm

in accordance with ISO Standard 2796[1)].

The test shall be completed after 48 ± 2 h and the percentage change in the length, width and thickness shall be determined.

2.10 Determination of Density

Apparent density of cellular plastics is determined by weighing the specimen, determining its volume by measurement its dimensions at a temperature of 23 ± 2 °C and at a relative humidity of 50 ± 5%, and calculating the density as a quotient of the specimen mass and volume.

The density shall be determined on 5 conditioned specimens of a such shape that their volumes can be easily calculated and of the total surface area at least 100 cm^2, in accordance with ISO Standard 845[2)].

2.11 Determination of Textile-glass Content

The test shall be carried out on 4 specimens of glass-reinforced plastic of a mass at least 2 g and a thickness not exceeding 5 mm. Calcinated crucible containing the specimen shall be subjected to calcination in a muffle furnace at a temperature of 625 ± 20 °C and heat to constant mass, in accordance with ISO Standard 1172[3)].

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1) ISO Standard 2796:1986 Cellular plastics, rigid – Test for dimensional stability.

2) ISO Standard 845:1988 Cellular plastics and rubbers – Determination of apparent (bulk) density.

3) ISO Standard 1172:1996 Textile glass reinforced plastics – Prepregs, moulding compounds and laminates – Determination of the textile-glass and mineral-filler content – Calcination methods.

3 POLYMER COMPOSITES

3.1 Definitions

The following definition applies for the purpose of Chapter 3:

Polymer composites – materials composed of at least two components (with visible boundaries between each other) having properties superior to these of a single component, e.g. glass-reinforced polymers.

3.2 Glass-reinforced Plastics

3.2.1 General

The requirements of Chapter 3.2 apply to glass-reinforced plastics used in ship structures and in the manufacture of products being subject to PRS survey.

Glass-reinforced plastics shall be manufactured by a method approved, within the scope of the manufacturer's approval, by PRS and the conditions of their manufacturing and curing (temperature, humidity, time-period) shall comply with the conditions specified in the *Approval Certificate*.

3.2.2 Required Properties

3.2.2.1 Unsaturated polyester resins complying with the requirements of Chapter 5 shall be the bonding agent at the manufacture of glass-reinforced plastics.

Epoxy or other resins may be applied only after agreement with PRS.

The resin manufacturer is required to provide specification on the supplied resin physical and chemical properties as well as the application instruction.

Neither pigments nor other dyeing agents, which could adversely affect the resin or laminate properties, are to be added; the addition of pigments is permitted only for resins used as decorative layers (gelcoat resins).

3.2.2.2 The non-alkaline glass fibres in the form of mats, fabrics, as well as continuous or chopped roving, complying with the requirements of Chapter 4 shall be used as the reinforcement. Application of fibres other than glass fibres is subject to special consideration by PRS.

The manufacturer of the reinforcing material shall provide the certificate for each batch of a material containing the following particulars:

.1 manufacturer's name,
.2 product name and marking,
.3 alkali metals oxides content (converted into Na_2O),
.4 glass fibre diameter,
.5 fabric type,
.6 tensile strength (for fabrics – parallel with warp and weft),
.7 kind of active preparation,
.8 kind of bonding agent (for chopped strand mats).

3.2.2.3 Glass-reinforced plastic mechanical properties, such as tensile and flexural strength, shall be assumed depending on the reinforcement quantity and location as well as on the resin kind and material destination; the properties shall be agreed with PRS.

Influence of oils, seawater and other ageing agents shall not reduce the glass-reinforced plastic mechanical properties by more than 25 percent as compared with the initial values.

3.2.2.4 Percentage content of glass fibre in the glass-reinforced plastic mass shall be agreed with PRS depending on the given structure or product purpose and application conditions.

For glass-reinforced plastics used in structures or products exsposed to loads, a minimum content of glass fibre shall be 25 percent, while in the case of chopped strand mat reinforced plastics the glass fibre content shall not exceed 35%.

3.2.3 Test Specimens

In order to determine the physical and mechanical properties of glass-reinforced plastics, control plates, from which test specimens will be cut, shall be prepared during the same laminating process and with the same proportion of reinforcing material.

The control plate dimensions shall be ca. $400 \times 500 \times$ laminate thickness [mm].

Flat specimens shape and dimensions shall comply with the requirements of Chapter 2. The method of cutting specimens from the control plate shall be agreed with PRS surveyor.

The test specimens may also be cut from the material allowances of the laminated product or from its areas intended for cutting. When it is technically reasonable, PRS may request cutting the specimens directly from the product itself.

The specimens shall be cut and subjected to testing after the period of time necessary to achieve full physical and mechanical laminate properties. The time-period shall be specified by the resin manufacturer.

Determination of laminate properties by methods other than the mentioned in Chapter 2 shall be agreed with PRS.

3.2.4 Scope of Testing

3.2.4.1 Testing of glass-reinforced plastics shall include the tensile strength and modulus of elasticity – in accordance with 2.2.2, flexural strength and modulus – in accordance with 2.4.1, as well as the proportion of reinforcing material in glass-reinforced plastic mass – in accordance with 2.11.

PRS may recommend carrying out the impact test and determining the shear strength and the modulus of elasticity at shearing in the plate plane.

3.2.4.2 The above-mentioned strength properties shall be determined by testing on aged glass-reinforced plastic specimens. The ageing tests shall be performed:

– in accordance with 2.8.1 – for sea-water resistance, and
– in accordance with 2.8.2 – for oil resistance.

3.2.5 The completely cured glass-reinforced plastic shall have the following properties:

– tensile strength	min. 80 N/mm^2,
– modulus of elasticity in tension	min. 7000 N/mm^2,
– flexural strength	min. 135 N/mm^2,
– flexural modulus	min. 6000 N/mm^2,
– glass content	min. 25 %.

3.2.6 Visual Examination

Glass-reinforced plastics products shall be free of delaminations, blisters, foreign inclusions and other defects having an adverse effect on the product properties. If internal defects are suspected, PRS may recommend that the product be subjected to the appropriate tests, the scope of which shall be specially agreed with PRS.

4 TECHNICAL FIBRES AND FABRICS

4.1 General

The requirements of Chapter 4 apply to glass fibre reinforcements in the form of mats, fabrics and roving used for the manufacture of the products subject to PRS' survey.

Fabrics, mats, unwoven fabrics and fibres made of other materials intended for reinforcement of plastics are subject to special consideration by PRS.

4.2 Required Properties

4.2.1 The glass used for the manufacture of the reinforcing materials shall be of E type therefore non-alkaline, i.e. with alkali metal oxides Na_2O and K_2O content (converted into Na_2O) lower than 1%.

4.2.2 The E type glass shall have the following chemical composition:

SiO_2 from 52 to 56%	B_2O_3 from 6 to 12%
CaO from 16 to 25%	Na_2O+K_2O from 0 to 1%
Al_2O_3 from 12 to 16%	MgO up to 6%.

4.3 Scope of Testing

4.3.1 The reinforcing materials shall be subjected to examination determining:
- moisture content, in accordance with ISO 3344[1)] – not exceeding 0.2% at delivery,
- loss on calcination, in accordance with ISO 1887[2)] – tolerance ±10%
- mass per unit area:
  - linear density for roving, in accordance with ISO 1889[3)] – tolerance ±10%,
  - for chopped-strand mats, in accordance with ISO 3374[4)] – tolerance ±10%,
  - for woven roving, in accordance with ISO 3374 – tolerance ±10%.

4.3.2 When approving the glass reinforcements, the testing of the properties of glass-reinforced plastics containing the reinforcement shall be carried out in accordance with 3.2.4. The type of resin used for glass-reinforced plastics specimens shall be agreed with PRS.

5 SYNTHETIC RESINS

5.1 General

The requirements of Chapter 5 apply to unsaturated polyester resins used for the manufacture of the products subject to PRS survey.

The structural resins used for glass-reinforced plastics manufacture shall be of the grades approved by PRS.

Application of other grades of resins is subject to special consideration by PRS.

5.2 Scope of Testing

5.2.1 Liquid polyester resins shall be subjected to the examination determining:
- density, in accordance with ISO 1675[5)] – for conformity with the manufacturer's specification,
- viscosity, in accordance with ISO 2555[6)] – tolerance ±20% in relation to the manufacturer's specifications,
- acid value, in accordance with ISO 2114[7)] – tolerance ±10% in relation to the manufacturer's specification,

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1) ISO Standard 3344:1997 Reinforcement products – Determination of moisture content.
2) ISO Standard 1887:1995 Textile glass – Determination of combustible-matter content.
3) ISO Standard 1889:1997 Reinforcement yarns – Determination of linear density.
4) ISO Standard 3374:2000 Reinforcement products – Mats and fabrics – Determination of mass per unit area.
5) ISO Standard 1675:1985 Plastics – Liquid resins – Determination of density by the pyknometer method.
6) ISO Standard 2555:1989 Plastics – Resins in the liquid state or as emulsions or dispersions – Determination of apparent viscosity by the Brookfield Test method.
7) ISO Standard 2114:2000 Plastics (polyester resins) and paints and varnishes (binders) – Determination of partial acid value and total acid value.

– volatile material content, in accordance with the procedure agreed with PRS – tolerance ±10% in relation to the manufacturer's specification,
– gel time, in accordance with ISO 2535[1)] – tolerance ±20% in relation to the manufacturer's specification,
– overall volume shrinkage during curing, in accordance with ISO 3521[2)] – for conformity with the manufacturer's specification.

5.2.2 The cured structural resins shall be subjected to the test determining:
– density,
– hardness, in accordance with EN 59[3)] – not less than 35 in Barcol scale,
– temperature of deflection using a flexural stress of 1.8 MPa in accordance with ISO 75-2[4)] – not lower than 60 °C,
– water absorption (in accordance with 2.7.1 using the specimens of the following dimensions: 50 ±1 × 50 ±1 × 4 ±0.2 mm within 28 days) – not exceeding 80 mg,
– tensile strength (in accordance with 2.2.1) – not less than 50 N/mm^2,
– modulus of elasticity (in accordance with 2.2.1) – not less than 3000 N/mm^2,
– tensile failure strain (in accordance with 2.2.1) – not less than 2%.

The postcure of resins at a temperature of 40 °C for 16 hours and subsequent stabilizing at the room temperature for 24 hours may be accepted.

5.2.3 Gel coat resins shall not contain more than 15% of pigments and fillers and shall make the covering of 500 µm maximum thickness.

6 FOAMED PLASTICS

6.1 General

6.1.1 The requirements of Chapter 6 apply to foamed plastics used for the manufacture of the products subject to PRS survey. The foamed plastics used as an insulating material shall comply with the requirements of Chapter 8.

6.1.2 Foamed plastics used for filling the spaces within the sandwich panels between the bearing surfaces, lifeboat buoyancy tanks and similar void spaces shall be of grades approved by PRS.

6.1.3 Filling void spaces shall be effected by inserting plates intended for this purpose or foaming the plastic at place or by spraying.

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1) ISO Standard 2535:2001 Plastics – Unsaturated polyester resins – Measurement of gel time at ambient temperature.
2) ISO Standard 3521:1997 Plastics – Unsaturated polyester and epoxy resins – Determination of overall volume shrinkage.
3) EN Standard 59:1977 Glass reinforced plastics – Measurement of hardness by means of a Barcol impressor.
4) ISO Standard 75-2:2004 Plastics – Determination of temperature of deflection under load– Part 2: Plastics and ebonite.

6.2 Properties

Foamed plastics, such as rigid polyvinyl chloride, rigid polyurethane or rigid polystyrene shall have closed cell structure and, in the course of time, they shall not show shrinkages exceeding dimensional tolerances. The shrinkage of the foamed plastics applied to filling void spaces shall not result in the loss of its adherence to the adjacent surface.

All foamed plastics shall have limited opportunity to flame spread and be oil resistant and seawater resistant materials.

The rigid foamed plastics shall comply with the following requirements:

- apparent density — min. 40 kg/m^3
- compressive strength — min. 0.7 N/mm^2
- compressive modulus — min. 30 N/mm^2
- shear strength — min. 0.6 N/mm^2
- water absorption after 24 hours — max. 0.6 %.

6.3 Test Specimens

The test specimens shall be cut from the middle of the foamed plastic piece to choose the ones of the most uniform cellular structure. When preparing the specimens, the cellular structure shall not be damaged. The skin shall be removed.

The compressive strength shall be determined using specimens of a thickness of 50 ± 1 mm, cut in the shape of a rectangular prism of the base length of 100 ± 1 mm, the flexural strength – on specimens of 350 ± 5 mm in length, 100 ± 1 mm in width and 25 ±0.5 mm in thickness, while the shear strength – on specimens of $250\,^{0}_{-5}$ mm in length, $50\,^{0}_{-1}$ mm in width and 25 ±0.5 mm in thickness.

6.4 Scope of Testing

The foam plastics shall be subjected to the test determining:

- density – in accordance with 2.10,
- compressive strength – in accordance with 2.3.2,
- flexural strength – in accordance with 2.4.2,
- shear strength – in accordance with 2.5,
- water absorption – in accordance with 2.7.2,
- oil resistance and seawater resistance – in accordance with 2.8,
- flame spread on surface – in accordance with ISO 9772[1)],
- dimensional stability – in accordance with 2.9, at temperatures –25 ± 3 °C and 23 ± 2 °C in dry conditions and at a temperature of 70 ± 2 °C in a relative humidity 90÷100%.

[1)] ISO Standard 9772:2001 Cellular plastics – Determination of horizontal burning characteristics of small specimens subjected to a small flame.

7 RUBBER OR PLASTIC COATED FABRICS

7.1 General

7.1.1 The requirements of Chapter 7 apply to the rubber coated fabrics or plastics coated fabrics intended for manufacture of the equipment subject to PRS survey.

7.1.2 The materials used for the life-saving appliances shall be manufactured at works approved by PRS.

7.2 Test Specimens

Test specimens shall be taken from each batch of the coated fabric at a distance of at least 10 cm from the material edge and 1 m from the roll end.

7.3 Scope of Testing

7.3.1 The testing shall be performed using specimens prepared from one roll of the fabric manufactured during one processing cycle.

7.3.2 The coated fabrics intended for the manufacture of the life saving appliances shall comply with the relevant requirements of *International Life-Saving Appliances Code (LSA Code)*[1], and with IMO Resolutions: A.689(17)[2] and MSC.81(70)[3].

7.3.3 When approving coated fabrics intended for other purpose, the scope of testing is subject to special consideration by PRS.

7.4 Marking

The coated fabrics shall be marked in accordance with 1.4.

8 INSULATING MATERIALS

8.1 The requirements of Chapter 8 apply to insulating materials used in ship structures and interiors.

8.2 Insulating materials shall be non-combustible, except in cargo spaces and refrigerated compartments of service spaces. The insulation cover and used adhesives shall have low flame-spread characteristics and be inpenetrable for vapour and moisture. Insulation of pipe fittings for cold service systems need not be non-combustible, but their exposed surfaces shall have low flame-spread characteristics.

Non-combustibility of the insulating materials used in ship structures shall be verified by testing every two years.

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1) *International Life-Saving Appliances Code (LSA Code).*
2) Resolution A.689(17) – Recommendation on testing of life-saving appliances.
3) Resolution MSC.81(70) – Revised recommendation on testing of life-saving appliances.

8.3 Depending on their intended application, the insulating materials shall comply with the requirements of the *International Code for Application of Fire Test Procedures (FTP Code)*[1)], as amended, Annex 1: Part 1 or Annex 1: Part 2 and Part 5.

9 RUBBER AND PLASTIC MATERIALS

The decision on approval of rubber materials and products or other plastic materials (e.g. flexible elements of couplings as well as seals and gaskets) used in ship structures is made by PRS in each particular case during documentation approval. Depending on the product designation, either its properties are accepted on the basis of the manufacturer's specification or the *Type Approval Certificate* issued by PRS is required.

For the purpose of approval, the products and the product material shall be subjected to testing, in accordance with the programme of the material acceptance tests agreed with PRS.

The rubber element or other plastic material design conformity with agreed standard shall be verified by visual examination and measurements.

10 FLOOR COVERINGS

10.1 The requirements of Chapter 10 apply to floor coverings intended for ship's interiors on vessels subject to PRS survey.

10.2 All floor coverings shall have low flame spread characteristics and shall neither generate excessive quantities of smoke nor toxic products in fire.

In the case of floor coverings in the form of compound applied directly on steel sheet or other basis (e.g. plywood, primary deck covering), the low flame spread characteristics shall be confirmed by testing the specimens taken from the floor covering laid on a steel sheet of 3 mm thickness.

10.3 Floor coverings shall comply with the requirements of the *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 2 and Part 5.

11 SURFACE FINISHES

11.1 The requirements of Chapter 11 apply to decorative coverings, veneers, and decorative laminates used in ship's interiors, accommodation spaces and service spaces.

11.2 Finishes shall have low flame spread characteristics and shall neither generate excessive quantities of smoke nor toxic products in fire.

[1)] Resolution MSC.61(67) – Adoption of the International Code for Application of Fire Test Procedures.

11.3 Decorative coverings, veneers and decorative laminates shall comply with the requirements of the *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 2 and Part 5 (including the gross calorific potential requirements).

12 DECORATIVE FABRICS

12.1 The requirements of Chapter 12 apply to draperies, curtains and wall tapestries intended for ship interiors on vessels subject to PRS survey.

The requirements for furniture upholstery are specified in Chapter 17.

12.2 Decorative fabrics shall neither generate excessive quantities of smoke nor toxic products in fire.

Draperies, curtains and other similar vertically supported textiles shall be made of fabrics resistant to the propagation of flame, whereas tapestries shall have low flame-spread characteristcs.

12.3 The materials intended for such vertically supported textiles as draperies or curtains shall comply with the requirements of the *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 2, Part 5 (in determination of gross calorific potential only) and Part 7. Tapestries shall comply with the requirements of *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 2 and Part 5 (including the gross calorific potential requirements).

13 PRIMARY DECK COVERINGS

13.1 The requirements of Chapter 13 apply to primary steel deck coverings laid during the ship construction, whithout decorative coverings.

13.2 Primary deck coverings shall be not readily ignitable as confirmed by testing the specimens taken from the covering laid on a steel sheet of 3 mm thickness and shall generate neither excessive quantities of smoke nor toxic products in fire.

13.3 Primary deck coverings shall comply with the requirements of the *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 2 and Part 6.

In the case of approval of the material intended for primary deck coverings, it is required to submit the data of material composition and application method to PRS.

14 ADHESIVES

14.1 The requirements of Chapter 14 apply to the adhesives intended for joining parts and components of structure, e.g. insulation. Adhesives intended for joining of the load-bearing elements are subject to special consideration of PRS.

14.2 Adhesives shall have low flame spread characteristics confirmed by testing the specimens taken from the adhesive layer laid on mineral board of 800 ± 100 kg/m^3 density (e.g. calcium silicate board) and approximately 20 mm in thickness. They shall generate neither excessive quantities of smoke nor toxic products in fire.

14.3 Adhesives shall comply with the requirements of the *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 2 and Part 5.

15 PLASTIC PIPES AND FITTINGS

Plastic pipes and fittings shall comply with the requirements of *Publication No. 53/P – Plastic Pipelines on Ships* and of *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 2.

16 FIBRE ROPES

Fibre ropes shall comply with the requirements of *Part IX – Materials and Welding*.

17 FURNITURE AND BEDDING COMPONENTS

17.1 The requirements of Chapter 17 apply to the upholstered and non-upholstered furniture used in ship interiors on the vessels subject to PRS survey.

17.2 The furniture veneers shall have low flame spread characteristics and the upholstered furniture coverings shall be resistant to ignition and the propagation of flame.

17.3 The structural materials of upholstered furniture and mattresses shall have PRS type approval.

17.4 Bedding components such as blankets, quilts, bedspreads, pillows and mattresses shall be neither readily ignitable nor fire sustaining.

17.5 The materials intended for non-combustible furniture supporting structure shall comply with the requirements of *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 1.

17.6 Furniture veneers shall comply with the requirements of *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 1 and Part 5 (including gross calorific potential requirements).

17.7 Fabrics for upholstered furniture shall comply with the requirements of *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 2 and Part 8.

17.8 Bedding components (including mattresses) shall comply with the requirements of the *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1 Part 9.

18 COMPOSITE DIVISIONS

18.1 General

18.1.1 For the purpose of applying composite materials for load-bearing A Class or B Class divisions of superstructures, structural bulkheads except for those in contact with liquids, decks and deckhouses of ships, as equivalent to steel, it shall be demonstrated that they are able to withstand the applied loads during and at the end of fire, by means of the relevant test procedure.

18.1.2 The composite materials shall comply with criteria of non-combustibility, generation of smoke/flame and toxicity as determined by the *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 1 and Part 2.

18.2 Definitions

18.2.1 The following definitions apply for the purpose of Chapter 18:

Composite material – a material with an organic or inorganic matrix (e.g. polyester, melamine formaldehyde, phenolic resins or ceramic), reinforced by fibres (e.g. glass, carbon, ceramic fibres) with suitable orientation.

Composite strength – the tension, compression, flexure, shear and torsion ultimate strength at each temperature multiplied by a safety factor assigned to the satisfaction of the Administration (e.g. 0.8).

Core region – the inner part or the outer part, not exposed to fire, of the load-bearing division which is capable of a minimum residual strength and stiffness to withstand the applied loads during and at the end of fire.

Insulation – the outer part of the load-bearing division with suitable thickness to ensure thermal protection of the core region. The structural strength of the insulating material, if any, shall be fully disregarded.

Load-bearing division – a panel made of composite material (e.g. layers of laminates, adhesives bonds and a core region of composite or other materials) which is able to withstand the applied functional, environmental and local loads.

Transition temperature – the temperature corresponding to an abrupt loss of stiffness of the material.

18.3 Determination of Structural Properties

18.3.1 Tests shall be performed using small specimens of suitable shape, including all the elements of the core region. Specimens shall be tested in a uniform temperature furnace. The temperature of the core region shall be determined, during testing, to define the behavioural relationship between the applied loads and temperature.

18.3.2 The tension, compression, flexure, shear and torsion loads shall be scaled in specimens appropriate for the material's application on board. Loads shall be applied in specimens with a different orientation to take account of the anisotropic behaviour of the composite material.

18.3.3 The tests shall be performed at a temperature of the furnace increasing from the ambient temperature to the temperature foreseen for the core region at the end of the standard fire test on the prototype of the division of composite material.

18.3.4 The composite strength shall be scaled from the dimensions of the small specimens to the actual dimensions of the composite material used on board.

18.4 Critical Temperature

18.4.1 The critical temperature is the temperature of the composite strength corresponding to the most critical applied load relative to the application on board. When the application involves a combination of load (e.g. compression and bending), the most critical load shall be defined for the most unfavourable load combination.

18.4.2 The critical temperature shall not exceed the transition temperature, when applicable.

18.5 Performance of Standard Fire Test

18.5.1 Standard fire tests shall be performed in accordance with the requirements of the *International Code for Application of Fire Test Procedures (FTP Code)*, as amended, Annex 1: Part 3.

18.5.2 Additionally, the temperature in any point of the most exposed side of the core region of load-bearing divisions shall be lower than the critical temperature. Special considerations shall be given to the measured temperatures, thermal distortions and transmission of loads of joints.