IACS Common Structural Rules for Double Hull Oil Tankers, January 2006

Background Document

SECTION 12 – SHIP IN OPERATION RENEWAL CRITERIA

NOTE:

- This TB is published to improve the transparency of CSRs and increase the understanding of CSRs in the industry.
- The content of the TB is not to be considered as requirements.
- This TB cannot be used to avoid any requirements in CSRs, and in cases where this TB deviates from the Rules, the Rules have precedence.
- This TB provides the background for the first version (January 2006) of the CSRs, and is not subject to maintenance.

IACS

INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES LTD.

Enquiries should be addressed to the Permanent Secretary,
International Association of Classification Societies Ltd,
36 Broadway
London, SW1H 0BH
Telephone: +44 (0)20 7976 0660
Fax: +44 (0)20 7808 1100
Email: PERMSEC@IACS.ORG.UK

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1 ALLOWABLE THICKNESS DIMINUTION FOR HULL STRUCTURE

1.1 General

1.1.1 Applicability

1.1.1.a An important difference between these Rules and pre-CSR Rules is that the CSR Rules have a clear and direct link between the wastage allowance given during operation of the vessel and the corrosion additions used during newbuilding assessment. The actual wastage allowance numbers reflect this concept and are in addition greater for certain areas than those allowances given in accordance with existing Rules. As a consequence of this, the criteria given in *Section 12 of the Rules* can only be applied to ships that are designed and built in accordance with the CSR Rules.

1.1.2 Wastage allowance concept

1.1.2.a The wastage allowance concept is described in further detail in *Section 2/4.3.4 of the Rules*. Application details for assessment of newbuildings is give in *Section 6/3.3 of the Rules.*

1.1.3 Requirements for documentation

1.1.3.a The renewal thickness and any owner's extra are to be included in the plans to ensure easy and transparent access to the renewal thickness during operation of the vessel.

1.1.3.b With the new net thickness approach where all calculations are done during newbuilding evaluation and the renewal thickness is determined without further calculations it is a simple task for the designers to add the renewal thickness to the plans.

1.2 Assessment of Thickness Measurements

1.2.1 General

1.2.1.a The basic requirements common to the majority of societies in IACS are given in *IACS Unified Requirement Z10.4* and are not repeated in the Rules.

1.2.2 Assessment of local wastage

1.2.2.a The concept of annual thickness measurements is introduced to ensure that the actual thickness of the structural member does not reduce below the net thickness to which the strength has been verified. Service records and statistics show that a significant reduction in thickness may be seen during the standard inspection interval of 2.5 years between special and intermediate surveys. Consequently the Rules require that the intervals are reduced to 1 year for areas that are getting close to the renewal thickness.

1.2.3 Assessment of overall hull girder wastage

1.2.3.a It is considered that for this topic, no information in addition to that shown in the Rules, is necessary to explain the background

1.3 Categories of Corrosion

1.3.1 General corrosion

1.3.1.a General uniform reduction is typically considered extensive when the reduced area extends across a plate panel between local support members, extends from attached plate to flange on web of a stiffener, extends across the breadth of a flange/faceplate etc.

1.3.2 Pitting corrosion

1.3.2.a It is considered that for this topic, no information in addition to that shown in the Rules, is necessary to explain the background.

1.3.3 Edge corrosion

1.3.3.a It is considered that for this topic, no information in addition to that shown in the Rules, is necessary to explain the background.

1.3.4 Groove corrosion

1.3.4.a It is considered that for this topic, no information in addition to that shown in the Rules, is necessary to explain the background.

1.4 Renewal Criteria of Local Structure for General Corrosion

1.4.1 Application

1.4.1.a It is considered that for this topic, no information in addition to that shown in the Rules, is necessary to explain the background.

1.4.2 Renewal criteria

1.4.2.a The information provided in the Rules with respect to the relationship of the as built thickness, wastage allowance, and any owner/builder specified additional corrosion allowance generally follows the present practice of LR, ABS and DNV. The value to which repairs are to be made is also included.

1.4.2.b Table 12.1.2 indicates local wastage allowance values for each individual side of the structure subject to its exposure to various corrosion environments. The total wastage allowance for a structural component is determined by adding the two allowances for each side together and then rounding up to the nearest 0.5mm – then adding the 0.5mm to cover the reserve and any owners extra. See *12/1.4.2.1* of the Rules.

1.4.2.c As stated in *1.1.1.a* above, it should be noted that the wastage allowance values used in the review of gaugings is the same as used in the newbuilding assessment. For worked examples of the wastage allowances for various structural members, see Section 6/3.3 of the Rules.

1.4.2.d The total wastage allowance values used in the Rules were, in a large part, based on information taken directly from the NK prepared documents that were being used by IACS WP/S (Working Party/Strength) to arrive at wastage allowance values based on historical data on record of gaugings.

1.4.2.e Structures considered and the appropriate wastage allowance values are as given in *Table 12.1.2 of the Rules* and is not repeated here.

1.4.2.f The general philosophy for establishing wastage allowances was that they are to be:

(a) based, in general, on the premise that today's practice is a reference point, and departures from today's practice will need to be backed-up with technical justification;

(b) established based on the basic assumption of coatings provided (where required) at time of newbuilding, however, there should not be provisions to reduce wastage allowance values based on "superior" coating systems or extra-ordinary maintenance of coating systems or another type of corrosion protection system;

(c) appropriate for a 25-year service life;

(d) based on absolute numbers, i.e., 4.0mm (not 25%);

(e) independent of type of local failure mode employed, i.e., yielding, buckling, or fatigue;

(f) based on published data (OCIMF, NK Corrosion Data provided to IACS) and recent experience of LR / ABS / DNV;

(g) consider work done by and agreements made by the JTP group dealing with unification of corrosion requirements for existing (pre-JTP Rule) ships.

1.4.2.g The following basic assumptions were made:

(a) with respect to stiffener and web members, wastage should be based on thickness loss, not section modulus loss;

(b) wastage values, though linked to net thickness deductions, should first be developed independently of the net thickness deductions, and based on the philosophy outlined above;

(c) the wastage values should be based on typical wastage values experienced in service for crude oil carriers;

(d) dependencies on cargo type and vessel size should be considered, but should not be variables used for determining the actual value of the permitted wastage on a ship-by-ship basis;

(e) structural elements within the same area, environment and orientation should as far as possible have the same wastage allowance; and

(f) safety margins should not be included in wastage allowances (i.e., criticality issues should be dealt with in "net" requirements, and not with an increase in the wastage allowance).

1.4.2.h The following itemizes the primary steps applied in the process of deriving wastage values:

(a) collection of historical diminution information from published sources and LR / ABS /DNV databases;

(b) itemization or the wastage values that result from agreements made by the JTP group dealing with unification of corrosion requirements for existing (pre-JTP Rule) ships;

(c) conversion of present practice percentage values to absolute wastage values in millimetres of thickness. This required some adjustments to the numbers, in order to convert percentages of typical varying thickness to like wastage values as a function of location/environment. Also, it was noted that particular

attention was made to the orientation of each member's surface, i.e. horizontal or otherwise;

(d) assessment of published LR / ABS / DNV corrosion data to determine recommendations for JTP wastage values; and

(e) agreement on wastage allowance values appropriate for a 25-year service life.

1.4.2.i Following the direction being taken by IACS WP/S, the 95 percent probability level corrosion measurement values for a 20-year life are taken as being approximately equal to the 90 percent values for a 25-year life. However, due to feedback received during the development process additional work was done to reconsider this approach, NK re-evaluated the data and wastage allowances through additional statistical analysis using the 95 percent probability level corrosion measurement values for a 25-year life and the corrosion were updated to increase wastage in the side shell, etc.

1.4.2.j Each of the individual societies took into consideration data that they had on hand regarding their own in-house reports and studies.

1.4.2.k In arriving at the agreed to wastage allowance values it was decided to create a simple table of structural members that was generally divided by structural component and relative corrosion environment.

1.4.2.l It was noted that the "deck-head area" of tanks needed to be dealt with separately from other areas of tanks, as an area of relative increased corrosion. It was decided that the deck head area would be taken as the area above a horizontal line 3.0 metres below the top of the tank at the deck level. With regards to the bilge plate, it was decided to include the bilge shell plate in with the bottom shell plate (rather than the side shell plate) primarily because there often tends to be a collection of rubbish and sediment in the bilge area making the bilge plate more similar to the bottom shell than the side shell, from a corrosion perspective.

1.4.2.m A comparison of the JTP wastage allowance values and typical values used to represent today's Rule requirements for VLCC, Suezmax, and Product Carrier size vessels is provided in the table below (note, wastage allowances associated with heated cargo is not included in this table):

1	2	3	4	5	6	7	8	9	10	11	12
	"Today's Rules"	VLCC (LBP=320)		Suezmax		Product Carrier		Average	NKK 95percentile, 20 year (approx. 90percentile, 25 year)		
Structural element	%	thickness	allowance	thickness	allowance	thickness	allowance	allowance	massaged	raw	Maximum
Within Deck & Bottom Structure											
Deck plating	20	19.00	3.80	20.00	4.00	12.50	2.50	3.43		3.11	3.11
Sheer strake plating	20	19.00	3.80	20.00	4.00	12.50	2.50	3.43			
Bilge and bottom plating	20	20.00	4.00	19.00	3.80	15.00	3.00	3.60	2.20		2.20
Upper strake of inner skin	20	20.00	4.00	19.00	3.80	11.00	2.20	3.33	2.20	1.95	2.20
Upper strake of longitudinal bulkhead plating	20	18.00	3.60	19.00	3.80	------	------	3.70	2.30	2.00	2.30
Underdeck longitudinal stiffeners (Web)	20	12.00	2.40	11.50	2.30	11.00	2.20	2.30	2.20	1.97	2.20
Bottom shell longitudinal stiffeners (Web)	20	12.00	2.40	12.00	2.40	13.00	2.60	2.47	2.40	1.85	2.40
Other Longitudinal & Transverse Structure											
Side shell plating	20	20.50	4.10	16.60	3.32	13.00	2.60	3.34		1.77	1.77
Innerskin and hopper plating	20	17.50	3.50	16.50	3.30	12.50	2.50	3.10	2.30	2.00	2.30
Longitudinal bulkhead plating	20	18.00	3.60	16.00	3.20	15.50	3.10	3.30	2.20	2.00	2.20
Inner bottom plating	20	19.50	3.90	17.00	3.40	16.00	3.20	3.50	3.30		3.30
Longitudinal girders (in Doubel Bottom)	20	15.00	3.00	15.50	3.10	14.50	2.90	3.00	2.20		2.20
Longitudinal stringers in WBT	20	15.00	3.00	------	------	11.00	2.20	2.60	2.40		2.40
Longitudinal stiffeners in COT - (Web at 12mm)	20	12.00	2.40	12.00	2.40	------	------	2.40	2.20		2.20
Longitudinal stiffeners in WBT - (Web at 12mm)	20	12.00	2.40	12.00	2.40	12.00	2.40	2.40	2.40	1.64	2.40
Web plating of transverse web frames in COT	20	14.00	2.80	13.00	2.60	------	------	2.70	2.20	2.13	2.20
Web plating of transverse web frames in WBT	20	15.00	3.00	14.00	2.80	11.00	2.20	2.67	2.40	2.29	2.40
Bottom floors	20	18.00	3.60	17.00	3.40	11.00	2.20	3.07	2.40		2.40
Web plating of cross tie	20	15.00	3.00	------	------	------	------	3.00	2.20	1.89	2.20
Face plate of cross tie	20	40.00	8.00	------	------	------	------	8.00	2.80	1.95	2.80
Face plate of transverse web frame	20	35.00	7.00	20.00	4.00	15.50	3.10	4.70	2.80	2.25	2.80
Transverse bulkhead plating in COT	20	17.00	3.40	15.00	3.00	17.50	3.50	3.30	2.20	2.35	2.35
Transverse bulkhead stiffeners in COT (Web at 12mm)	20	12.00	2.40	12.00	2.40	------	------	2.40	2.20		2.20
Transverse bulkhead stringer web plating	20	20.00	4.00	16.00	3.20	------	------	3.60	2.20	2.08	2.20
Transverse bulkhead stringer flange (face plate)	20	40.00	8.00	27.50	5.50	------	------	6.75	2.80	3.05	3.05

1	13	14	15	16	17	18
Structural element	CSR Wastage Allowance incl $t_{corr\_2.5}$	VLCC %	Suezmax %	Product Carrier %	Average %	"Today's Rules" %
Within Deck & Bottom Structure						
Deck plating	**4.00**	21	20	32	24	20
Sheer strake plating	**3.50**	18	18	28	21	20
Bilge and bottom plating	**3.00**	15	16	20	17	20
Upper strake of inner skin	**4.00**	20	21	36	26	20
Upper strake of longitudinal bulkhead plating	**4.00**	22	21		22	20
Underdeck longitudinal stiffeners (Web)	**4.00**	33	35	36	35	20
Bottom shell longitudinal stiffeners (Web)	**3.00**	25	25	23	24	20
Other Longitudinal & Transverse Structure						
Side shell plating	**3.50**	17	21	27	22	20
Innerskin and hopper plating	**3.00**	17	18	24	20	20
Longitudinal bulkhead plating	**2.50**	14	16	16	15	20
Inner bottom plating	**4.00**	21	24	25	23	20
Longitudinal girders (in Double Bottom)	**3.00**	20	19	21	20	20
Longitudinal stringers in WBT	**3.00**	20		27	24	20
Longitudinal stiffeners in COT - (Web at 12mm)	**2.50**	21	21		21	20
Longitudinal stiffeners in WBT - (Web at 12mm)	**3.00**	25	25	25	25	20
Web plating of transverse web frames in COT	**2.50**	18	19		19	20
Web plating of transverse web frames in WBT	**3.00**	20	21	27	23	20
Bottom floors	**3.00**	17	18	27	21	20
Web plating of cross tie	**2.50**	17			17	20
Face plate of cross tie	**3.50**	9			9	20
Face plate of transverse web frame	**3.50**	10	18	23	17	20
Transverse bulkhead plating in COT	**2.50**	15	17	14	15	20
Transverse bulkhead stiffeners in COT (Web at 12mm)	**2.50**	21	21		21	20
Transverse bulkhead stringer web plating	**2.50**	13	16		14	20
Transverse bulkhead stringer flange (face plate)	**3.50**	9	13		11	20

As further explanation of the table above, the following items are noted.

(1) Column 1 summarizes major structural elements used to compare today's practice of LR, ABS, and DNV with the wastage allowances permitted in the new Rules.

(2) Column 2 provides a notional percentage to represent today's wastage allowance, as permitted by LR, ABS, and DNV. There is not a unified percentage value, therefore a value of 20% was selected as a typical average to represent present practice.

(3) Columns 3 – 8 give "as-built required" scantlings and the millimetre wastage allowances that would be permitted for these vessels using the percentages in column 2. The information in these columns is for three of the selected JTP calibration vessels: the VLCC (LBP = 320m), the Suezmax, and the Product Carrier. Scantlings for the structural elements are averaged values, i.e., on a longitudinal bulkhead there are several strakes of different thickness that are reported as one "average" value.

(4) Column 9 is an average of columns 4, 6 and 8. This represents the wastage allowance, in millimetres, for a typical vessel according to today's requirements.

(5) Columns 10 – 12 give the measured wastage values from the NK study. The values in columns 10 and 11 are the 95 percentile values at 20-years. It is noted that at IACS WP/S this value is also being used to represent the 90 percentile value at 25 years. Column 10, which is labelled "massaged", gives final values recommended by NK based on further analysis of the raw measured wastage values. It is noted that this massaging needed to be done in some cases (i.e., in the case of the inner-bottom) since the measured values were taken on single hull tankers. Column 11 represents statistics based directly on actual wastage measurements. Column 12 represents the "final" wastage allowance for a 25-year service life. Column 12 is derived by taking the higher of the values in columns 10 and 11.

(6) Column 13 represents the CSR wastage allowances which includes the 0.5mm $t_{corr\_2.5}$ but does not include wastage allowances for heated cargo. The side shell wastage allowance includes an additional 0.5mm in way of the quay contact region.

(7) Columns 14 – 18 give the percentage wastage allowance values that the proposed millimetre wastage values represent for the given scantlings for the three selected calibration values

1.5 Renewal Criteria of Hull Girder Sectional Properties for General Corrosion

1.5.1 General

1.5.1.a The sectional properties listed in *Section 12/1.5.1 of the Rules* are required to be verified based on thickness measurements to ensure that the hull girder stresses used as basis for the newbuilding assessment are not exceeded.

1.5.2 Renewal criteria

1.5.2.a It is considered that for this topic, no information in addition to that shown in the Rules, is necessary to explain the background.

1.5.3 Calculation of the minimum allowable hull girder sectional properties

1.5.3.a It is considered that for this topic, no information in addition to that shown in the Rules, is necessary to explain the background.

1.6 Allowable Material Diminution for Pitting, Grooving and Edge Corrosion

1.6.1 General

1.6.1.a It is considered that for this topic, no information in addition to that shown in the Rules, is necessary to explain the background.

1.6.2 Pitting

1.6.2.a The renewal criteria for pitting is given as a percentage of the as-built thickness and not the net thickness to provide simple assessment. Pitting is more a leakage problem than a strength problem and hence the general net thickness approach is not used as basis for the criteria.

1.6.2.b The allowable 30% thickness reduction for pitting was selected based on existing practice among LR, ABS and DNV and was selected based on the most conservative criteria among the three.

1.6.2.c The guaranteed pitting allowance of t_{corr} + 1mm is introduced to ensure that the pitting allowance is at least 1mm greater than the allowance for general corrosion. As mentioned above the pitting criterion is related to an area that is smaller than the basis for the general corrosion and hence the allowance is greater.

1.6.3 Edge corrosion

1.6.3.a The renewal criteria for edge corrosion is given as a percentage of the as-built thickness and not the net thickness to provide simple assessment. Edge corrosion is not believed to be a strength problem provided the extent of 25% as defined in *Figure 12.1.2 of the Rules* is not exceeded and hence the general net thickness approach is not used as basis for the criteria

1.6.3.b The guaranteed edge corrosion allowance of t_{corr} + 1mm is introduced to ensure that the edge corrosion allowance is at least 1mm greater than the allowance for general corrosion. As mentioned above the edge corrosion criterion is related to an area that is smaller than the basis for the general corrosion and hence the allowance is greater.

1.6.3.c For structural elements subject to edge corrosion the strength is ensured through the criteria for average diminution as given in *Section 12/1.6.3.2 of the Rules.*

1.6.3.d The renewal criteria for edge corrosion around openings are based on DNV Classification Note 72.1, 4.2.5.

1.6.4 Grooving

1.6.4.a The renewal criteria for grooving is given as a percentage of the as-built thickness and not the net thickness to provide simple assessment. Grooving is not believed to be a strength problem provided the extent defined in *Section 12/1.6.4* and *Figure 12.1.3 of the Rules* is not exceeded and hence the general net thickness approach is not used as basis for the criteria

1.6.4.b The guaranteed edge corrosion allowance of t_{corr} + 0.5mm is introduced to ensure that the edge corrosion allowance is at least 1mm greater than the allowance for general corrosion. As mentioned above the edge corrosion criterion is related to an area that is smaller than the basis for the general corrosion and hence the allowance is greater.

1.6.4.c The allowance for grooving is less than that of pitting and edge corrosion as extensive grooving may lead to detachment of the stiffener and hence loss of strength.