RUSSIAN MARITIME REGISTER OF SHIPPING

HEAD OFFICE

CIRCULAR LETTER **№ 314-53-708 с** dated 27.12.2013 г.

Re: IACS Unified Requirement (UR) S33 (Jan 2013)
"Requirements for Use of Extremely Thick Steel Plates".

Item of technical supervision:

Extremely thick steel plates used for construction of container ships

Implementation since	01.01.2014
Valid: until	ND re-publication
Validity period extended till	.
Cancels/amends/adds Circular Letter №	- dated -
Number of pages:	1+9
Appendices:	Amendments to the Rules – 9 pages

Director of Classification Directorate V.I. Evenko

Amends Rules for the Classification and Construction of Sea-Going Ships, ND No. 2-020101-077

We hereby inform you that IACS Unified Requirement (UR) IACS S33 (Jan 2013) "Requirements for Use of Extremely Thick Steel Plates" comes into force since 1 January 2014. UR specifies requirements for extremely thick steel plates used for construction of container ships.

In view of the above, the amendments given in the Appendix to the Circular Letter shall be introduced into the Rules for the Classification and Construction of Sea-Going Ships, ND No. 2-020101-077.

It is necessary to do the following:

1. Apply the amendments to the RS Rules given in the Appendix to the Circular Letter.
2. 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.

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DMS "THESIS": 13-244025 26.11.2013

APPENDIX to Circular Letter No.
№ 314-53- 708c of 27.12.2013г.

Amendments to be introduced to the Rules for the Classification and Construction of Sea-Going Ships (2014)

PART XIII. MATERIALS

Section 3 shall be supplemented with the following text:

"3.20 REQUIREMENTS FOR USE OF EXTREMELY THICK STEEL PLATES

3.20.1 Scope of application.

3.20.1.1 General.

3.19.1.1.1 These requirements apply to the container carriers incorporating extremely thick steel plates in accordance with 3.20.1.2 and 3.20.1.3.

3.20.1.1.2 This section gives measures for identification and prevention of brittle fractures of container carriers to which extremely thick steel plates are applied for longitudinal structural members.

3.20.1.1.3 The application of the measures specified in 3.20.2 – 3.20.4 shall comply with 3.20.5.

3.20.1.1.4 Brittle fracture toughness of welded joints shall comply with 2.4, 3.19, Part XIV "Welding" and requirements of the present Chapter.

3.20.1.2 Steel grade.

3.20.1.2.1 These requirements apply to the container carriers, to which any of YP36, YP40 and YP47 steel plates having the thickness specified in 3.20.1.3 are used for the longitudinal structure members.

3.20.1.2.2 Steel designations used herein: YP36, YP40 and YP47 mean the steel plates having the minimum specified yield points of 355, 390 and 460 N/mm^2, respectively.

3.20.1.3 Thickness.

3.20.1.3.1 These requirements apply to the steel plates with thickness of over 50 mm and not greater than 100 mm.

3.20.1.3.2 For steel plates with thickness exceeding 100 mm, appropriate measures for prevention of brittle crack initiation and propagation shall be subject to the special consideration by the Register.

3.20.2 Non-destructive testing (NDT) during construction (№ 1, 30.2.5).

Where NDT during construction is required in 3.20.5, the NDT shall be in accordance with 3.20.2.1 and 3.20.2.2. Enhanced NDT as specified in 3.20.4.3.1.2.4 shall be carried out in compliance with the documents approved by the Register and recognized standards.

3.20.2.1 General.

3.20.2.1.1 Ultrasonic testing (UT) in compliance with Section 3, Part XIV "Welding" shall be carried out on all block-to-block butt joints of all upper flange longitudinal structural members in the cargo hold region, including include the topmost strakes of the inner hull/bulkhead, the sheer strake, main deck, coam-

ing plate, coaming top plate, and all attached longitudinal stiffeners (refer to Fig. 3.20.2.1).

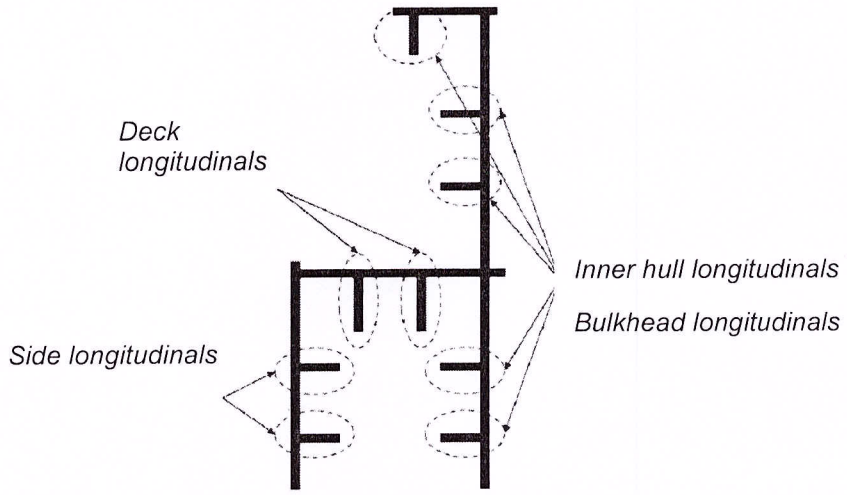

Fig. 3.20.2.1 Upper flange longitudinal structural members

3.20.2.2 Acceptance criteria of UT.

3.20.2.2.1 Acceptance criteria of UT shall be in compliance with Section 3, Part XIV "Welding" documentation approved by the Register and/or recognized standards.

3.20.2.2.2 The acceptance criteria may be adjusted under consideration of the appertaining brittle crack initiation prevention procedure, and where this is more severe than that found in the Rules and standards to be amended accordingly to a more severe sensitivity.

3.20.3 Periodic NDT after delivery (№ 2, 30.2.5).

Where periodic NDT after delivery is required, the NDT shall be in accordance with 3.20.3.1 – 3.20.3.3.

3.20.3.1 General.

3.20.3.1.1 The procedure of the NDT shall be in accordance with 3.2 and the documentation approved with the Register for the steel supply.

3.20.3.2 Timing of UT.

3.20.3.2.1 Where UT is carried out, the frequency of survey shall be in compliance with the Register requirements.

3.20.4 Brittle crack stopping design (No.3, 4 and 5 of 30.2.5).

3.20.4.1 General.

3.20.4.1.1 Measures for prevention of brittle crack propagation, which is the same meaning as brittle crack arrest design, are to be taken within the cargo hold region.

3.20.4.1.2 It shall be noted that cracks can initiate and propagate away from such joints, therefore, appropriate measures shall be considered in accordance with 3.20.4.2.1.2.2.

3.20.4.1.3 Brittle crack stopping steel is defined as steel plate with measured crack stopping properties K_{ca} at $-10\ °C \geq 6{,}000\ N/mm^{3/2}$. Where the thickness of the steel exceeds 80 mm, the required K_{ca} value shall be subject to special consideration by the Register.

Brittle crack stopping steel parameters, as well as the appropriate methods to determine shall be agreed

with the Register (e.g. T_{kb} not exceeding – 10 °C). The tests shall be carried out in a laboratory recognized by the Register.

3.20.4.2 Functional requirements of brittle crack stopping design.

3.20.4.2.1 The purpose of the brittle crack stopping design is aimed at arresting propagation of a crack at a proper position and to prevent large scale fracture of the hull girder:

.1 the point of a brittle crack initiation shall be considered in the block-to-block butt joints both of hatch side coamings and upper deck;

.2 the following cases shall be considered:

.2.1 where the brittle crack runs straight along the butt joint;

.2.2 where the brittle crack initiates or deviates away from the butt joint and runs into base metal.

3.20.4.3 Concept examples of brittle crack stopping design.

3.20.4.3.1 The following are considered to be acceptable examples of brittle crack stopping design. Other concept designs shall be subject to special consideration by the Register.

3.20.4.3.1.1 Brittle crack stoppingdesign for 3.20.4.2.12.2:

.1 brittle crack stopping steel shall be used for the upper deck along the cargo hold region in a way suitable to arrest a brittle crack initiating from the coaming and propagating into the structure below.

3.20.4.3.1.2 Brittle crack stopping design for 3.20.4.2.1.2.1:

.1 where the block-to-block butt welds of the hatch side coaming and those of the upper deck are shifted, this shift shall be greater than or equal to 300 mm. Brittle crack stopping steel shall be provided for
the hatch side coaming;

.2 where crack stopping holes are provided in way of the block-to-block butt welds at the region where
hatch side coaming weld meets the deck weld, the fatigue strength of the lower end of the butt weld shall be assessed. Additional countermeasures shall be taken for the possibility that a running brittle crack may deviate from the weld line into upper deck or hatch side coaming. These countermeasures shall include the application of brittle crack stopping steel in hatch side coaming;

.3 where arrest insert plates of brittle crack stopping steel or weld metal inserts with high crack stopping
toughness properties are provided in way of the block-to-block butt welds at the region where hatch side coaming weld meets the deck weld, additional countermeasures shall be taken for the possibility that a running brittle crack may deviate from the weld line into upper deck or hatch side coaming. These cou termeasures shall include the application of brittle crack stopping steel in hatch side coaming;

.4 the application of enhanced NDT particularly time of flight diffraction (TOFD) technique us-ingstricter defect acceptance in lieu of standard UT technique specified in 3.20.2 can be an alternative to 3.20.4.3.1.2.1 – 3.20.4.3.1.2.3.

3.20.5 Measures for extremely thick steel plates.

The thickness and the yield strength shown in Table 3.20.5 apply to the hatch coaming structure steel, and are the controlling parameters for the application of countermeasures.
If the as-built thickness of the hatch coaming structure is below the values given in Table 3.20.5, countermeasures are not necessary regardless of the thickness and yield strength of the upper deck steel.

Table 3.20.5

Tensile strength, N/mm^2	Thickness, mm	Option[1]	Measures			
			1	2	3 + 4	5
36	$50 < t \leq 85$	–	N/A	N/A	N/A	N/A
	$85 < t \leq 100$	–	X	N/A	N/A	N/A
40	$50 < t \leq 85$	–	X	N/A	N/A	N/A
	$85 < t \leq 100$	A	X	N/A	X	X
		B	X[2]	N/A[3]	N/A	X
47 FCAW	$50 < t \leq 100$	A	X	N/A	X	X
		B	X[2]	N/A[3]	N/A	X
47 EGW	$50 < t \leq 100$	–	X	N/A	X	X

[1] Selectable from option A or B.
[2] Refer to 3.20.4.3.4.
[3] Upon agreement with the Register.

Symbol:
X – to be applied.

Measures (to Table 3.20.5):
1. NDT other than visual inspection on all target block joints according to 3.20.2 (during construction).
2. Periodic NDT other than visual inspection on all target block joints according to 3.20.3 (after delivery and during construction).
3. Brittle crack arrest design against straight propagation of brittle crack along weldline (during construction). Refer to 3.20.4.3.1.2.1, 3.20.4.3.1.2.2.
4. Brittle crack arrest design against deviation of brittle crack from weldline (during construction). Refer to 3.20.4.3.1.1.1.
5. Brittle crack arrest design against propagation of cracks from other weld areas such as fillets and attachment welds (during construction). Refer to 3.20.4.3.1.1.1.

3.20.6 Standard ESSO test.

3.20.6.1 Scope of application.

3.20.6.1.1 The ESSO test method is used to estimate the brittle crack stopping toughness value K_{ca} of rolled steel plates for hull of thickness 100 mm or less.

3.20.6.2 Symbols.

Table 3.20.6.2

Symbols used and their meanings

Symbol	Unit	Meaning
t_s	mm	Thickness of test specimen
W_s	mm	Width of test specimen
L_s	mm	Length of test specimen
t_r	mm	Thickness of tab plate
W_r	mm	Width of tab plate
L_r	mm	Length of tab plate
L_p	mm	Distance between pins
a	mm	Length of crack projected on surface normal to the line of load
a_a	mm	Maximum crack length at brittle crack stopping position
T	°C	Temperature of test specimen
dT/da	°C/mm	Temperature gradient of test specimen
σ	N/mm^2	Gross stress in tested part ($load / W_s \cdot t_s$)
K_{ca}	N/mm^2	Brittle crack stopping toughness value

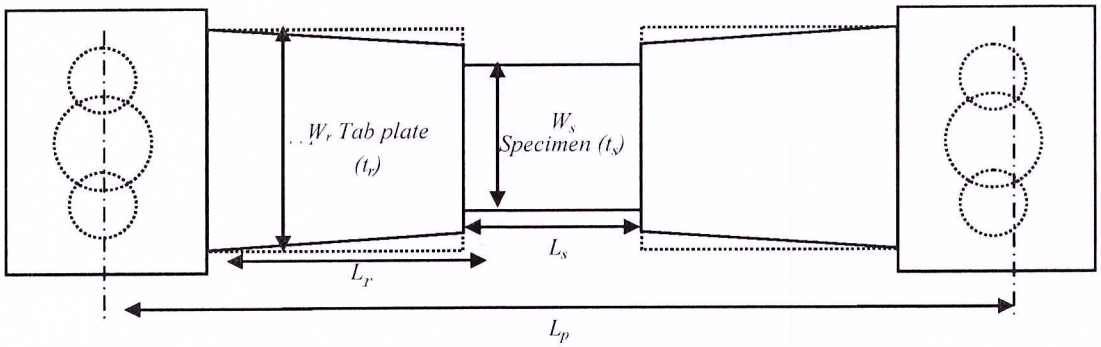

Fig. 3.20.6.2 Conceptual view of test specimen, tab and load jig

3.20.6.3 Purpose.

3.20.6.3.1 The purpose of this test shall encourage the performance of a standard test for assessment of brittle crack stopping toughness with temperature gradient and to obtain the corresponding brittle crack stopping toughness value K_{ca}.

3.20.6.4 Standard test specimen.

3.20.6.4.1 Fig. 3.20.6.4.1 shows the shape and size of the standard test specimen.

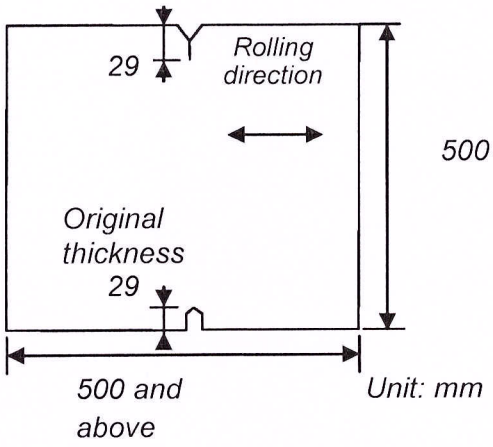

Fig. 3.20.6.4.1 Shape and size of test specimen

3.20.6.4.2 The thickness and width of the test specimen shall be in accordance with Table 3.20.6.4.2.

Table 3.20.6.4.2

Thickness and width of test specimen

Thickness t_s	100 mm and below
Width of test specimen W_s	500 mm
Note. If the width of the test specimen cannot be made at 500 mm, it may be taken as 600 mm.	

3.20.6.4.3 The test specimens shall be taken from the same steel plate.

3.20.6.4.4 Test specimens shall be taken in such a way that the axial direction of the load is parallel to the rolling direction of the steel plate.

3.20.6.4.5 The thickness of the test specimen shall be the same as the thickness of the steel plate to be used in the ship's hull structures.

3.20.6.5 Test equipment.

3.20.6.5.1 The test equipment to be used shall consist of pin load type hydraulic test equipment capable of tensile tests.

3.20.6.5.2 The distance between the pins shall be not less than 2000 mm.

3.20.6.5.3 Drop weight type or air gun type impact equipment may be used for the impact energy required for generating brittle cracks.

3.20.6.5.4 The wedge shall have an angle greater than the upper notch of the test specimen, and an opening force shall be applied on the notch.

3.20.6.6 Test preparation.

3.20.6.6.1 The test piece shall be fixed directly to the pin load jig or by means of weld joint through the tab plate. The overall length of the test specimen and tab plate shall be not less than $3W_s$. The thickness

and width of the tab plate shall be in accordance with Table 3.20.6.6.1.

Table 3.20.6.6.1

Allowable dimensions of tab plate

	Thickness t_r	Width W_r
Dimensions of tab plate	$0{,}8t_s \le t_r \le 1{,}5t_s$	$W_s \le W_r \le 2W_s$
Notes: 1. t_s – thickness of test specimen. 2. If the tab plate has a thickness smaller than the test specimen, the reflection of stress wave will be on the safer side for the assessment; therefore, the minimum value of thickness is taken as $0{,}8t_s$.		

3.20.6.6.2 Thermocouples shall be fitted at 50 mm pitch on the notch extension line of the test specimen.

3.20.6.6.3 If the brittle crack is estimated to deviate from its presumed course, thermocouples shall be fitted at two points separated by 100 mm on the line of load from the notch extension line at the centre of width of the test specimen.

3.20.6.6.4 If dynamic measurements are necessary, strain gauges shall be fitted at specific locations.

3.20.6.6.5 The test specimen shall be fixed to the testing machine together with the tab plate after welding and the pin load jig.

3.20.6.6.6 The impact equipment shall be mounted. The construction of the impact equipment shall be such that the impact energy is correctly transmitted. An appropriate jig shall be arranged to minimize the effect of bending load due to the impact equipment.

3.20.7 Test method.

3.20.6.7.1 To eliminate the effect of residual stress or correct the angular deformation of tab welding, a preload less than the test load may be applied before cooling.

3.20.6.7.2 Cooling and heating may be implemented from one side on the side opposite the side on which the thermocouple is fitted, or from both sides.

3.20.6.7.3 The temperature gradient shall be controlled in the range of 0,25 °C/mm to 0,35 °C/mm in the range of width from $0{,}3W_s$ to $0{,}7W_s$ at the central part of the test specimen.

3.20.6.7.4 When the specific temperature gradient is reached, the temperature shall be maintained for more than 10 min, after which the specified test load shall then be applied.

3.20.6.7.5 After maintaining the test load for at least 30 s, a brittle crack shall be generated by impact. The standard impact energy is taken as 20 to 60 J per 1 mm plate thickness. If the brittle crack initiation characteristics of the base metal are high, and it is difficult to generate a brittle crack, the impact energy may be increased to the upper limit of 120 J per 1 mm plate thickness.

3.20.6.7.6 Loading is stopped when the initiation, propagation, and arrest of brittle crack have been confirmed. Normal temperature is restored, and if necessary, the ligament is broken by gas cutting and forcibly the specimen is broken by using the testing machine. Or, after the ductile crack has been propagated

to an adequate length with the testing machine, the ligament is broken by gas cutting.

3.20.6.7.7 After forcing the fracture, photos of the fractured surface and the propagation route shall be taken, and the crack length shall be measured.

3.20.8 Test results.

3.20.6.8.1 The distance from the top of the test specimen, including the notch to the maximum length in the plate thickness direction of the arrested crack tip, shall be measured. If the crack surface deviates from the surface normal to the line of load of the test specimen, the projected length on the surface normal to the line of load shall be measured. In this case, if the trace of brittle crack arrest is clearly visible on the fractured surface, the first crack arrest position is taken as the stopping crack position.

3.20.6.8.2 From the results of thermocouple measurement, the temperature distribution curve shall be plotted, and the stopping crack temperature shall be measured corresponding to the stopping crack length.

3.20.6.8.3 The brittle crack stopping toughness value K_{ca} of each test shall be determined by using the following formula:

$$K_{ca} = \sigma\sqrt{\pi a}\sqrt{\frac{2Ws}{\pi a}}\tan(\pi a/2Ws).$$

3.20.9 Test report.

3.20.6.9.1 The following items shall be reported:

.1 testing machine specifications; testing machine capacity, distance between pins L_p;

.2 load jig dimensions; tab plate thickness t_r, tab plate width W_r, test specimen length including tab plate $L_s + 2L_r$;

.3 test specimen dimensions; plate thickness t_s; test specimen width W_s and length L_s;

.4 test conditions; preload stress, test stress, temperature distribution (figure or table); impact energy;

.5 test results; crack arrest length a_a, temperature gradient at arrest position, brittle crack stopping toughness K_{ca};

.6 dynamic measurement results (if measurement is carried out); crack growth rate, strain change;

.7 test specimen photos; fracture route, fractured surface.

3.20.6.9.2 If the conditions below are not satisfied, the test results are to be treated as reference values.

.1 the brittle crack stopping position shall be in the range of the hatched part shown in Fig. 3.20.6.9.2.1. In this case, if the brittle crack stopping position is more than 50 mm away from the centre of the test specimen in the longitudinal direction of the test specimen, the temperature of the thermocople at the ±100 mm position shall be within ±3 °C of the thermocouple at the centre;

.2 the brittle crack shall not have a distinct crack bifurcation while it propagates.

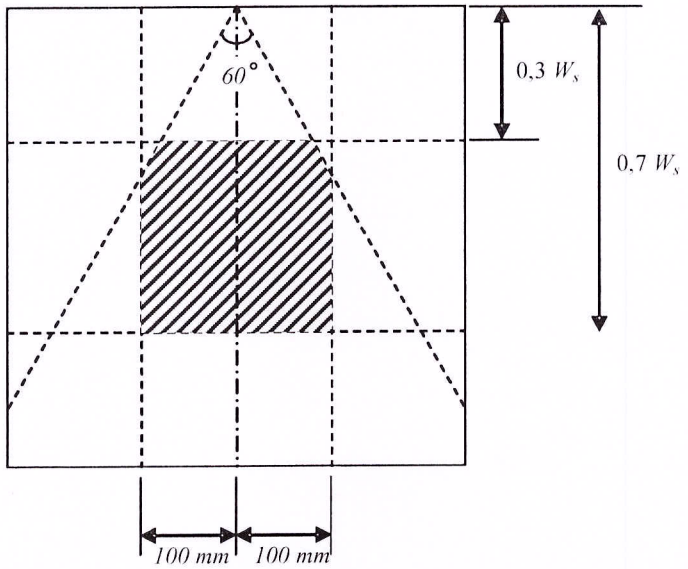

Fig. 3.20.6.9.2.1 Necessary conditions of stopping crack position

3.20.6.9.3 From effective test results measured at more than 3 points, the linear approximation equation shall be determined on the Arrhenius plot, and K_{ca} at the desired temperature shall be calculated. In this case, data shall exist on both sides, that is, the high temperature and low temperature sides around the assessed temperature.".