RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER **No. 314-01-1452c** dated 19.10.2020

Re:

amendments to the Rules for the Classification and Construction of Sea-Going Ships, 2020, ND No. 2-020101-124-E

Item(s) of supervision:

ships under construction

Entry-into-force date: ~~Valid till:~~ ~~Validity period extended till:~~
01.12.2020

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

Number of pages: 1 + 8

Appendices:

Appendix 1: information on amendments introduced by the Circular Letter

Appendix 2: text of amendments to Part XIII "Materials"

Director General Konstantin G. Palnikov

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, as well as 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 ships contracted for construction or conversion on or after 01.12.2020, in the absence of a contract — on ships, the keels of which are laid or which are at a similar stage of construction on or after 01.12.2020.

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

Part XIII: Section 11

Person in charge: Maxim E. Yurkov 314 +7 (812) 312-85-72

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Appendix 1 to Circular Letter
No. 314-01-1452c dated 19.10.2020

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	Section 11	New Section with the requirements for additive manufacturing products has been introduced	314-01-1452c of 19.10.2020	01.12.2020

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2020,

ND No. 2-020101-124-E

PART XIII. MATERIALS

The Part is supplemented by **new Section 11** reading as follows:

"ADDITIVE MANUFACTURING PRODUCTS

11.1 GENERAL

11.1.1 The requirements of this Section apply to semi-finished products, finished products and alternative products obtained by additive synthesis methods and used for manufacturing of hull structural members, parts of machinery, arrangements/gearing and other ship's components, being items of the Register technical supervision in accordance with the RS Nomenclature.

11.1.2 In accordance with 1.1.4, all the products specified in this Section shall be manufactured at the firms recognized according to 1.3.1.2.

11.1.3 The requirements of this Section apply to the products from metallic materials.

11.1.4 Application of additive synthesis methods and materials of the nature other than that described in this Section may be allowed by the Register after examination under RS technical supervision. The examinations are carried out is performed to determine product performance and their scope shall be specified by the customer's requirements. The product may be allowed in accordance with 2.4.1.3 of Part III "Technical supervision during manufacture of materials" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships.

11.2 DEFINITIONS AND EXPLANATIONS

11.2.1 The following definitions and explanations have been adopted in this Section of the Rules.

Additive manufacturing (AM), additive synthesis means a process of manufacture of semi-manufactured products, items and other products based on creation of a physical object from an electronic geometric model by adding material, generally layer upon layer, alternatively to subtractive production (machining) and conventional forming production (casting, stamping).

An additive product means a semi-manufactured product, item and other product resulting from addition production.

A precursor means an ingoing forming material in a state preceding the additive product synthesis.

A prototype means a semi-manufactured product or a product obtained using the methods described in other sections of the RS Rules. Inter alia, prototypes include: hot-rolled products, stampings, castings, forgings, etc. A semi-manufactured product manufactured in compliance with national and international standards may also be a prototype.

11.3 METAL ADDITIVE PRODUCTS

11.3.1 General.

11.3.1.1 The present requirements cover metal semi-manufactured articles, end products of ship's arrangements and ship machine-building components from metals produced using additive manufacturing methods.

Metal powder, welding wire or strip may be used as precursors. Most commonly, heat input required for the synthesis is supplied by laser beam, electronic beam, plasma, electric arc or other ways.

11.3.1.2 This Chapter contains the requirements for additive product material pertaining to scope of required tests, delivery characteristics and surface condition.

11.3.1.3 Selection of the particular applicable type of metal for manufacture of additive products is within the manufacturer's responsibility. Correctness of selection shall be verified by the tests specified in this Chapter.

11.3.1.4 Material grade designation shall be maintained in compliance with national and international standards.

11.3.2 Production.

11.3.2.1 Additive products are manufactured according to specifications, technical conditions, standards or other normative documents, which the supply complies with.

11.3.2.2 RS recognition of additive products manufacturers shall be carried out in compliance with 2.1, Part III "Technical Supervision during Manufacture of Materials" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships. Scope of application of the issued Recognition Certificate for Manufacturer covers the surveyed metals and additive synthesis methods. Furthermore, apart from the requirements of other sections of the Rules, the Certificate shall contain the following:

types (steel, titanium or other alloys, compositions, etc.);

kinds (carbon steel, corrosion-resistant steel, etc.)

classes and grades (categories) (AF-7, BT6, etc.);

synthesis method (selective laser melting, selective laser sintering, etc.);

types of precursors applied;

maximum overall dimensions of the product.

11.3.2.3 The manufacturer's responsibility shall be determined by the normative document for supply and shall ensure compliance of additive manufacturing and additive product properties with the specified requirements of the normative document and these Rules. Where occurrences of product quality index reduction are detected by control system, the manufacturer shall identify them and take appropriate measures for prevention thereof. Report on performed investigations and appropriate actions shall be submitted to the Register.

11.3.2.4 During the manufacturer survey, normative documentation regulating the procedures of production process, such as applied radiated power, rebuild welding rate, etc. shall be submitted. In compliance with the requirements of 11.3.2.3, the manufacturer is responsible for further observation of all specified processing methods during the additive product manufacture. The relevant records shall be controlled by the manufacturer and submitted to the RS representative during the survey.

Deviations from the established synthesis procedures may be permitted provided that the quality of manufactured products meets the requirements to product materials. The identified deviations shall be agreed with the consumer.

11.3.2.5 Synthesis of additive products shall be performed using metal powder, combination of welding wire with gas or inert gas, combination of welding wire or strip and flux. Chemical composition of precursors shall be controlled by the manufacturer of the additive product by verifying the compliance of international and national standards, technical conditions, technical requirements, specifications or other normative documents.

When precursors are manufactured at one firm, and the additive product synthesis is carried out at another firm, a Manufacturer's Certificate specifying the manufacturer, method of manufacture, batch number, chemical composition and granulometric composition for powder material shall be submitted to the surveyor.

11.3.2.6 Each precursor batch shall be subjected to incoming inspection by the following parameters:

check of accompanying documentation (Manufacturer's Certificate);

check of packing;
check of chemical composition including gases;
check of powder granulometric composition, where applicable;
check of powder pour density and plastic yield, where applicable;
check of mechanical properties;
check of intergranular corrosion resistance (for corrosion-resistant materials);
control of ferritic phase content (for austenitic corrosion-resistant materials).

Determination of chemical and granulometric composition, pour density and plastic yield of powder shall be carried out in accordance with the procedures that shall be included in the test program approved by the Register. Incoming inspection shall be carried out at the most one month prior to the additive manufacturing start.

11.3.2.7 Incoming inspection of welding wire, strip and flux applied for manufacture of additive products shall be carried out in compliance with the requirements of Section 4, Part XIV "Welding" or national and international standards approved by RS for application.

11.3.2.8 Procedures of tensile test, impact test, metallographic examination, tests for intergranular, pitting and crevice corrosion resistance, α-phase determination, etc. of additive product material shall comply with the requirements of Section 2 and/or national and international standards accepted by RS for application.

11.3.2.9 While selecting precursor material grade, the selection of these materials shall be substantiated with respect to obtaining the required performance properties based on the product functionality and the requirements of applicable sections of this Part for prototypes and/or documents for supply for chemical composition of the prototypes.

11.3.2.10 During the approval of the requirements to mechanical properties of additive product material by the Register, the requirements of the Rules for prototypes and/or documents for supply, as well as the requirements specifying by the product purpose in respect of the minimum operating temperature, possible exposure to corrosive environment, cycling of operating loads and other operating conditions shall be taken into consideration.

11.3.2.11 Selection of the condition of supply shall be determined by the required quality of additive product that ensure obtaining of mechanical properties, in its turn determined by documents for supply. Unless stated otherwise, the following supply conditions are permitted:
in the condition without heat treatment;
homogenizing annealing;
annealing;
heat refining (quenching and tempering).

Parameters of additional heat treatment shall be included in documentation regulating the procedures of production process.

11.3.3 Sampling.

11.3.3.1 Specimens for testing shall be taken from extension to the additive product body. The procedure of sampling and specimen cutting out shall be specified in design documentation and/or test program approved by the Register.

For scheduled testing and control, additive synthesis of specimens separate from the product is permitted. Individual samples shall be manufactured from precursor of the same batch, using the same equipment and the same process parameters as the additive product. In this case, the dimensions of a specimen in thickness and diameter may differ from the maximum dimensions of the additive product not more than by 25 % or with at least 1 mm of machining allowance, whichever is less.

Samples for test specimen shall be taken upon completion of all types of heat treatment.

Individual samples shall be subjected to heat treatment in one furnace charge with the additive product submitted for survey.

11.3.3.2 Dimensions of samples shall ensure performance of the required tests and possible retesting.

11.3.3.3 Specimens for mechanic testing and microstructure check, taking into consideration the possible properties anisotropy, shall be cut in two directions with respect to synthesis direction, i.e. longitudinal axes of specimens shall be parallel and perpendicular respectively to direction of the additive product growing.

11.3.4 Scope of testing.

11.3.4.1 Types of tests the additive products to be subjected to are given in Table 11.3.4.1. Tests to be carried out for supplies under the RS technical supervision are marked by "+".

Table 11.3.4.1

Types of additive product tests

Parameters	Types of materials		
	Low-alloyed steels	Corrosion-resistant steels	Titanium alloys
Chemical composition	+	+	+
Tensile tests at 20 °C:			
tensile strength R_m	+	+	+
yield stress $R_{0,2}$	+	+	+
elongation A_5	+	+	+
relative reduction Z	+	+	+
Fracture energy at impact bending at the minimum operating temperature	+	+	+
Microstructure check	+	+	+
α-phase control	–	+[1]	–
Intergranular corrosion resistance	–	+	–
Pitting and crevice corrosion resistance	–	+	–
Non-destructive testing	+	+	+
Note. Types of samples and testing procedures shall comply with the requirements of Section 2. [1] For austenitic steels prior to heat treatment.			

11.3.4.2 Additive products shall be submitted for testing in batches or in pieces. In case of survey of a batch of additive products, one product from the batch shall be subjected to mechanical tests. Each product of the batch shall be subjected to non-destructive testing.

The batch shall consist of additive products of the same name and range, manufactured from precursor of one batch, at the similar synthesis process parameters, and heat treatment shall be carried out in the same furnace charge. Batch size shall be also restricted by a total weight of additive products equal to 200 kg.

Additive products from low-alloyed steel intended for the use at operating temperatures below –30 °C shall be submitted for testing in pieces.

11.3.4.3 If not otherwise stated, a minimum number of specimens shall be made from one sample according to Table 11.3.4.3.

Table 11.3.4.3

Test type	Number of specimens
Determination of chemical composition	One
Tensile test	Three test specimens per each of two directions
Determination of impact energy	Three test specimens per each of two directions
Intergranular corrosion resistance	4 (two check samples)
Pitting corrosion and gap corrosion resistance	Three test specimens per each test type
Microstructure check	One specimen per two faces of cross section preparing

11.3.4.4 Retesting of additive product material shall be carried out in compliance with 1.3.2.3. In retesting the parameters having unsatisfactory results shall be determined. In this case the scope of testing shall be duplicated.

11.3.5 Non-destructive testing.

11.3.5.1 Non-destructive testing of the additive products shall be carried out using the following procedures:

visual testing and measuring;

radiographic testing;

where the requirements in the terms of supply are available – dye penetrant and ultrasonic testing.

Use and scope of other control methods shall be agreed with the consumer.

11.3.5.2 Non-destructive testing shall be carried out in compliance with IACS recommendations Nos. 68 and 69 accordingly to the selected prototypes, and/or national and international standards permitted for application by the Register.

11.3.6 Surface condition.

11.3.6.1 The surface quality of objects of additive products application shall comply with the requirements of design documentation and/or national and international standards.

The manufacturer is responsible for surface quality conformance of such objects. Manufacturer quality system shall ensure the required scope surface check preceding the product supply to the consumer. Where material surface defects are detected during the latter stages of manufacture, repair may be carried out in compliance with 11.3.6.2.3.

11.3.6.2 Acceptance criteria.

11.3.6.2.1 Acceptance criteria of the additive product shall be agreed with the consumer and presented in the documents for supply.

11.3.6.2.2 Cracks, flaw, delaminations, sharp edges and other visible surface defects, as well as preventing end use of the products require cutting-out or grinding with subsequent repair.

11.3.6.2.3 Surface defect elimination.

11.3.6.2.3.1 Grinding of defects without rebuild welding is acceptable under the following conditions:

elimination of surface defects by local grinding is permitted for the depth not exceeding 7 % of the nominal thickness, but not exceeding 3 mm;

the area of separate grinding zones shall not exceed 1 % of the total area of the additive product;

the total grinding area shall not exceed 2 % of the total area of the additive product;

In such a case, the defects located at the distance less than their average width from each other are considered as a single defect area;

Grinded surface shall have smooth transition to surrounding surface of the product. Complete elimination of the defect shall be verified by magnetic particle or by dye penetrant testing.

11.3.6.2.3.2 Surface reconditioning after defect elimination

Elimination of additive product defects by rebuilding shall be carried out using precursors of the same grade as the additive products manufactured.

Technology process of surface defect elimination by rebuilding shall be submitted to the Register for approval. Elimination of defects shall be accompanied by subsequent non-destructive testing.

11.3.7 Use of additive products.

11.3.7.1 For additive product manufacture by direct laser growing from powder materials, application of precursors complying with the requirements on chemical composition and mechanical properties specified in 11.3.7.2 and 11.3.7.3 is approved by the Register.

11.3.7.2 Chemical composition of additive product material manufactured by direct laser growing method from powder material shall meet the requirements of Table 11.3.7.2-1 for steel and Table 11.3.7.2-2 for titanium alloy.

11.3.7.3 Mechanical properties of additive product material manufactured by direct laser growing method from powder material shall meet the requirements of Table 11.3.7.3.

11.3.7.4 For additive products made by a method of direct laser growing from low-alloyed and corrosion-resistant steel and given in Table 11.3.7.4, heat treatment is mandatorily required. The recommended heat treatment procedures are given in Table 11.3.7.4.

The type and procedure of heat treatment shall be specified in a certificate for an additive product.

11.3.7.5 Manufacture and delivery of additive products of other grades and/or using other synthesis methods under RS technical supervision may be carried out after performing a set of studies and tests according to the Program developed in accordance with the requirements of this Section and approved by the Register.

11.3.8 Marking and documents.

11.3.8.1 Identification, marking and the documents issued shall comply with the requirements of 1.4.

11.3.8.2 Each additive product shall be accompanied with the RS Certificate.

11.3.8.3 Each batch of precursor subject to subsequent application for the product shall be accompanied by the Manufacturer's Certificate.

Table 11.3.7.2-1

Grade of precursor material	C	Si	Mn	Cr	Ni	Mo	S	P	Al	Cu
							Not more than			
09ХН2МД	0,08 – 0,11	0,17 – 0,37	0,30 – 0,60	0,30 – 0,70	1,80 – 2,20	0,25 – 0,35	0,010	0,015	0,01 – 0,05	0,40 – 0,70
08ГДНФЛ	Not more than 0,10	0,15 – 0,40	0,60 – 1,00	Not more than 0,30	1,15 – 1,55	–	0,035	0,035	–	0,80 – 1,20
06Х15Н4ДМЛ	≤ 0,06	0,40	0,60-0,90	14,0 – 15,5	4,0 – 4,4	0,11 – 0,28	0,015	0,015	–	1,0 – 1,5

Table 11.3.7.2-2

Grade of precursor material	Ti	Alloying, %			Impurities, %, not more than					
ТЛ5	base	Al	V	B	O	H	N	C	Fe	Si
		3,5 – 5,0	1,5 – 2,5	0,002 – 0,006	0,15	0,008	0,04	0,15	0,25	0,12

Table 11.3.7.3

Grade of precursor material	Yield stress, MPa,	Ultimate tensile strength, MPa	Elongation, %	Impact energy on test specimens *KV* / *KU*, J	
				t = 20 °C	*t* = –40 °C
	not less				
09ХН2МД	530	650	18	KV 78	KV 26
08ГДНФЛ	360	420	10	KU 56	KU 32
06Х15Н4ДМЛ	620	790	10	K 40	KV 32
ТЛ5	590	640	8	KV 30	KV 22

Table 11.3.7.4

Grade of precursor material	Heat treatment procedure
09ХН2МД	Homogenizing at *T* = 1100 °C, conditioning for 6 h, heating and cooling in a furnace Quenching at *T* = 920 °C, conditioning for 2 h, cooling in oil High tempering at *T* = 650 °C, conditioning for 5 h, cooling in the air
08ГДНФЛ	Homogenizing at *T* = 1100 °C, conditioning for 6 h, heating and cooling in a furnace Normalizing at *T* = 940 °C, conditioning for 2 h, cooling in the air Quenching at *T* = 940 °C, heating in a furnace, conditioning for 2 h, cooling in water High tempering at *T* = 640 °C, conditioning for 2 h, cooling in the air
06Х15Н4ДМЛ	Homogenizing at *T* = 1200 °C, conditioning for 6 h, heating in a furnace, cooling in the furnace up to 150°C, then in the air Quenching at *T* = 1060 °C, conditioning for 3 h, cooling in the air 1st high tempering at *T* = 625 °C, conditioning for 5 h, heating in a furnace, cooling in the air 2nd high tempering at *T* = 625 °C, conditioning for 5 h, heating in a furnace, cooling in the air 3rd high tempering at *T* = 625 °C, conditioning for 5 h, cooling in a furnace up to 150°C, then cooling in the air

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