RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER **No. 314-01-1460c** dated 12.11.2020

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:~~
15.12.2020

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

Number of pages: 1 + 19

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, 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 15.12.2020, in the absence of a contract, the keels of which are laid or which are at a similar stage of construction on or after 15.12.2020.

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

Part XIII: paras 2.2.6, 2.2.10.1 — 2.2.10.3, 2.2.10.5, 2.2.10.6, 3.2.9, 3.5.1.1, 3.5.1.2, 3.5.1.6 — 3.5.1.9, 3.5.2 — 3.5.7, 3.13.1, 3.13.7, 3.17.4.1 and 3.17.4.1.6 — 3.17.4.1.12

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Appendix 1 to Circular Letter
No. 314-01-1460c dated 12.11.2020

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	Para 2.2.6	Requirements for test procedures have been specified; provisions have been transferred from the Rules for the Classification, Construction and Equipment of Mobile Offshore Drilling Units and Fixed Offshore Platforms (MODU/FOP)	314-01-1460c of 12.11.2020	15.12.2020
2	Paras 2.2.10.1 — 2.2.10.3	Requirements for test procedures have been specified; provisions have been transferred from the Rules for the Classification, Construction and Equipment of (MODU/FOP)	314-01-1460c of 12.11.2020	15.12.2020
3	Para 2.2.10.5	Requirements for test procedures have been specified; provisions have been transferred from the Rules for the Classification, Construction and Equipment of (MODU/FOP)	314-01-1460c of 12.11.2020	15.12.2020
4	Para 2.2.10.6	Requirements for test procedures have been specified; provisions have been transferred from the Rules for the Classification, Construction and Equipment of (MODU/FOP)	314-01-1460c of 12.11.2020	15.12.2020
5	Para 3.2.9	Requirements for F grade steel and steel with index "Arc" have been specified	314-01-1460c of 12.11.2020	15.12.2020

Nos.	Amended paras/chapters/sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
6	Para 3.5.1.1	Requirements for F grade steel and steel with index "Arc" have been specified	314-01-1460c of 12.11.2020	15.12.2020
7	Para 3.5.1.2	Requirements for F grade steel and steel with index "Arc" have been specified	314-01-1460c of 12.11.2020	15.12.2020
8	Para 3.5.1.6 — 3.5.1.8	Requirements for F grade steel and steel with index "Arc" have been specified	314-01-1460c of 12.11.2020	15.12.2020
9	Para 3.5.1.9	The para has been deleted	314-01-1460c of 12.11.2020	15.12.2020
10	Para 3.5.2	Requirements for F grade steel and steel with index "Arc" have been specified	314-01-1460c of 12.11.2020	15.12.2020
11	Para 3.5.3	Requirements for F grade steel and steel with index "Arc" have been specified	314-01-1460c of 12.11.2020	15.12.2020
12	Para 3.5.4	Requirements for F grade steel and steel with index "Arc" have been specified	314-01-1460c of 12.11.2020	15.12.2020
13	Para 3.5.5	Requirements for F grade steel and steel with index "Arc" have been specified; requirements have transferred from the existing para 3.5.3	314-01-1460c of 12.11.2020	15.12.2020
14	Para 3.5.6	A new para with the requirements for F grade steel and steel with index "Arc" has been introduced; requirements have transferred from the existing para 3.5.4	314-01-1460c of 12.11.2020	15.12.2020
15	Para 3.5.7	A new para with the requirements for F grade steel and steel with index "Arc" has been introduced; requirements have revised and transferred from the existing para 3.5.5	314-01-1460c of 12.11.2020	15.12.2020

Nos.	Amended paras/chapters/sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
16	Paras 3.13.1	Requirements for high strength and clad steel have been specified	314-01-1460c of 12.11.2020	15.12.2020
17	Para 3.13.7	Requirements for high strength and clad steel have been specified	314-01-1460c of 12.11.2020	15.12.2020
18	Para 3.17.1.3	Requirements for high strength and clad steel have been specified	314-01-1460c of 12.11.2020	15.12.2020
19	Para 3.17.4.1	Requirements for high strength and clad steel have been specified	314-01-1460c of 12.11.2020	15.12.2020
20	Para 3.17.4.1.6	Requirements for tests of main layer have been specified	314-01-1460c of 12.11.2020	15.12.2020
21	Paras 3.17.4.1.7 — 3.17.4.1.11	Paras have been deleted	314-01-1460c of 12.11.2020	15.12.2020
22	Para 3.17.4.1.7 (renumbered para 3.17.4.1.12)	Requirements for weld testing for intergranular corrosion resistance have been specified	314-01-1460c of 12.11.2020	15.12.2020

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

ND No. 2-020101-124-E

PART XIII. MATERIALS

2 PROCEDURES OF TESTING

1 **Para 2.2.6** is replaced by the following text:

"**2.2.6 Dropweight tests for determination of nil-ductility temperature (*NDT*).**

2.2.6.1 General.

2.2.6.1.1 The main purpose of the testing is determination of brittle fracture development conditions in a material with thickness of at least 16 mm.

2.2.6.1.2 The test consists in impact bend loading of a number of specimens provided by a free-falling weight at a sequence of temperatures aimed at determination of a highest temperature at which standard specimens break, or nil-ductility temperature (*NDT*) at 5 °C intervals.

The deflection shall be limited by a stop in accordance with the applicable test standard.

2.2.6.2 Specimens for *NDT* determination.

2.2.6.2.1 The samples used for *NDT* test specimens shall be taken from places closest to places from which the samples for mechanical testing were taken. If for taking the samples gas cutting is used, the allowance for machining on each side shall not be less than 25 mm.

2.2.6.2.2 Where rolled product is tested, the specimen orientation in their manufacture, unless otherwise specified, shall be such that the longitudinal axes are perpendicular to the last semi-finished product rolling direction (predominant direction of metal deformation).

Manufacture of specimens from castings and forgings shall be performed according to the procedure agreed with the Register in compliance with the requirements of Section 2.

2.2.6.2.3 It is recommended to perform *NDT* determination for a series of nine specimens taken from the semi-product from one place.

2.2.6.2.4 The specimens to determine nil-ductility temperature are manufactured in accordance with ASTM E208 standard. Tests shall be carried out on the specimen types indicated in Table 2.2.6.2.4.

Table 2.2.6.2.4

Specimen type	Thickness	Width	Length
P-1	25 ± 2,5	90 ± 2,0	360 ± 2,0
P-2	19 ± 1,0	50 ± 1,0	130 ± 1,0
P-3	16 ± 0,5	50 ± 1,0	130 ± 1,0

The dimensions of specimens are chosen so that the specimen thickness shall be closest to the thickness of the semi-product subjected for the testing. Exception: if actual material yield strength exceeds 900 MPa, only specimens of types P-2 and P-3 are used.

2.2.6.2.5 As a rule, specimens are prepared by a mechanical method. No overheating of specimens is allowed. The specimen tension side shall not be subjected to machining except for cases of additional testing indicated in 2.2.6.2.7.

2.2.6.2.6 Serial specimens shall have the same orientation.

2.2.6.2.7 Employed for testing are rectangular specimens with brittle weld deposit on the non-machined tension side. In the deposit a notch is made across the specimen, from which a crack is propagated under an impact load.

Where rolled products are tested, additional tests shall be conducted at the specimens with the notch made as follows:

for the rolled steel with the thickness from 40 but less than 50 mm, from the middle thickness of the plate in the plate plane across the rolling direction (specimens of types P-1 or P-2);

for the rolled steel with the thickness of 50 mm and above, from the middle thickness perpendicular to the plate plane in such a way as to the direction of fracture propagation coincides with the rolling direction (specimens of type P-2).

2.2.6.2.8 Only the deposited metal shall be notched with monitored weld thickness under the notch bottom — 2 — 0,2 mm and width of the notch ≤ 1,5 mm.

2.2.6.2.9 The electrodes for brittle overlay (deposit) shall have the core diameter of 4 to 6 mm. Each batch of electrodes shall be checked to perform satisfactory as follows:

in addition to the main series of specimens of the product under study three more specimens shall be manufactured which, after a preliminary estimation of NDT temperature, shall be tested at a temperature of not lower than NDT +60 °C. Each of the tested specimens shall present a visually detected crack propagating from the notch in the deposited metal.

2.2.6.2.10 The brittle weld shall be deposited in a single run, placing it along the specimen in the centre of non-machined surface. The width of the deposit shall be 13 ± 2 mm, length 65 ± 5 mm, the bead height, approximately uniform along the whole length, shall be at least 4 mm but max. 8 mm, which can be achieved by selecting the appropriate welding procedures.

2.2.6.3 Equipment, jigs and fixtures, instrumentation.

2.2.6.3.1 The equipment, jigs and fixtures, and instrumentation shall comply with the requirements of the standards and these Rules and shall be periodically checked and calibrated by authorized national bodies.

2.2.6.3.2 The tests are carried out at an impact testing machine with a free-falling weight ensuring the impact energy from 330 to 1750 J. The impact energy is established according to ASTM E208 in accordance with the specimen type and actual material yield strength.

The necessary level of energy for a particular material and size of product is selected in accordance with the standards. The anvil manufactured of solid metal shall have hardness of 50 — 55 HRC.

2.2.6.4 The specimen is considered to be failed when the crack is propagated from the notch to at least one lateral edge of the specimen. When it is not evident that the crack is propagated until the lateral edge, but there is a groove at the uncut surface in the notch plane (the result of metal tightening during the test), the specimen shall be subject to thermal coloration and shall be broken completely for examination of the form and dimensions of the crack.

The specimen is considered to be failed when the crack is propagated at least to any lateral edge (the top of the crack is located at the distance not exceeding 3 mm from the lateral edge).

2.2.6.5 Validity conditions of obtained NDT values:

.1 the geometrical dimensions of the specimens shall be within the limits of standard tolerances;

.2 the weld-deposit notch is visibly cracked;

.3 the specimens in the course of bending reach the stop;

.4 the deposited layer on the specimens does not contact with the stop;

.5 the obtained value of the nil-ductility temperature is confirmed by testing of three specimens at the temperature of NDT + 5 °C, none of which was broken;

.6 the fitness of the electrodes used for brittle deposit has been proved.".

2 **Paras 2.2.10.1 — 2.2.10.3** are replaced by the following text:

"**2.2.10.1** The present procedures may be used in developing and correcting the programs needed in survey of manufacture of steel intended for use at low temperatures (refer to 3.5) including the steel marked with index "Arc" (refer to 3.5.3). The present provisions apply to:

procedures for determining the temperature of a ductile-brittle transition to estimate the material property with regard to retarding the spread of brittle failure (T_{kb}, *NDT*, *DWTT*);

procedures for determining crack resistance parameter *CTOD* for the base metal, the heat-affected zone (HAZ) and weld metal in testing the specimens cut out from butt-welded joints.

Where one procedure for steel production is concerned (smelting, rolling, condition of supply), the results of tests carried out for the greatest thickness of rolled products may be extended to the rolled products with thicknesses smaller by 40 %, of all lower grades and strength levels where chemical composition, production technology and technology of thermal processing are identical to the tested material. At that, if, according to the calculations, the spread reaches the thickness of 15 mm and less, the minimum thickness approved by the Register shall exceed 15 mm.".

2.2.10.2 Tests for determination of ductile-brittle transition temperature T_{kb}.

2.2.10.2.1 General.

2.2.10.2.1.1 The T_{kb} temperature is a ductile-to-brittle transition temperature characterized by 70 % fibrous component in the fracture of a full-thickness specimen. The tests carried out for determination of T_{kb} allow evaluating cold resistance of the tested material, to compare cold resistance of various steels as well as to evaluate the temperature of brittle crack arrest in tested material.

2.2.10.2.1.2 The procedure for T_{kb} measurement involves the three-point bend testing of a series of steel specimens in full thickness till fracture. The tests are carried out at successively lowered temperatures.

2.2.10.2.1.3 In the course of testing control is effected over the area of crystalline (brittle) or fibrous (ductile) components in the specimen fracture and over the test temperature. Moreover, upon completion of the tests, the existence of cleavage in the fracture within the fibrous component is estimated. In case of multiple cleavage or single cleavage that extends for more than one-half the specimen high (specimen high minus notch depth) an entry shall be made in the test report and the estimation of $T_{d(Tkb)}$ temperature of material usability is deemed invalid.

2.2.10.2.1.4 To determine T_{kb}, a temperature curve of average percentage of fibrous component in the fracture of specimens is created. It is recommended to carry out the tests in the following temperature range, two specimens for one temperature value with max. intervals 20 °C.

.1 for steel with thickness of less than 50 mm: –20 °C, –40 °C, –60 °C, etc., to the temperature when the fibrous component in the fracture does not exceed 50 %;

.2 for thermally improved steel and TM steel: 0 °C, –20 °C, –40 °C, –60 °C, etc.;

.3 for steel with thickness exceeding 50 mm: 20 °C, 0 °C, –20 °C, –40 °C, –60 °C, etc.

Then with 5 °C interval, minimum temperature is determined when the average percentage of fibrous component in the fracture is not less than 70 % and check tests under this temperature shall be carried out.

2.2.10.2.2 Specimens for determination of T_{kb}

2.2.10.2.2.1 The samples used for preparation of T_{kb} specimens shall be taken from places closest to those from which the samples for mechanical testing were taken.

2.2.10.2.2.2 The specimen orientation, unless otherwise specified, shall be such that the longitudinal axes are perpendicular to the last rolling direction (principal direction of metal deformation). Orientation of each specimen is indicated in the test record.

2.2.10.2.2.3 It is recommended to determine T_{kb} by testing a series of 12 specimens taken from one place of the semi-finished product.

2.2.10.2.2.4 The specimens shall be prepared using a mechanical method. It is permitted to use gas or plasma cutting for specimen cutting, provided that the bearing and loaded surfaces are subjected to machining to provide parallelism between them and perpendicularity of the plate.

2.2.10.2.2.5 The dimensions of specimens made of metal in full thickness shall meet the requirements of Table 2.2.10.2.2.5. The radius of top notch in flat prismatic specimens shall be equal to half the notch width.

Table 2.2.10.2.2.5

Thickness, mm	Length, mm	Height, mm	Notch depth, mm	Notch width, mm
Above 10 to 14	288 + 20	60 + 5	20 + 5	3 + 3
Above 14 to 32	400 + 20	90 + 5	30 + 5	3 + 3
Above 32 to 60	520 + 20	120 + 5	40 + 5	5 + 5
Above 60 to 100	640 + 20	150 + 5	75 + 5	5 + 5
Above 100	6 thicknesses + 20	1,5 thicknesses + 5	0,75 thickness + 5	10 + 5

2.2.10.2.3 Equipment, jigs and fixtures, instrumentation.

2.2.10.2.3.1 The equipment, jigs and fixtures, and instrumentation shall comply with the requirements of the standards and these Rules and shall be periodically checked and calibrated by authorized national bodies.

2.2.10.2.3.2 The stress rate under testing shall be monitored when moving the loading yoke and shall be 1,00 mm/with a tolerance of –0,2.

2.2.10.2.4 The procedure for determination of the fibrous component in the fractures.

2.2.10.2.4.1 After testing the compliance of the fracture type shall be determined within the account area based on one or several types of failure shown in Fig. 2.2.10.2.4.1. When combining

the failure types, the total area of the crystalline component shall be evaluated according to the principle accepted for the failure type III:

.1 the area of the crystalline component S_{cr} shall be measured by manual measuring tool, the portion of the fibrous component S_d shall be calculated;

.2 the same portion of the fibrous component S_d shall be calculated by the digital photo of the specimen fracture;

.3 the values obtained by both methods shall be compared. In case their difference exceeds 5 %, the procedure of measurements and calculations shall be changed. The value, measured by the photo, shall be preferable.

The standard area S_0 is a fracture area where the availability of crystalline and fibrous components shall be determined after testing. Standard area dimensions shall be specified prior to the test.

Fibrous component in the fracture (fibrous, ductile) is of dull grayish colour with specific "fibres", usually with thickness reduction and plastic deformation of section, includes the shear zones at side edges of the specimen located at an angle to the notch plane of the specimen.

Crystalline component in the fracture (cleavage, crystalline) is a part of the fracture with no thickness reduction and visible traces of plastic deformation. Usually it has metallic shine, for high-strength steel it may be distinguished only by lighter shade. Crystalline component stains may be located both in the notch plane and at the significant angle to it.

Failure in the form of "arrow" means the triangular fracture areas with alternate strips of smaller scale. These areas may be considered as fibrous component when they are located at the shear lips. Otherwise, the fracture area corresponding to this failure type shall be considered both as fibrous and crystalline components at the ratio 1:1, when no fractographic examinations were conducted.

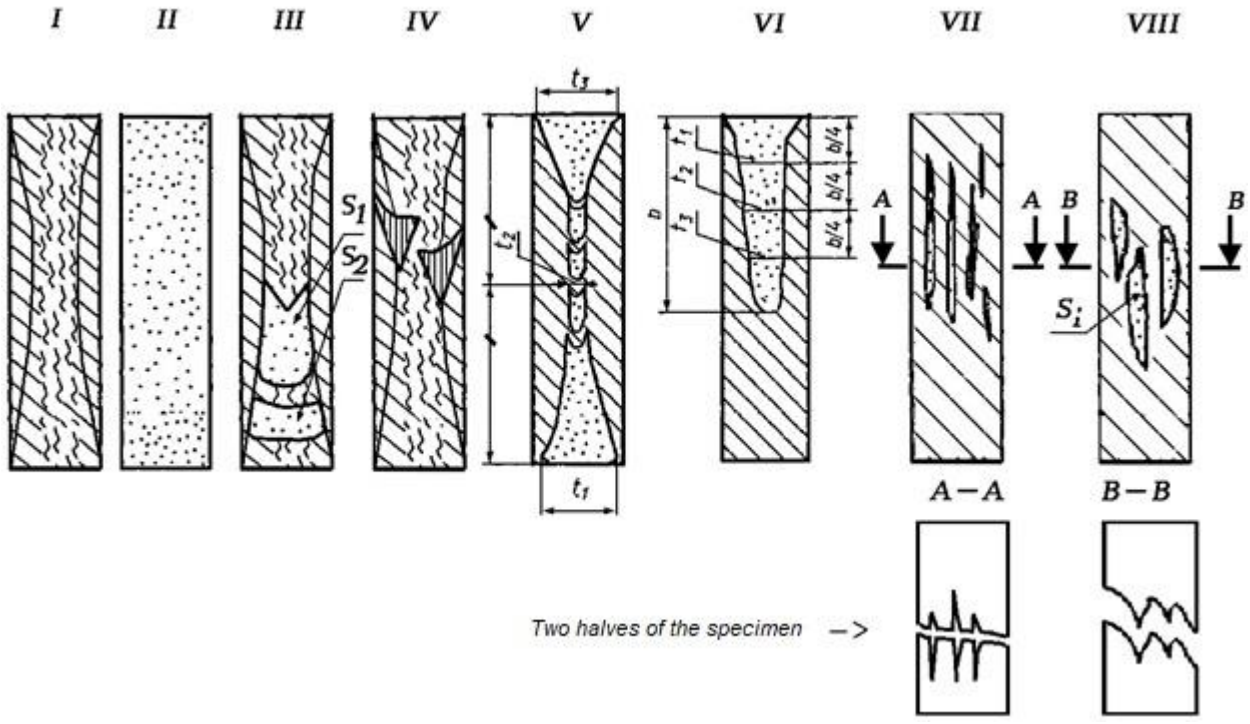

Fig. 2.2.10.2.4.1 Failure types within the account area

Alternating failure means vertical crystalline strip in the fracture with thin straps of the fibrous component.

Separations mean narrow slots, projections and hollows, "ears" in the fracture, parallel to loose face of metal on one or both mating failure surfaces. They are generated during the testing. Areas of crystalline component located on the surfaces of separations are not taken into account at fracture evaluation.

The procedure of referring the fracture areas to the crystalline type (cleavage fracture) and calculating the area of crystalline component S_{cr} in compliance with Fig. 2.2.10.2.4.1:

I — fibrous component, dull surface, S_{cr} = 0, S_d = 100 %;

II — crystalline component, S_{cr} = S_0, S_d = 0 %. When shear lips exist, they shall not be considered when their width does not exceed 0,5 mm per the side;

III — individual spots of the crystalline component: $S_{cr} = \sum S_i$;

IV — the areas of the arrow shape shall be considered as the crystalline component with the reduction factor, when they are not located at the shear lips: $S_{cr} = 0{,}5 \sum S_i$;

V — alternating failure;

$$S_{cr} = S_0 \times (\frac{t_1+t_3}{2} + t_2)/2t,$$

where t — thickness of undeformed specimen prior to testing. Fibrous straps shall not be considered when the crystalline spots are located along the entire fracture height, otherwise the fracture shall be referred to type III;

VI — crystalline ear;

$$S_{cr} = \left(\frac{t_1+t_2+t_3}{3}\right) b,$$

where b — the ear length;

VII — separations perpendicular to the fracture surface shall not be considered as the crystalline component. S_{cr} = 0, S_d = 100 % (both halves of the specimen shall be analyzed). The maximum separation height is measured in the fracture surface and shall be specified in the test report;

VIII — area of crystalline spots located at the angle to the notch surface shall be considered in the projection to the notch plane. At the significant deviation from the notch plane both halves of the specimen shall be analyzed to differentiate the failure types VII and VIII.

2.2.10.2.5 Validity conditions of obtained T_{kb} values**.**

2.2.10.2.5.1 The geometrical dimensions of the specimens shall be within the limits of standard tolerances.

2.2.10.2.5.2 The error of the required specimen temperature measurement in its notched cross-section does not exceed ± 2 °C within the range from 150 to –200 °C.

2.2.10.2.5.3 The error in determination of the quantity of fibrous or crystalline component in the specimen fracture does not exceed ± 5 % of the fracture area.

2.2.10.2.5.4 The obtained value of T_{kb} is the minimum test temperature with maximum 5 °C interval confirmed by testing of three test specimens. The average value of fibrous component in the fracture shall not be less than 65 % (and no individual value shall be less than 60 %).

2.2.10.3 Test for determining NDT temperature – in accordance with 2.2.6.".

3 **Para 2.2.10.5** is replaced by the following text:

"**2.2.10.5** Tests for determining crack resistance parameter *CTOD* for base metal, heat-affected zone (HAZ) and weld metal.

2.2.10.5.1 General.

2.2.10.5.1.1 The principal goal of testing is control over certain type of material fracture in presence of a crack within the climatic temperature range. The tests shall define the crack resistance parameter *CTOD* (crack tip opening displacement) at static loading.

The *CTOD* is one of the listed below crack opening values connected with a certain type of crack propagation and calculated in accordance with the recognized standards:

δ_c — when before the beginning of non-stable fracture (brittle crack propagation) its mean stable extension was less than 0,2 mm;

δ_u — when before the beginning of non-stable fracture (brittle crack propagation) its mean stable extension exceeded 0,2 mm;

δ_m — when the maximum load was reached without non-stable fracture.

2.2.10.5.1.2 To define the *CTOD* value fatigue precracked specimens are used and tested at a specified travel speed of the test machine loading cross-piece ensuring the stress intensity factor growth rate within $(0{,}5 - 1{,}5)\ \text{MPa} \cdot \frac{m^{0,5}}{s}$ during linear elastic specimen deformation. The specimens are loaded up to the fracture (total or partial) or until the maximum force recorded in plastic deformation is exceeded.

2.2.10.5.2 Specimens for *CTOD* testing.

2.2.10.5.2.1 Samples for preparation of specimens for *CTOD* testing shall be taken from areas nearest to those where samples for tensile and impact tests are taken.

2.2.10.5.2.2 Orientation of specimens in the course of manufacture shall be such, unless otherwise specified, that the direction of crack propagation shall coincide with the direction of the last rolling (principal direction of metal deformation).

2.2.10.5.2.3 It is permitted to test specimens manufactured from semi-finished products having angular deformations and curvature (for example, pipes). In such cases the samples can be straightened taking care that load application points are located at a distance of at least equal to the specimen thickness from the line of notch, and the notch zone shall not suffer from strains affecting the test results.

2.2.10.5.2.4 For specimens with residual stress and those subjected to straightening, mechanical removal of residual stress is permitted. The heat treatment in this case is not allowed. It is recommended to use for mechanical relieving of residual stress a method consisting in local compression of specimen side surfaces applied in the notch tip zone, with plastic deformation of the specimen not exceeding 0,5 % of the specimen thickness on each side. For this purpose, punches of sufficient pressure area shall be used to achieve specimen covering in one run if possible. It is necessary to ensure the notch tip covering.

2.2.10.5.2.5 When evaluating the crack resistance of the HAZ (heat-affected zone) the notch shall be made so that the crack tip, on the largest possible length of its front, could be located in a layer of supposedly minimum toughness. To achieve this, it is recommended to use welding with special edge preparation (K- or asymmetrical V- weld with single bevel). The welding procedure shall be approved by the Register.

Special attention shall be paid to employed welding consumables and heat input. The heat input shall be:

not less than 35 kJ/cm in general case;

not less than 50 kJ/cm for steel intended for welding under high heat input. At that the heat input shall be equal to the maximum input applied during survey of steel with index "W".

When testing HAZ metal it is recommended to provide weld metal testing for applied technological welding process by making a notch in the weld metal at the distance of 1 mm from the fusion line. The results of these tests shall be taken into account to determine correctness of data obtained for specimens with notch marking on the HAZ metal if the initial fatigue crack front containing more brittle non-target structural components has been reported by metallographic analysis.

Before application of marking and before notching the specimen, it is necessary to perform the etching and to investigate the heat-affected zone metal structure. Unless otherwise indicated, estimated minimum toughness zones shall be tested, where HAZ-I shall be a zone of the largest grain size and maximum overheating at welding and HAZ-II shall be a zone of partial recrystallization. It is necessary to consider the width of structure portions equal to 0,5 mm measured inside HAZ from fusion line (for HAZ-I) and from the pickling edge (for HAZ-II).

For both zones it is necessary to obtain at least three correct test results. Total number of notched specimens on HAZ in the series is up to 12 for one test temperature value, as some results may not satisfy conditions of test correctness specified in 2.2.10.5.5.

2.2.10.5.2.6 For testing with notch location within the fusion line or some other suitable microstructure it is considered sufficient, if in the initial fatigue crack front there is a portion of suitable microstructure of about 15 % specimen thickness length, unless otherwise specified by the Register. For testing with the notch located in the weld centre it is considered sufficient to have 70 % of weld metal within the initial crack front.

2.2.10.5.3 Types of specimens.

2.2.10.5.3.1 For the purpose of testing specimens of the following types are prepared:

.1 rectangular cross-section specimens for threepoint bending;

.2 compact specimens for eccentric tension;

.3 square cross-section specimens for threepoint bending.

The thickness of test specimens *t* shall be not less than 85 % of full thickness of the semi-product. For semi-products with thickness more than 80 mm the thickness of test specimen is allowed to be reduced in comparison with the full thickness of the semi-product *S* more that 15 % but not exceeding 50 % that shall result in reduction of the test temperature by $17\ln\left(\frac{S}{t}\right)$ °C.

2.2.10.5.3.2 Test specimens of rectangular cross-section *t* x (2*t*) for threepoint bending are principle. To reduce metal intensity and simplify tests of base metal and welded joint metal it is allowed to apply compact specimens with thickness closest to the full thickness of the semi-product from the following range: 25 mm, 50 mm, 75 mm, 100 mm. For the same purpose, to test

heat-affected zone (HAZ) metal and welded joint metal with thickness of 40 mm and more it is permitted to apply square cross-section specimens for threepoint bending *t* x *t*.

2.2.10.5.4 Equipment, jigs and fixtures, instrumentation.

2.2.10.5.4.1 In general the equipment, jigs and fixtures, as well as measuring apparatus shall meet the requirements of the standards and these Rules and shall be periodically checked and calibrated by authorized national bodies.

2.2.10.5.4.2 Hydraulic servomotor-operated or electromechanical machines with the upper limit of operating load range between 100 and 3000 kN capable of applying force at rates specified by 2.2.10.5.1 and force measuring error not exceeding ± 0,1 % of the operating range upper limit, shall be employed as the machines for testing. The systems for measuring of applied forces and recording of the results shall allow the applied force to be recorded against notch edges opening.

2.2.10.5.4.3 The jigs and fixtures for three-point bend tests shall allow the support rollers to rotate and move apart slightly, thus maintaining rolling contact throughout the test. The roller diameter shall be from 0,5 to 1,0 of the specimen height.

2.2.10.5.4.4 The arrangements for loading of compact specimens (clevis and pin) shall permit alignment as the specimen is loaded, for which purpose the gap between the specimen and clevis inner surfaces shall be increased to 0,5 to 1,0 mm and shall prevent pins jamming during the specimen plastic deformation.

2.2.10.5.4.5 The error in test temperature measurement shall not exceed ± 1,5 °C. The temperature shall be measured by thermoelectric temperature transducers provided with secondary measuring devices complying with the accuracy grade not lower than 0,5.

2.2.10.5.4.6 The crack edges opening is measured by means of displacement gauges with base length of 5,0 to 12,5 mm, with measuring range from ±10 % to ±50 % counting from the base. If the above are employed, the displacement measuring error shall not exceed ± 1,5 % from the upper boundary of the operating range.

2.2.10.5.4.7 The displacement gauges shall be subjected to a calibration check before starting a new series of measurements of identical specimens. It is especially important for low temperature testing. If a gauge is properly isolated from the specimen, the calibration may be done at room temperature.

The calibration error shall not exceed 0,003 mm.

2.2.10.5.5 Validity conditions of received *CTOD* values.

2.2.10.5.5.1 The geometrical dimensions of specimens shall be within the standard tolerances.

2.2.10.5.5.2 The crack length/specimen height ratio shall be within the range from 0,45 to 0,55 for all types of specimens.

2.2.10.5.5.3 The fatigue crack extent shall make at least: 1,3 mm or 2,5 % of the specimen height whichever is greater.

2.2.10.5.5.4 The difference between any two measurements of the initial fatigue crack length shall not exceed 10 % of the crack length mean value for the above measurements. When making the measurements in the heat affected zone, the tolerance may be increased to 20 %.

N o t e . The length of initial fatigue crack is measured at nine equally-separated points where extreme points are located at the distance of 0,01*t* from lateral surfaces of the specimen in the place of maximum reduction after testing.

2.2.10.5.5.5 When testing the metal of heat-affected zone, it is considered sufficient if the initial fatigue crack front contains a specified microstructure portion with the length equal to 15 % within average three quarters of the specimen thickness.

2.2.10.5.6 Determination of the *CTOD* test result.

2.2.10.5.6.1 The *CTOD* value of base metal and weld metal for this temperature shall be determined as the mean value of the test results under the following conditions:

when obtaining three-four correct test results, none of the obtained results shall be equal to less than 70 % of the mean value for the base metal and less than 50 % for the weld metal.

When obtaining five and more correct test results, the lowest result may be discarded. Other results shall not be less than 70 % of the mean value for the base metal and less than 50 % for the weld metal.

Where the above conditions are not complied with, the minimum recorded value of this parameter shall be taken as *CTOD* value.

2.2.10.5.6.2 Non-stable failure of specimen is full or partial destruction (crack overshoot) of the specimen, at which falling of load is recorded, as well as non-controlled rising of displacements by more than 1%.".

4 **Para 2.2.10.6** is deleted.

3 STEEL AND CAST IRON

5 **Para 3.2.9** is replaced by the following text:

"**3.2.9 Marking and documentation.**

3.2.9.1 Identification, marking and issued documentation — in accordance with the requirements of 1.4.

3.2.9.2 Every plate and strip semi-finished product shall have clearly visible brand of the Register marked by the specified method and in specified location.

3.2.9.2.1 The marking shall include the unified indication mark for grade of steel and strength level (e.g., A, B36, E550).

3.2.9.2.2 When required by the Register or the customer, material shall have index indicating the condition of supply (e.g. E36TM, E690QT).

3.2.9.2.3 The steel, supplied under the Register technical supervision may have index "PC" before the unified identification mark for grade of steel and strength level (e.g., PCE36TM).

3.2.9.2.4 Steel complying with the requirements of 3.5.3 for ductility and cold resistance shall have an index "Arc" with the value of design temperature of the material without the minus symbol (for example, PCF36Arc40, PCD500Arc30) after the unified identification mark for grade of steel and strength level.

3.2.9.2.5 Steel complying with the requirements of 3.14 shall have an index "Z" with relevant level value of Z-properties added to unified identification mark for grade of steel and strength level (PCD40Z35).

3.2.9.2.6 Steel complying with the requirements of 2.2.3, 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 shall have index "W" after the unified identification mark for grade of steel and strength level. A reference note of the maximum heat output used in the production of test specimens may be added after the indicated index (for example, PCF500W, PCD460W300).

3.2.9.2.7 In case of the Register approved supply of steel, which does not fully comply with the requirements of the Rules (refer to 3.2.1.1) for chemical composition, index "S" may be added after the identification mark for grade of steel and strength level (e.g., PCE368TM or PCB368).".

6 **Paras 3.5.1.1** and **3.5.1.2** are replaced by the following text:

"**3.5.1.1** The present requirements apply to the following materials used in structures and machinery of ships and MODU/FOP:

Grade F higher strength steel plates, strips, sections and bars;

steel plates, strip, sections and bars of higher and high strength with index "Arc";

forgings and castings used at operating temperatures –30 °C and lower.

3.5.1.2 The general requirements for rolled products depending on the strength level specified and operation conditions including manufacture, inspection, identification, marking and documentation for rolled products, are given in 3.2, 3.13, 3.14 and 3.17.

The general requirements for manufacture, inspection, identification, marking and documentation for forgings and castings are specified in 3.7 and 3.8 accordingly.

Additional requirements for Grade F steel rolled products of higher strength are given in 3.5.2.

Additional requirements for steels with index "Arc" are given in 3.5.3.

Additional requirements for rolled products with thickness of 15 mm and less are given in 3.5.4.

Additional requirements for forgings and castings operated at design temperature –30 °C are given in 3.5.5 and 3.5.6, accordingly.".

7 **Paras 3.5.1.6, — 3.5.1.8** are replaced by the following text:

"**3.5.1.6** Steel rolled products in plates, strips, sections, as well as steel forgings and castings for hull structural members, equipment and machinery subjected to long-term exposure to low temperatures are selected with due regard for the set value of the structure design temperature and/or the structural member category.

3.5.1.7 For manufacture of hull structural members of ships and MODU/FOP, with thicknesses beyond the scope of those specified by the Rules, as well as members subjected to long-term exposure to low temperatures and multi-cycle loads it is recommended to apply steel with index "Arc" complying with the requirements of 3.5.3 with T_d meeting the design temperature of structural member T_D.

3.5.1.8 Steel is tested in accordance with the requirements of Section 2 with the use of the Register approved programs.".

8 **Para 3.5.1.9** is deleted.

9 **Para 3.5.2** is replaced by the following text:

"**3.5.2 Hull structural Grade F higher strength steel.**

3.5.2.1 General.

The present requirements apply to Grade F higher strength steel plates, strips, sections and bars.

In cases specified in other parts of the Rules for Grade F steel rolled products of higher strength, additional requirements may be applied.

The general requirements for Grade F higher strength steel are given in 3.13.

3.5.2.2 The rate of plastic deformation in rolling shall be 5:1 as a minimum.

3.5.2.3 Chemical composition and structure.

The content of chemical elements in the composition shall not extend beyond the extreme values given in Table 3.5.2.3. The steel shall be fully killed and treated with grain-refining elements.

3.5.2.3.1 The following microstructure parameters shall comply with the following requirements:

.1 for higher strength steels with ferrite-pearlite structure

.1.1 the grain size shall not be larger than 8 in accordance with GOST 5639-82;

.1.2 ferrite/pearlite banding shall be no more than size 2 in accordance with GOST 5640-68 (scale 3, row A);

.2 for higher strength steels with ferrite-bainite structure:

.2.1 the ferrite grain size shall not be larger than 9 in accordance with GOST 5639-82;

.2.2 structure anisotropy factor shall not be more than 1;

.2.3 the portion and size of bainite areas with lath morphology shall also be determined;

.3 for strengthened bainite-martensite steels the austenite grain size shall not be larger than 6 in accordance with GOST 5639-82.

Structure assessment criteria shall comply with the above standards or shall be equivalent to them (for example, ASTM E112-13).

3.5.2.4 Mechanical properties.

The mechanical properties of Grades F32, F36 and F40 steels during tensile test and impact test shall meet the requirements of Table 3.5.2.4. Additionally to the requirements of 3.2.5, tests for determining impact energy in the specimens cut out from the plate midthickness are carried out for steel over 40 mm thick. In this case the test results shall also meet the requirements of Table 3.5.2.4.

3.5.2.5 Condition of supply.

Condition of steel supply for Grades F32, F36 and F40 – according to the requirements of Table 3.2.6.4.

Table 3.5.2.3

Chemical composition of hull structural steel

Steel grade	Content of elements, %													
	C	Mn	Si	P	S	Al, (acidsoluble), min	Nb	V	Ti	Cu	Cr	Ni	Mo	N
	max		max						max					
F32	0,16	0,90 – 1,60	0,50	0,025	0,025	0,015	0,02 – 0,05	0,05 – 0,10	0,02	0,35	0,20	0,80	0,08	0,009
F36	0,16	0,90 – 1,60	0,50	0,025	0,025	0,015	0,02 – 0,05	0,05 – 0,10	0,02	0,35	0,20	0,80	0,08	(0,012 – if Al
F40	0,16	0,90 – 1,60	0,50	0,025	0,025	0,015	0,02 – 0,05	0,05 – 0,10	0,02	0,35	0,20	0,80	0,08	is present)
							Total content 0,12 % max							
Note . Refer to Notes 1 — 7 in Table 3.2.2-2.														

Table 3.5.2.4

Mechanical properties of F grade higher strength steel

Grade	Yield stress *ReH*,, min, MPs	Tensile strength *Rm*, MPa	Elongation *A*5, min, %	Impact test						
				Test temperature, °C	Average impact energy value *KV*, min, J					
					t ≤ 50 mm		50 < t ≤ 70 mm		70 <t mm	
					KVL	*KVT*	*KVL*	*KVT*	*KVL*	*KVT*
F32	315	440 – 570	22	–60	31	22	38	26	46	31
F36	355	490 – 630	21	–60	34	24	41	27	50	34
F40	390	510 – 660	20	–60	39	26	46	31	55	37
Note. Refer to Notes 8 and 9 in Table 3.2.2-2.										

".

10 **Paras 3.5.3** and **3.5.4** are replaced by the following text:

"**3.5.3 Hull structural steel with index "Arc".**

3.5.3.1 General.

3.5.3.1.1 "Arc" is the symbol added to the designation of steel grade for which additional tests were performed according to the Register programs to determine ductility and cold resistance properties (refer to 2.2.10, 3.5.3.3 to 3.5.3.6) meeting the relevant requirements for Z-properties not less than 35 % according to the requirements of 3.14. The minimum material service/operating temperature T_d (without the minus symbol) down to which the steel may be used for any structural members without limitations shall be indicated next to the symbol.

3.5.3.1.2 The rate of plastic deformation in rolling shall be 5:1 as a minimum.

3.5.3.2 Chemical composition and structure.

3.5.3.2.1 The chemical composition of higher strength steel marked with index "Arc" shall meet the relevant requirements of Table 3.5.3.2.1. Unless otherwise specified, chemical composition of high strength steel with index "Arc" shall comply with the requirements in Table 3.13.3.1. For higher strength steels, deviations in the content of individual chemical elements are allowed, including carbon equivalent C_{eq} and crack resistance parameter P_{cm} specified by the necessity to meet the requirements for cold resistance.

Table 3.5.3.2.1

Chemical composition of higher strength steel with index "Arc"

Grade	PCA32Arc PCD32Arc PCE32Arc PCF32Arc	PCA36Arc PCD36Arc PCE36Arc PCF36Arc	PCA40Arc PCD40Arc PCE40Arc PCF40Arc
Deoxidation	Killed, fine grain treated		
C max	0,12		
Si max	0,50		
Mn	0,60-1,60		
P max	0,015		
S max	0,008		
Cu max	0,35		
Cr max	–		
Ni max	0,40 (0,80 – for F Grade steel)		
Mo max	0,08		
$Al_{ac..sol}$, max	0,055		
Al_{total}, max	0,06		
Nb max	0,05		
V max	0,10		
Ti max	0,05		
N max	0,009		
Sn max	0,02		
Sb max	0,10		
Pb max	0,005		
As max	0,02		
Bi max	0,005		
B max	0,0005		
P_{cm}* max	0,22 for low-carbon and manganese steels		
$P_{cm} = C + \frac{Si}{30} + \frac{Mn + Cu + Cr}{20} + \frac{Ni}{60} + \frac{Mo}{15} + \frac{V}{10} + 5 \cdot B$			

3.5.3.2.2 The higher strength steel shall be killed and fine grain treated. Vacuum degassing shall be applied during manufacture of higher strength steel. In steel with index "Arc" the carbon content shall not exceed 0,12 %, sulphur content shall not exceed 0,005 %, the phosphorus content — 0,010 %, the nitrogen content — 0,008 %, the oxygen content — 30 ppm, the hydrogen content — 2,5 ppm. The nitrogen content may be up to 0,012 % provided that Al/N < 2. Where the nitrogen content is in the range from 0,009 up to 0,012 inclusive, the additional ageing tests shall be carried out.

3.5.3.2.3 In thermo-mechanically rolled (TM) and controlled rolled (CR) stock of higher and high strength steels of 420, 460 and 500 grades, the carbon content may be reduced to 0,05 %, therewith, the carbon content may be 0,10 % maximum.

3.5.3.2.4 Structure condition shall comply with the requirements of 3.5.2.3.1.

3.5.3.3 Mechanical properties

3.5.3.3.1 The mechanical properties of steel shall comply with the requirements for the steel of a relevant grade according to 3.2, 3.5.2 and 3.13 for relevant strength level and 3.14 for level of Z-properties of 35 %. Value of impact energy during impact tests shall comply with the requirements of Table 3.5.3.3.1.

Table 3.5.3.3.1

Values of impact energy for higher and high strength steels with index "Arc" at impact test

Grade	Impact test temperature, °C	Mean value of impact energy, KV_T, J, min	Impact energy, KV_T, J, per one specimen, min
PCA32Arc PCD32Arc PCE32Arc PCF32Arc	0 –20 –40 –60	50	35
PCA36Arc PCD36Arc PCE36Arc PCF36Arc	0 –20 –40 –60	50	35
PCA40Arc PCD40Arc PCE40Arc PCF40Arc	0 –20 –40 –60	50	35
PCA420Arc PCD420Arc PCE420Arc PCF420Arc	0 –20 –40 –60	80	56
PCA500Arc PCD500Arc PCE500Arc PCF500Arc	0 –20 –40 –60		
PCA550Arc PCD550Arc PCE550Arc PCF550Arc	0 –20 –40 –60		
PCA620Arc PCD620Arc PCE620Arc PCF620Arc	0 –20 –40 –60		
PCA690Arc PCD690Arc PCE690Arc PCF690Arc	0 –20 –40 –60		

In this case, the test program during the initial survey of manufacture by the Register in accordance with 1.3.1.2 in order to determine the possibility of adding index "Arc" to a steel grade includes the following:

.1 determining the temperature of a ductile-brittle transition to estimate the material property with regard to retarding the spread of brittle failure (T_{kb}, *NDT*, *DWTT*):

tests for determining the temperature T_{kb} are carried out according to 2.2.10.2 for rolled plates with thickness of 10 mm and more;

tests for determining the temperature *NDT* are carried out according to 2.2.10.3 for rolled plates with thickness of 16 mm and more;

tests for determining the temperature *DWTT* are carried out according to 2.2.10.4 for rolled plates with thickness between 10 mm and 40 mm;

.2 determining the crack resistance parameter *CTOD* for the base metal and HAZ metal in testing the specimens cut from butt-welded joints in accordance with 2.2.10.5 for rolled plates with thickness of 16 mm and more.

Tests of steel with index "Arc" to determine T_d temperature, as a rule, are carried out in the temperature interval including T_D temperature. The value of T_d is determined with 10 °C interval.

Where one procedure for steel manufacture is concerned (smelting, rolling, condition of supply), the results of the above tests obtained with the thickest rolled products may be extended to the rolling products with thicknesses smaller by 40 %, of all lower grades and strength levels where chemical composition, production technology and technology of thermal processing are identical to the tested material. At that, if, according to the calculations, the spread reaches the thickness of 15 mm and less, the minimum thickness approved by the Register shall exceed 15 mm.

3.5.3.3.2 The average value of *CTOD* for base metal shall be not less than that specified in Table 3.5.3.3.2 with the minimum value at least 0,7 of the required one. Tests are carried out in accordance with the requirements of Section 2 by RS-approved programs.

The lowest test temperature at which requirements specified in Table 3.5.3.3.2 are met, is assumed to be the minimum temperature $T_{d(CTODbm)}$ for the given type of tests.

Table 3.5.3.3.2

Requirements for *CTOD* value for base metal with index "Arc", mm

Thickness, mm, max.	Strength level (required minimum value of yield stress, MPa)									
	normal	315	355	390	420	460	500	550	620	690
20	–	0,10	0,10	0,10	0,10	0,15	0,15	0,15	0,20[1]	0,20[1]
30	–	0,15	0,15	0,15	0,15	0,20	0,20	0,20	0,20[1]	0,25[1]
40	0,10	0,15	0,15	0,20	0,20	0,20	0,20	0,25	0,25[1]	0,30[1]
50	0,15	0,20	0,20	0,20	0,20	0,25	0,25	0,25[1]	0,25[1]	0,30[1]
70	0,20	0,20	0,20	0,25	0,25	0,30	0,30	0,30[1]	0,30[1]	0,35[1]
80	0,20	0,25	0,25	0,25	0,30	0,30	0,30	0,30[1]	0,35[1]	0,35[1]
100	0,25	0,25	0,25	0,30	0,30	0,35	0,35	0,35[1]	0,40[1]	0,40[1]

[1] The test result is also considered satisfactory, if prior to non-stable brittle fracture for all tested specimens the maximum load has been obtained irrespective of obtained value δ_m, refer to 2.2.10.5.1.1

3.5.3.3.3 The average value of *CTOD* for the HAZ metal shall be not less than that required by Table 3.5.3.3.3 with the minimum value at least 0,5 of the required one. If the number of correct tests is increased up to five and more, the lowest result may be ignored.

Table 3.5.3.3.3

Requirements for CTOD value for HAZ metal, mm

Thickness, mm, max.	Strength level (required minimum value of yield stress, MPa)									
	normal	315	355	390	420	460	500	550	620	690
20	–	0,10	0,10	0,10	0,10	0,10	0,15	0,15	0,15[1]	0,20[1]
30	–	0,10	0,10	0,10	0,15	0,15	0,15	0,15	0,20[1]	0,20[1]
40	0,10	0,10	0,10	0,15	0,15	0,15	0,15	0,15	0,20[1]	0,20[1]
50	0,10	0,10	0,10	0,15	0,15	0,15	0,15	0,20[1]	0,20[1]	0,25[1]
70	0,10	0,15	0,15	0,15	0,20	0,20	0,20	0,25[1]	0,25[1]	0,30[1]
80	0,15	0,15	0,15	0,20	0,20	0,20	0,25	0,25[1]	0,30[1]	0,30[1]
100	0,15	0,15	0,20	0,20	0,20	0,25	0,25	0,30[1]	0,35[1]	0,35[1]

[1] The test result is also considered satisfactory, if prior to non-stable brittle fracture for all tested specimens the maximum load has been obtained irrespective of obtained value δ_m, refer to 2.2.10.5.1.1.

The lowest test temperature at which the Table 3.5.3.3.3 requirements are met, is assumed to be the minimum temperature $Td_{(CTODhaz)}$ for the given type of tests.

3.5.3.3.4 Based on the results of *NDT*, T_{kb} and *DWTT* the design material temperatures ($T_{d(NDT)}$, $T_{d(Tkb)}$, $T_{d(DWTT)}$) for each test type are determined, the greatest of all the values is $T_{d(b\text{-}d)}$, assumed to be the ductile-brittle transition temperature of the sampling steel. Depending on the rolled products thickness the required temperature values $T_{d(NDT)}$, $T_{d(Tkb)}$, $T_{d(DWTT)}$ for the steel marked with index "Arc" are given in Table 3.5.3.3.4.

Table 3.5.3.3.4

Determination of temperatures $T_{d(NDT)}$, $T_{d(Tkb)}$, $T_{d(DWTT)}$

Rolled product thickness, mm	$T_{d(NDT)}$, °C	$T_{d(Tkb)}$, °C	$T_{d(DWTT)}$, °C
From 10 up to 15 incl.	–	T_{kb}	*DWTT*
Over 15 up to 25 incl.	*NDT*	T_{kb}	*DWTT*
Over 25 up to 30 incl.	*NDT* + 15	T_{kb}	*DWTT*
Over 30 up to 40 incl.	*NDT* + 20	$T_{kb} - 15$	*DWTT* – 10
Over 40 up to 50 incl.	*NDT* + 25	$T_{kb} - 25$	—
Over 50 up to 60 incl.	*NDT* + 30	$T_{kb} - 30$	—
Over 60	*NDT* + 30	[1]	—

[1] Provided in addition to: $T_{kb} < 0{,}5T_{d(NDT)} + 15$.
Note. Additional condition means $T_{kb} \leq -5°$ for Arc40, and $T_{kb} \leq -15°$ for Arc60.

For the metal thickness of 40 mm and more, in case the difference between *NDT* and T_{kb} temperatures is over 50 °C, to control discontinuity of the material properties on resistance to brittle fracture, *NDT* specimens cut out from the mid-thickness of rolled products may be additionally tested in accordance with 2.2.10.3. *NDT* obtained during the test may be considered as a replacement of temperature $T_{d(Tkb)}$. It is possible to determine $T_{d(b\text{-}d)}$ based on one or two ductile-brittle transition temperatures determined: $T_{d(NDT)}$, $T_{d(Tkb)}$ or $T_{d(DWTT)}$.

3.5.3.3.5 In all types of tests the greatest value shall be accepted as the minimum operating material temperature T_d, up to which the steel in question may be used for all the structural members without limitations:

$$T_d = \max\left(T_{d(CTODbm)}, T_{d(CTODhaz)}, T_{d(b-d)}\right).".$$

3.5.4 Requirements for rolled plates with thickness of 15 mm and less.

Manufacture and supply of steel rolled products designed for operation at low temperatures having thickness between 6 and 15 mm inclusive, is not allowed without mechanical tests. Mechanical tests shall mandatory include impact bending tests (*KV*) at a temperature not exceeding T_d on test specimens in compliance with 2.2.3.1.

For the rolled products with strength class of 460 MPa and above, additional tests results shall be submitted (refer to 2.2.10). Procedures, criteria and scope of these tests shall be agreed with the Register in advance. Besides, if the above special tests were not performed, special standards shall be specified for the impact energy of the base metal and welded joint metal (refer to Table 3.5.4) at a temperature not exceeding T_D. The impact energy may be reduced to 70 % of the required value for one of the three test specimens. For the rolled products with thickness of less than 10 mm, the required impact energy shall be determined by Formula (2.2.3.1.1).

Table 3.5.4

The impact energy standards for the rolled plates and welded joints with thickness of up to 15 mm at a temperature not exceeding T_d for the ships of ice class and icebreakers in absence of the special tests

Minimum yield stress in MPa	Minimum average value for three test pieces	
	Rolled product thickness up to 10 mm	Rolled product thickness above 10 to 15 mm inclusive
460	46 *L*, 31 *T*	60 *L*, 40 *T*
500	50 *L*, 33 *T*	68 *L*, 45 *T*
550	55 *L*, 37 *T*	83 *L*, 55 *T*
620	70 *L*, 46 *T*	98 *L*, 65 *T*
690	86 *L*, 57 *T*	120 *L*, 80 *T*

".

11 Requirements of the **existing paras 3.5.3** and **3.5.4** are transferred to the **new paras 3.5.5** and **3.5.6**, accordingly.

12 **Existing para 3.5.5** is replaced by the following text:

"**3.5.7 Welding.**

3.5.7.1 Technological requirements for the processes of welded structures manufacture, welded joints testing and for welding consumables shall be in compliance with Part XIV "Welding".

3.5.7.2 The grades of welding consumables for welding structures of normal, higher and high strength steels are chosen in compliance with 2.2, Part XIV "Welding" of these Rules and/or 2.5, Part XIII "Welding" of the Rules for the Classification, Construction and Equipment of MODU/FOP.".

13 **Para 3.13.1** is replaced by the following text:

"**3.13.1 General.**

The present requirements apply to hot-rolled, fine-grain, weldable plates and wide flats of high strength steel subject to the survey by the Register during manufacture and intended for use in sea-going ships and in MODU/FOP.

Proceeding from the minimum yield stress guaranteed the steel is divided into eight strength levels: 420, 460, 500, 550, 620, 690, 890 and 960 MPa. For each yield strength level grades A, D, E and F are conventionally specified, based on the impact test temperature, except for yield strength level of 890 and 960 MPa for which grade F is not applicable.

The requirements for the hot-rolled products with thickness of 15 mm or less designed for operation at low temperatures are specified in 3.5.4. High strength steel is manufactured at works recognized according to 1.3.1.2.

The attention of the consumers shall be drawn to the fact that when material fatigue loading is present, the effective fatigue strength of a welded joint of high strength steel may not be greater than that of a welded joint in normal strength steels.

Before subjecting steels produced by thermomechanical rolling to further heating for forming or stress relieving, or using high heat-input welding, special consideration shall be given to the possibility of a consequent reduction in mechanical properties.".

14 **Para 3.13.7**. The text of the para is replaced by the following text:

"**3.13.7 Mechanical properties.**

Requirements for the tensile strength and impact energy of high strength steel rolled product are given in Tables 3.13.7-1 and 3.13.7-2.

Where rolled products of other shapes (sections, construction pipes, etc.) are tested, the elongation required for longitudinal specimens shall exceed that stated in Tables 3.13.7-1 and 3.13.7-2 by 2 %.".

15 **Para 3.17.1.3** is replaced by the following text:

"**3.17.1.3** Hull structural rolled products of B to F Grades with a yield stress from 235 MPa to 690 MPa shall be used as base material of clad steel in accordance with the requirements of 3.2, 3.5, 3.13 and 3.14. The steel shall be selected in compliance with the structure function (refer to 1.2, Part II "Hull" of these Rules and 1.5, Part II "Hull" of the Rules for the Classification, Construction and Equipment of MODU/FOP) reasoning from the design service temperature of the material T_D, the function of a structural member (special or primary), the base material thickness, requirements for Z-properties and loading conditions.

In cases not specified in Table 1.5.1.2, Part II "Hull" of the Rules for the Classification, Construction and Equipment of MODU/FOP the selection of the base material steel grade shall meet the requirements of 3.5 for steel with index "Arc". The base metal shall be over 10 mm thick.

Austenitic or austenitic-ferritic stainless steels (classes A and AF) having a chemical composition and properties meeting the requirements of 3.16 shall be used as the cladding metal.

The use of other classes of corrosion-resistant materials as the cladding metal shall be approved by the customer and shall be the responsibility of the manufacturer. The nominal thickness of the cladding metal shall be not less than 2 mm.

The cladding metal shall be chosen considering the operational conditions.".

16 **Para 3.17.4.1**. Text of the para (up to **3.17.4.1.1**) is replaced by the following text:

"**3.17.4.1** The scope of testing at the initial survey of the manufacturer shall be determined by the program developed in compliance with the requirements of 2.2.1.3.1, 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. The program shall be approved by the Register.

The following types of tests shall additionally be carried out:

tensile test on the full thickness clad plate test specimen;

bend test on the clad test specimens;

shear test on the cladding metal;

resistance of the cladding metal against intergranular corrosion where such test has not been carried out on the initial material;

test for determining the base material Z-properties where such test has not been carried out on the initial material;

test for determining the base material cold and crack resistance of the base layer where such tests have not been carried out on the initial material.".

17 **Para 3.17.4.1.6** is replaced by the following text:

"**3.17.4.1.6** The crack and cold resistance of the base material shall be defined in tests by procedures given in 2.2.10.

Test criteria are given in 3.5.3.3.5.".

18 **Paras 3.17.4.1.7 — 3.17.4.1.11** are deleted.

19 **Para 3.17.4.1.12** is replaced by the following text:

"**3.17.4.1.7** Tests of welded joints for resistance against intergranular corrosion.

3.17.4.1.7.1 Welded joints of clad steel shall be subject to intergranular corrosion test in accordance with 6.7.3.7, 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.

3.17.4.1.7.2 The welded joint resistance against intergranular corrosion shall be checked for each welding process for each batch of clad plates which have the cladding from one batch and made in a similar manner.

3.17.4.1.7.3 The procedure for testing welded joints for the resistance against intergranular corrosion shall be previously agreed with the Register and shall meet the requirements of Section 2.".