RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER **No. 314-04-1897c** dated 15.02.2023

Re:

amendments to the Rules for the Classification and Construction of Sea-Going Ships, 2023, ND No. 2-020101-174-E

Item(s) of supervision:

shafting and materials

Entry-into-force date:
01.03.2023

~~Cancels / amends / adds Circular Letter No.~~ ~~dated~~

Number of pages: 1 + 10

Appendices:

Appendix 1: information on amendments introduced by the Circular Letter

Appendix 2: text of amendments to VII "Machinery Installations" and XIII "Materials"

Acting Director General Sergey A. Kulikov

Text of CL:

We hereby inform that the Rules for the Classification and Construction of Sea-Going Ships shall be amended as specified in the Appendices to the Circular Letter.

It is necessary to do the following:

1. Bring the content of the Circular Letter to the notice of the RS surveyors, interested organizations and persons in the area of the RS Branch Offices' activity.
2. Apply the provisions of the Circular Letter during review and approval of the technical documentation on materials applied on ships contracted for construction or conversion on or after 01.03.2023, in the absence of a ship's data, during review and approval of the technical documentation on materials requested for review on or after 01.03.2023.

List of the amended and/or introduced paras/chapters/sections:

Rules for the Classification and Construction of Sea-Going Ships

Part VII: Chapter 5.10

Part XIII: Chapters 6.12 — 6.14

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Appendix 1 to Circular Letter
No. 314-04-1897c dated 15.02.2023

Information on amendments introduced by the Circular Letter
(for inclusion in the Revision History to the RS Publication)

Nos.	Amended paras/chapters/ sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
1	Part VII, Chapter 5.10	Requirements for the shafting elements made of polymer composite material have been introduced	314-04-1897c of 15.02.2023	01.03.2023
2	Part XIII, Chapter 6.12	New Chapter has been introduced containing requirements for fiber-reinforced plastics (polymer composite materials) for manufacture of shafting elements	314-04-1897c of 15.02.2023	01.03.2023
3	Part XIII, Chapter 6.13	New Chapter has been introduced containing requirements for synthetic materials applied for bearings of marine shafts and rudder stocks	314-04-1897c of 15.02.2023	01.03.2023
4	Part XIII, Chapter 6.14	New Chapter has been introduced containing requirements for polymer materials applied as the core for sandwich panels	314-04-1897c of 15.02.2023	01.03.2023

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA- GOING SHIPS, 2023,

ND No. 2-020101-174-E

PART VII. MACHINERY INSTALLATIONS

5 SHAFTING

1 **Chapter 5.10** is replaced by the following text:

"5.10 SHAFTS WITH FIBER-REINFORCED COMPOSITE PLASTIC COMPONENTS

5.10.1 Requirements for polymer composite materials for manufacturing of the shafting parts are given in 6.12 of Part XIII "Materials".

5.10.2 In addition to the documentation specified in Section 3 of Part I "Classification" the following shall be submitted

specification for the materials used, including a list of initial components, technological and auxiliary materials, the composition of the fiber-polymer plastic and its physical and mechanical properties;

a guideline document on manufacturing technology indicating the composition of the reinforcement material and the binder, the structure of the reinforcement by layers, the packing density (surface density), the number of layers of the reinforcement material, as well as the requirements for manufacturing quality control, including the norms of permissible defects, as well as technological instructions for eliminating unacceptable defects;

drawings of joining parts of fiber-polymer plastic with metal elements as well as strength calculations considering 5.10.3.

5.10.3 Strength calculations shall take into account shaft loads, considering Chapter 5.2, and check the conditions of strength, stiffness and stability of the links. The norms of hazardous and permissible stresses and strains shall be determined, it has been demonstrated that the strength of the joints of parts made of polymer composite material with metal elements is not lower than the strength of the parts to be joined. The accuracy of the calculations, the design scheme and the applied methodology shall be agreed with the Register.

5.10.4 Manufacturer’s documents of parts of shaftings shall specify:

permissible and unacceptable defects, their types and evaluation criteria, including the internal defects determined by non-destructive testing methods;

the frequency of visual inspections of the amount of damage by non-destructive testing for the accumulation of internal damage over the period of operation shall be performed at least every 5 years.

5.10.5 Shafts shall remain operative under environmental conditions in accordance with the requirement of 2.3.1, be resistant to vibration loads, taking into account Section 9, be moisture and oil resistant.".

PART XIII. MATERIALS

6 PLASTICS AND MATERIALS OF ORGANIC ORIGIN

2 **New Chapters 6.12 — 6.14** are introduced reading as follows:

"6.12 POLYMER COMPOSITE MATERIALS (FIBER-REINFORCED PLASTICS) USED IN THE MANUFACTURE OF SHAFTING COMPONENTS

6.12.1 These requirements apply to structural fiber-reinforced plastics (FRP) based on reinforcement cores manufactured of glass and/or carbon fibers and polymer binders: polyester, vinylester and epoxy ones, which are used for manufacture of shafting parts in accordance with 5.10, Part VII "Machinery Installations". One shall be guided by the requirements when choosing materials and technology for production of shafting components.

The choice of FRP components shall be confirmed by obtained design structural features, strength calculations and tests in accordance with 5.10, Part VII "Machinery Installations".

6.12.2. Reinforcement materials.

6.12.2.1 Reinforcement materials in FRPs shall ensure specified stiffness and strength characteristics, including the material exposed to various operational factors (external forces, temperature, humidity, etc.).

6.12.2.2 The following types of fibers are allowed: glass and carbon fibers.

6.12.2.3 Other types of fibers may be accepted if FRP physical and mechanical properties obtained on their basis are not less than those given in Table 2.3.5.11 of Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships". The choice of reinforcement material for FRP shall be confirmed by obtained design structural features, strength calculations and tests of shafting component structure.

6.12.2.4 Glass reinforcement materials shall meet the requirements 2.3.1.3 of Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships".

6.12.2.5 Material with fiber density 200 to 4800 tex is allowed to be used as a reinforcement material[1].

6.12.2.6 During the incoming inspection of fibers and reinforcement materials on their basis the requirements of 2.3.1.6, Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships" shall be met.

6.12.2.7 The fibers and reinforcement materials on their basis shall be supplied with a Manufacturer's Certificate of Quality in accordance with 2.3.1.8, Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships".

6.12.3 Binder materials.

6.12.3.1 Epoxy resin is accepted as a primary component of binder with characteristics in hardened state not less than those given in Table 2.3.2.2 of Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships". Other binders may be accepted if their physical and mechanical properties are not less than those given in Table 2.3.2.2 of Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships" (except for density) and strength and elasticity design FRP features on the basis of this resin, are not less than that given in Table 2.3.5.11 of Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships".

6.12.3.2 For thermosetting binders the requirements of 2.3.2.1, Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships" shall apply.

6.12.3.3 All resins used for manufacture shall be subject to incoming inspection. The list of parameters to be checked during the incoming inspection shall be determined by the quality control standards of FRP shafting components and shall be indicated in the documentation on production process agreed with the Register.

6.12.3.4 The manufacturer of the shaft shall establish the compliance of resin properties with characteristics described in the instruction on production process considering the tolerance. All applied additives to the binder (catalysts, accelerants, hardeners) as well as additives enhancing shaft features (thixotropic agents, cores, colorants, fire protection and shock-proof

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[1] Complies with the linear density of fibers. It is a mass of a woven roving of 1 km in length.

coatings, etc.) shall be indicated in the instruction on shaft production process. Documents of the manufacturers shall be submitted for all additive materials.

6.12.3.5 When preparing the binder, recommendations of the manufacturers shall be met. The temperature of thermal deformation of resin shall exceed the maximum possible operation temperature of product at least by 20 °C and in all cases shall be less than 70 °C.

6.12.3.6 Tests to determine binder characteristics shall be carried out by the firm (manufacturer) according to the international and/or national standards or other documents agreed with the Register. Testing may be also carried out by a laboratory recognized by the Register.

6.12.3.7 Within the incoming inspection the binder characteristics confirmed by the technical documentation and quality control standards of the manufacturer of shafting components shall be checked.

If Type Approval Certificate (CTO) for binders is available, the testing shall be carried out by the firm (manufacturer) of fibers and reinforcement materials, and the results shall be recorded in the Manufacturer's Certificate of Quality of each product batch produced.

6.12.3.8 The binding material shall be supplied with the Manufacturer's Certificate of Quality in accordance with 2.3.2.9, Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships".

6.12.4 Requirements for adhesives.

6.12.4.1 Requirements of 2.3.4.1 of Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships" shall apply.

6.12.4.2 Minimum glue glass transition temperature shall exceed maximum operating temperature at least by 15 °C.

6.12.4.3 Adhesive shall be supplied with the Manufacturer's Certificate of Quality in accordance with 2.3.4.6, Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships".

6.12.5 Requirements for FRP.

6.12.5.1 When choosing FRP for application in shafting products the following shall be considered:

availability of required elasticity and strength characteristics, as well as operability of material under repeated static, permanent, vibration and impact loads;

maintain their elasticity and strength characteristics, as well as operability within specified limits in different climate conditions for an established service life.

6.12.5.2 FRPs shall have proven water absorption characteristics that shall be specified in the technical documentation for material.

6.12.5.3 Shafts shall be manufactured in accordance with the developed instruction on production process. For manufacture of shaft products made of FRP the following methods are accepted: filament winding (dry, wet) and prepregs. Winding shall be carried out in accordance with the lay-up scheme described in the instruction on production process. The winding rate is chosen in order to provide the required tension of the fiber and the binder impregnation degree. These two parameters shall be indicated in the instruction on production process. The width of winded bundles or straps and a gap between them during the lay-up shall be monitored for compliance with the requirements of instruction on production process.

6.12.5.4 The moulding technique shall provide correlation between reinforcement material and binder specified in the documentation on production process in order to obtain the required material properties.

6.12.5.5 Main FRP features shall not be less than those specified in Table 2.3.5.11, Part XVI "Structure and Strength of Fiber-Reinforced Plastic Ships".

6.13 SYNTHETIC MATERIALS USED FOR BEARINGS OF MARINE SHAFTS AND RUDDER STOCKS

6.13.1 The present requirements cover the synthetic materials subject to the Register survey, used for bearings of marine shafts and rudder stocks in accordance with 5.6, Part VII "Machinery Installations" and 2.8, Part III "Equipment, Arrangements and Outfit".

6.13.2 Synthetic materials for their application for bearings of marine shafts and rudder stocks shall be approved by the Register (shall have Type Approval Certificate (CTO) and/or the Register Certificate for a batch).

The Register approval shall cover the product (shells/bushes) of one material type and of each size. The type means the same chemical composition with or without reinforcement.

Materials of shells/bushes of different chemical compositions, resins, fibers, cores, etc. are deemed as different types.

Synthetic materials of shells/bushes are divided into two levels depending on the ability to withstand surface pressure during operation:

up to 5,5 N/mm^2;

5,5 N/mm^2 to 10 N/mm^2.

6.13.3 The material under approval shall be tested under supervision of the Register or in a laboratory recognized by the Register for determination of properties specified in Tables 6.13.3-1, 6.13.3-2 and 6.13.3-3.

Table 6.13.3-1

Test for all surface pressures

Property (parameter)	Unit	Testing method	Qty and choice of specimens, pc	Value	Acceptance criteria
Compressive properties					
Elastomeric materials					
Compressive relative deformation for 120 N/mm^2	%	Testing method is determined by the manufacturer. (Recommended standards: GOST 4651, ISO 604)	Isotropic: min. 5 Anisotropic: min. 10	Max. strain 4 %	All results are below the requirements
Non-elastomeric materials					
Compressive strength (transverse)	N/mm^2	GOST 4651, ISO 604	Isotropic: min. 5 Anisotropic: min. 10	Min. 100 N/mm^2	All results are above the requirements
Compressive strength (longitudinal). Required only for flats and strips	N/mm^2	GOST 4651, ISO 604	Isotropic: min. 5 Anisotropic: min. 10	Min. 85 N/mm^2	All results are above the requirements
Modulus of elasticity in compression (transverse)	N/mm^2	GOST 4651, ISO 604	–	Min. 1000 N/mm^2	All results are above the requirements
Swelling from water					
Volumetric swelling from water at temperature 20 °C and 80 °C	%	GOST 12020, ISO 175 4 weeks in substitute ocean water (ASTM D1141)	Minimum 3 specimens at each temperature. Specimens: pipe section or flat element with 50 x 50 x *t* mm dimensions, minimum *t* = 4 mm or minimum thickness of produced bush. Tests shall be carried out immediately after recovery (in wet condition)	max. up to 3 %	All results are below the requirements
Water resistance					
Elastomeric materials					
Water resistance after 4 weeks in substitute ocean water (ASTM D1141) at 20 °C	%	Max. permissible compressive strain of 120 N/mm^2	Isotropic: min. 5 Anisotropic: min. 10	Max. strain 4 %	All results are below the requirements
Non-elastomeric materials					
Water resistance after 4 weeks in substitute ocean water	%	ISO 604 Compression test	Isotropic: min. 5 Anisotropic: min. 10	Maintenance: min. 80 % of compression strength and	All results are above the requirements

Property (parameter)	Unit	Testing method	Qty and choice of specimens, pc	Value	Acceptance criteria
(ASTM D1141) at 20 °C				modulus of elasticity in compression	
Oil exposure					
Volumetric swelling from oil after 4 weeks at 20 °C	%	GOST 12020, ISO 175 In oil No. 3 according to ISO 1817:2016	minimum 3 specimens of 50 x 50 x *t* mm, minimum *t* = 4 mm or minimum thickness of produced bush. Tests shall be carried out immediately after immersion (in wet condition)	max. up to 3 %	All results are below the requirements
Heat resistance					
Elastomeric materials					
Compression test after specimen heating up to 50 °C	%	GOST 4651, ISO 604 At compression force of 120 N/mm^2	Isotropic: min. 5 Anisotropic: min. 10	Max. strain 4 %	All results are below the requirements
Non-elastomeric materials					
Compression test after specimen heating up to 50 °C	%	GOST 4651, ISO 604	Isotropic: min. 5 Anisotropic: min. 10	Maintenance: min. 80 % of compression strength and modulus of elasticity in compression	All results are above the requirements
Thermal expansion					
Transverse (perpendicular to the sheet) and longitudinal (parallel to the sheet)	mm/mm° C	GOST 32618.2 ISO 11359-2 ASTM D696	–	Value specified by the manufacturer	–

Table 6.13.3-2

Tests for all surface pressures up to 5,5 N/mm^2

Property (parameter)	Unit	Testing method	Qty and choice of specimens, pc	Value	Acceptance criteria
Wear					
Wear	years	Refer to 6.13.3.2 and 6.13.3.3	Refer to 6.13.3.2 and 6.13.3.3	Wear tests shall show minimum expected service life	–

Property (parameter)	Unit	Testing method	Qty and choice of specimens, pc	Value	Acceptance criteria
Friction					
Dynamic factor	–	Tests shall be performed on friction machine (recommended type: UTM-1): at temperatures 20 °C and 80 °C, in a form of pressure function or minimum at two different surface pressures (max. and 2 times greater than the max. one)	Minimum 3 specimens at each temperature and surface pressure	max. 0,25	All results are below the requirements
Static factor					

Table 6.13.3-3

Tests for surface overpressures above 5,5 N/mm^2 and up to 10 N/mm^2 and above

Property (parameter)	Unit	Testing method	Qty and choice of specimens, pc	Acceptance criteria	Value
Volumetric swelling from water	%	GOST 12020, ISO 175 wet/ dry/ wet cycle; 3 days wet + 3 days dry, within 4 weeks in substitute ocean water (ASTM D1141) at temperature 20 °C. Shall be started and terminated by 3-day wet cycle	Minimum 3 specimens of 50 x 50 x *t* mm dimensions, minimum *t* = 4 mm or minimum thickness of produced bush. Tests shall be carried out immediately after immersion (in wet condition)	max. up to 3 %	All results are below the requirements
Wear	Refer to 6.13.3.2 and 6.13.3.3	Refer to 6.13.3.2 and 6.13.3.3	Refer to 6.13.3.2 and 6.13.3.3	Wear tests shall show minimum expected service life	–
Dynamic factor	–	Friction coefficient shall be determined on friction machine (recommended type: UTM-1): at temperature – 20 °C: during wear testing at two different surface pressures (max. and 2 times greater than the max. one) in dry and wet conditions. –80 °C: on friction machines at two different surface pressures (max. and 2 times greater than the max. one).	–20 °C According to wear test procedure; –80 °C: minimum 3 specimens for each pressure	max. 0,25	All results are below the requirements
Static factor	–				

6.13.3.2 Wear test procedure for synthetic materials of rudder bearing bushes.

The present test procedure is considered as standard one, although other sizes and parameters may be accepted instead of those listed below according to the previous agreement with the Register.

6.13.3.2.1 Testing box consist of:

shaft with diameter (d_{shaft}) equal to 100 mm;

specimen that shall represent a fixed bearing section and shall cover minimum 50° or shaft circumference (by width) and shall have a bearing length $\ell = 1{,}2d$ (maximum length 120 mm for shaft of 100 mm, minimum length 80 mm; when using larger specimens, the same proportion shall be kept). Bearing diameter shall be

$$d_{bearing} = d_{shaft} + 1\ mm \qquad (6.13.3.2.1)$$

or in compliance with the requirements of the manufacturer (if any);

plants for lubrication with sea water.

6.13.3.2.2 Test parameters:

shaft oscillation ± 15°;

surface pressure testing shall be carried out in accordance with the required surface pressure. In addition, tests shall be performed under pressure which is two times greater than the required pressure;

lubrication: in dry state and with mechanical lubrication by sea water;

air temperature 20 °C;

speed 3,5 mm/s;

shaft movement under required surface pressure shall be continuous. If the surface pressure exceeds the required level, a pause/stop may be accepted for a period up to 10 s at each centerline plane passing and it shall be specified as a limitation for applicable PV parameter (pressure and speed — heat emission);

actual time of operation to obtain a stable wear level (minimum 192 h at 3,5 mm/s or maximum 850 h excluding disassembly and pause/stop). For lower speed and/or more long-term stops the duration shall be increased as appropriate.

6.13.3.2.3 Mating material:

type — stainless steel;

hardness — maximum 220 HV5.

Roughness of mating material surface with the processing frequency shall be R_a = 0,8 μm (in accordance with GOST 2789:1973, ISO 4287:2014).

6.13.3.2.4 Set parameters:

wear shall be constantly or regularly measured at the bush and shell/shaft. In case of regular measurement, the wear shall be measured by disassembling after every 48 h until at least on 4 points of measurement it is demonstrated that the degree/rate of wear has been stabilized. The following information shall be documented in tables and diagrams, wear relating to time (μm/h) and pressure (μm/MPa); wear relating to test cycle (μm/h); wear relating to distance traveled (μm/number of oscillations);

friction coefficient shall be measured until the degree/rate of wear is stabilized at 20 °C. Ratio between the friction coefficient and time and pressure shall be given both in tables and in diagrams;

all quantitative parameters shall be measured;

thermocouple (°C), if applicable (shall determine thermal expansion and measured wear for differentiation of these two parameters).

6.13.3.2.5 Swelling from thermal expansion and/or swelling from water shall be considered when determining the wear.

6.13.3.3 Wear test procedure for synthetic materials of propeller shaft bearings.

6.13.3.3.1 Wear tests for synthetic materials of propeller shaft bearings with continuous movement shall be performed at the following parameters and conditions:

mating material — shaft is made of stainless steel;

shaft diameter depends on the bearing size but shall be ≥ 35 mm;

shaft movement — smooth sliding;

peripheral speed 6 m/s for oil and water lubrication and 3 m/s for lubricating grease;

lubrication by sea water (room temperature) and mineral oil (80 °C), lubricating grease (80 °C), if applicable;

surface roughness R_a = 0,5 μm (in accordance with GOST 2789:1973, ISO 4287:2014);

pressure at joint minimum 0,6 N/mm^2;

tests continue until wear coefficient becomes constant (not less than 192 h, not more than 840 h);

to obtain mixed lubrication the tests shall break up every 8 h;

dimensions of testing specimen shall be in accordance with Fig. 6.13.3.3.1.

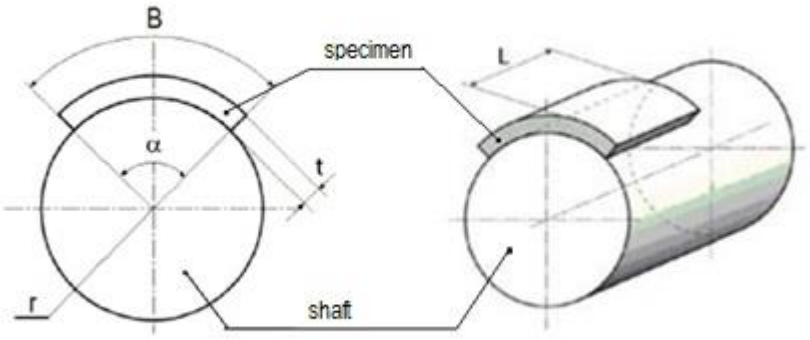

Fig. 6.13.3.3.1 Dimensions of testing specimen:
r — shaft radius; α — 50 °; *t* — specimen thickness;
L — specimen length; *L* = 2*B*, mm; *B* — specimen width; B = (π/180)·*r*·50, mm

6.13.3.3.2 Set parameters:

Wear shall be continuously and regularly measured on bushes and shaft. In case of regular changes, the wear shall be measured every 48 h until the constant wear rate is obtained (minimum at four measurement points). Measurements shall be presented both in tables and in diagrams;

wear relating to time (mm/h) and pressure (N/mm^2);

friction coefficient;

period between tests (h);

temperature of testing specimen during testing cycle (°C).

6.13.3.4 Approval of the materials of bearing shells/bushes for application in systems without lubrication (auto-lubrication).

6.13.3.4.1 The requirements of this Chapter apply only to synthetic materials of bearing shells/bushes that are manufactured as auto-lubrication bearings, i.e. that include shells, cores or similar components that provide lubrication. Manufacturer's technical specification or product description shall contain clear instructions that the material is produced as auto-lubricating and is suitable for auto-lubrication systems.

6.13.3.4.2 For confirmation of operation without water and/or oil lubrication, i.e. for operation without lubrication, the wear test procedure specified in 6.13.3.2 and 6.13.3.3, shall be supplemented as follows:

.1 only for dry mode; constant and regular temperature check of bush material on the contact surface;

.2 the time for wear tests shall be like that specified in 6.13.3.2, but in addition to it, the temperature shall achieve the stable level before test termination;

.3 bush temperature shall not exceed the maximum operating temperature set by the manufacturer and in any case shall not exceed:

temperature of deformation at heating and shall not be less that this temperature by 20 °C, for non-elastomeric materials;

50 °C for elastomeric materials or specially agreed in each case.

6.14 POLYMER MATERIALS APPLIED AS CORES FOR STEEL SANDWICH PANELS

6.14.1 The requirements of this Chapter cover polymeric elastomer (polyurethane) applied without reinforced elements as a core when mounting steel sandwich panels (hereinafter, SSP).

Standards given in this Chapter may be replaced by other ones agreed with the Register.

6.14.2 When mounting SSP the liquid modification of polyurethane shall be used. Mixing of polyurethane base components, polyol (A component) and isocyanate (B component), shall be carried out in accordance with the application procedure reviewed by RS.

6.14.3 The list of base properties and acceptable criteria of polyol and isocyanate are given in Table 6.14.3. These features shall be included in the accompanying documentation of the manufacturer. In addition, water clean-up system shall be applied to polyol. If this cleaning is unavailable, tests for water content shall be carried out in accordance with ISO 14897 (GOST 25261-82).

Table 6.14.3

Requirements for polyurethane base components

Property	Testing method	Acceptable criterion
Polyol (A component)		
Hydroxyl value	DIN 53240 (GOST 25261:82)	325 ± 35 mgKOH/g
Isocyanate (B component)		
Viscosity	DIN 53018 (GOST 33452:2015)	at 25°C: 210 ± 40 mPa•s
Isocyanate content (NCO content)	ISO 14896	31,5 ± 1 %

6.14.4 Each batch of A and B components supplied by the manufacturer shall be marked, checked for compliance with the established number, visual quality and expiry date. Each item from the batch shall be marked with the batch number.

Ready-for-use components shall be stored in stirred reservoirs at temperatures recommended by the manufacturer. If they differ from the ambient temperature it is necessary to provide calibrated devices for temperature measuring.

6.14.5 For core material in a hardened state properties specified in Table 6.14.5 shall be determined.

Table 6.14.5

Requirements for features of hardened polyurethane

Property	Testing method	Acceptable criterion
Density of hardened material	ISO 845	$\rho \geq 1000$ kg/m^3 at room temperature (RT)
Shore hardness, D	DIN 53505 (GOST 24621:81, ISO 868:85)	D ≥ 65 at RT
Shear modulus	ISO 6721-2 (GOST R 56745:2015)	G≥264 N/mm^2 at RT; G≥120 N/mm^2 at 80 °C
Tensile strength	ISO 527 (GOST 32656, ASTM D412)	≥ 20 N/mm^2 at RT; ≥ 5 N/mm^2 at 80 °C
(Fracture) elongation	ISO 527 (GOST 32656, ASTM D412)	≥ 10 % at –20 °C; ≥ 20 % at RT
Bond shear strength to steel substrate	ASTM D429:81	≥ 2,7 N/mm^2 (S-type abrasive) /shot/ ≥ 4 N/mm^2 (G-type abrasive) /grit/

6.14.6 Polyurethane applied for SSP shall remain operative within the temperature range –45 °C — +100 °C.".