GUIDE FOR

ALTERNATIVE REQUIREMENTS FOR HULL CONSTRUCTION OF VESSELS INTENDED TO CARRY VEHICLES (130 METERS OR MORE IN LENGTH) SEPTEMBER 2017

NOTICE NO. 1 – JUNE 2018

The following Rule Changes were approved by the ABS Rules Committee on 1 June 2018 and become **EFFECTIVE AS OF 1 JUNE 2018.**

(See http://www.eagle.org for the consolidated version of the Guide for Alternative Requirements for Hull Construction of Vessels Intended to Carry Vehicles (130 Meters or More in Length) 2017, with all Notices and Corrigenda incorporated.)

Notes - *The date in the parentheses means the date that the Rule becomes effective for new construction based on the contract date for construction. (See 1-1-4/3.3 of the ABS Rules for Conditions of Classification (Part 1).)*

SECTION 4 INITIAL SCANTLING CRITERIA

1 Longitudinal Strength

(Revise Paragraph 4/1.7, as follows:)

1.7 Buckling Strength *(1 June 2018)*

The requirements in 5C-10-2/1.5 of the *Steel Vessel Rules* are to be complied with.

Alternatively, the approach and criteria specified in Subsection 6/7 and Appendix 2 of this Guide are to be used to check the buckling strength.

(Revise Subsection 4/3, as follows:)

3 Bottom Structure *(1 June 2018)*

In general, bottom structures are to be in accordance with Section 3-2-4 of the *Steel Vessel Rules*.

3.1 Bottom Girders and Solid Floors

The thickness of center girders, if fitted, is not to be less than t specified below:

$t = 0.85 \times (0.056L + 5.5)$ mm for $L \le 427$ m

$t = 0.85 \times (0.00067L + 0.22)$ in. for $L \le 1400$ ft

The thickness of sider girders and solid floors is not to be less than t specified below:

$t = 0.85 \times (0.036L + 4.7 + c)$ mm for $L \le 427$ m

$t = 0.85 \times (0.00043L + 0.185 + c)$ in. for $L \le 1400$ ft

where

c	=	1.5 mm (0.06 in.)	for floors where the bottom shell and inner bottom are longitudinally framed
	=	0 mm (in.)	for side girders and brackets, and for floors where the bottom shell and inner bottom are transversely framed

3.3 Bottom Shell Plating

Alternatively, the bottom shell plating may be evaluated by the following criteria. The requirements in Subsection 4/13 are also to be complied with if the bottom shell plating forms the deep tank boundaries.

A nominal design corrosion value of 1.0 mm (0.04 in.) is to be used for bottom and bilge plating.

The net thickness of the longitudinally framed bottom shell plating, in addition to compliance with 4/1.3, 4/1.5, 4/1.7 and 4/1.9, is to be not less than t_1 and t_2 specified below for the midship 0.4L:

$t_1 = 0.73s(k_1p/f_1)^{1/2}$ mm (in.)

$t_2 = 0.73s(k_2p/f_2)^{1/2}$ mm (in.)

where

s = spacing of bottom longitudinals, in mm (in.)

k_1 = 0.342

k_2 = 0.500

p = nominal pressure in full draft condition with wave heading angle of 0° and $k_{ce} = 1.0$, in N/cm^2 (kgf/cm^2, lbf/in^2), as specified in Subsection 3/11

f_1 = permissible bending stress, in longitudinal direction, in N/cm^2 (kgf/cm^2, lbf/in^2)

= $(0.95 - 0.671\alpha_1 SM_{RB}/SM_B)S_m f_y \le K_p S_m f_y$

K_p = 0.36 for $L > 210$ m (689 ft)

= $0.36 + (210 - L)/900$ for $L \le 210$ m [$0.36 + (689 - L)/2950$ for $L \le 689$ ft]

α_1 = $S_{m1}f_{y1}/S_m f_y$

S_m = strength reduction factor for plating under consideration

= 1.0 for ordinary mild steel

= 0.95 for Grade H32 steel

= 0.908 for Grade H36 steel

= 0.875 for Grade H40 steel

S_{m1} = strength reduction factor for the bottom flange of the hull girder

f_y = minimum specified yield point of the material, in N/cm^2 (kgf/cm^2, lbf/in^2)

f_{y1} = minimum specified yield point of the bottom flange of the hull girder, in N/cm^2 (kgf/cm^2, lbf/in^2)

SM_{RB} = required gross hull girder section modulus based on material factor of the bottom flange of the hull girder, in accordance with 4/1.1 and 4/1.3, with k_w defined in Subsection 3/5 for the purpose of calculating M_w (sagging and hogging), based on the material factor of the bottom flange of the hull girder, in cm^2-m (in^2-ft)

SM_B = design (actual) gross hull girder section modulus at the bottom, amidships in cm^2-m (in^2-ft)

f_2 = permissible bending stress, in transverse direction, in N/cm^2 (kgf/cm^2, lbf/in^2)

= $0.8\, S_m f_y$

Bottom shell plating may be transversely framed in pipe tunnels or bilge areas, provided the net thickness of the bottom shell plating, t_n, is not less than t_4 specified below:

$t_4 = 0.73sk(k_2p/f_1)^{1/2}$ mm (in.)

where

s = spacing of bottom transverse frame, in mm (in.)

k = $(3.075(\alpha)^{1/2} - 2.077)/(\alpha + 0.272)$, $(1 \le \alpha \le 2)$

= 1.0 $(\alpha > 2)$

α = aspect ratio of the panel (longer edge/shorter edge)

k_2 = 0.500

All other parameters are as defined above.

In addition to the foregoing, the net thickness of the bottom shell plating, outboard of $0.3B$ from the centerline of the vessel, is to be not less than that of the lowest side shell plating required by 4/5.1, adjusted for the spacing of the bottom/bilge longitudinals or frames and the material factors.

3.5 Bottom Framing

Alternatively, the bottom framing may be evaluated by the following criteria. The requirements in Subsection 4/13 are also to be complied with if the bottom shell plating forms the deep tank boundaries.

A nominal design corrosion value of 2.0 mm (0.08 in.) is to be used for frames exposed to ballast water. For other spaces, nominal design corrosion values of 1.0 mm (0.04 in.) may be applied.

The net section modulus of each bottom longitudinal or each transverse frame in pipe tunnels or bilge area, in association with the effective plating to which it is attached, is to be not less than that obtained from the following equations:

$SM = M/f_b$ cm^3 (in^3)

$M = cps\ell^2 10^3/k$ N-cm (kgf-cm, lbf-in.)

where

s = spacing of longitudinals or transverse frames, in mm (in.)

ℓ = span of longitudinals or transverse frames between effective supports, as shown in Section 4, Figure 1

c = 1.0 without struts

= 0.65 with effective struts

p = nominal pressure in full draft condition with wave heading angle of 0° and k_{ce} = 1.0, in N/cm^2 (kgf/cm^2, lbf/in^2), at the middle span of each bottom longitudinal or transverse frame, as specified in Subsection 3/11.

k = 12 (12, 83.33)

f_b = permissible bending stress, in N/cm^2 (kgf/cm^2, lbf/in^2)

= $1.2[1.0 - 0.65\alpha_1 SM_{RB}/SM_B]S_m f_y \leq 0.60 S_m f_y$ for bottom longitudinals

= $0.70 S_m f_y$ for transverse frames

α_1 = $S_{m1} f_{y1}/S_m f_y$

S_m = strength reduction factor, as defined in 4/3.3, for the material of longitudinals or transverse frames considered

S_{m1} = strength reduction factor, as defined in 4/3.3, for the bottom flange material of the hull girder

f_y = minimum specified yield point for the material of longitudinals or transverse frames considered, in N/cm^2 (kgf/cm^2, lbf/in^2)

f_{y1} = minimum specified yield point of the bottom flange of the hull girder, in N/cm^2 (kgf/cm^2, lbf/in^2)

SM_{RB} and SM_B are as defined in 4/3.3.

The net section modulus of the bottom longitudinals, outboard of 0.3B from the centerline of the vessels, is also to be not less than that of the lowest side longitudinal required by 4/5.3, adjusted for the span and spacing of the longitudinals and the material factors.

When determining compliance with the foregoing, an effective breadth, b_e, of the attached plating is to be used in the calculation of the section modulus of the design longitudinal. b_e is to be calculated from Section 4, Figure 2.

(Revise Subsection 4/9 and add new Table 1, as follows:)

9 Web Frames and Stringers *(1 June 2018)*

The requirements in Section 3-2-6 of the *Steel Vessel Rules* are to be complied with.

For web thickness requirements in 3-2-6/3.5 and 3-2-6/5.3, alternatively, the net web thickness of the side transverse and stringer may be evaluated by the following criteria, provided the requirements specified in Section 6 of this Guide are complied with:

t_1 = 8.5 mm where $L \geq 200$ m

= $0.02L + 4.5$ mm where $200 > L \geq 130$ m for SI or MKS Units

= 0.334 in. where $L \geq 656$ ft

= $0.00024L + 0.177$ in. where 656 ft $> L \geq 427$ ft for U.S. Units

t_2 = $k_3 F/(d_w f_s)$ mm (in.)

F = $k_{shr} p s \ell$ N (kgf, lbf)

where

k_3 = 10 (10, 1.0)

f_s = permissible shear stress, in N/cm^2 (kgf/cm^2, lbf/in^2)

= $0.50 S_m f_y$

d_w = depth of the side transverse, in cm (in.)

s = spacing of primary supporting member, in cm (in.)

ℓ = span of primary supporting member, in cm (in.)

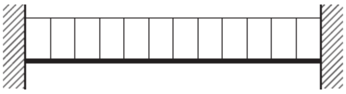
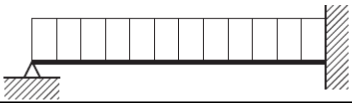
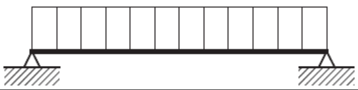
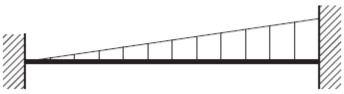
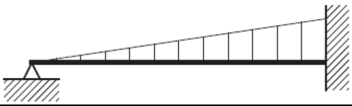
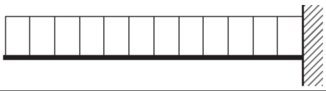
k_{shr} = shear force distribution factor, as given in Section 4, Table 1

p = nominal pressure in full draft condition with wave heading angle of 90°, k_{ce} = 1.0, in N/cm^2 (kgf/cm^2, lbf/in^2), at the middle of the span under consideration, as specified in Subsection 3/11, but is not to be taken less than 2.25 N/cm^2 (0.23 kgf/cm^2, 3.27 lbf/in^2).

For complex arrangements of side transverses and stringers, "*F*" for t_2 may be determined by direct engineering analysis.

A nominal design corrosion value of 1.5 mm (0.06 in.) is to be used for side transverses and stringers exposed to ballast water. For other spaces, nominal design corrosion values 0.5 mm (0.02 in.) may be applied.

TABLE 1 *(1 June 2018)*

Load and Boundary Condition				*Shear Force Distribution Factors (based on load at mid-span, where load varies)*		
Position				1	2	3
Load Model	1	2	3			
	Support	Field	Support	$k_{shr\text{-}1}$	---	$k_{shr\text{-}3}$
A				0.50	---	0.50
B				0.38	---	0.63
C				0.50	---	0.50
D				0.30	---	0.70
E				0.20	---	0.80
F				---	---	1.00

Notes:

The web thickness requirement of end connection within 0.2ℓ from the end of the effective span is to be determined using k_{shr} = 0.5 or the applicable $k_{shr\text{-}1}$ or $k_{shr\text{-}3}$, whichever is greater.

For model A through F, the value of k_{shr} may be gradually reduced outside of 0.2ℓ towards 0.5k_{shr} at mid-span, where k_{shr} is the greater value of $k_{shr\text{-}1}$ ans $k_{shr\text{-}3}$.

SECTION 5 TOTAL STRENGTH ASSESSMENT

3 Standard Design Load Cases

(Revise Paragraph 5/3.3, as follows:)

3.3 Standard Design Load Cases for Global FE Analysis *(1 June 2018)*

In addition to the requirement in 5/3.1, the transverse members of hull structures are to be analyzed by global FE analysis for the following standard design load cases:

- Load Cases G1 through G4 for maximum racking moment conditions

(Following text remains unchanged.)

(Revise Paragraph 5/3.5, as follows:)

3.5 Standard Design Load Cases for Fatigue Strength Assessment by Global FE Analysis *(1 June 2018)*

To assess the critical details of the hull structures, the cumulative fatigue damage may be calculated from load cases in Section 5, Table 2. The stress ranges to be used for the accumulative fatigue damage are to be calculated from the following two pairs of the load cases:

- Load Cases G1 and G2 for maximum racking moment conditions
- Load Cases G2 and G3 for maximum racking moment conditions

Depending on the operation of the vessel, other load cases may be considered for the accumulative fatigue damage.

The dominant load parameter as described in Section 5, Table 2 for each dynamic sea load case corresponds to a probability of exceedance of 10^{-4}, while the load combination factors for other load parameters represent phasing between all the load parameters.

(Revise Section 5, Table 2, as follows:)

TABLE 2
Standard Design Load Cases for Global FE analysis and Fatigue Strength Assessment *(1 June 2018)*

(Load Combination Factors for Dynamic Load Components)

Load Case Description	Maximum Racking Moment			
Load Case	LCG1	LCG2	LCG3	LCG4
Wave Heading (μ)	–90° beam	–90° beam	90° beam	90° beam
Draft (d_m)	d_f	d_f	d_f	d_f
External Pressure k_{ce}	1.00	1.00	1.00	1.00
Longitudinal Acceleration $k_{c\ell}$	0.00	0.00	0.00	0.00
Vertical Acceleration k_{cv}	–0.60	0.60	-0.60	0.60
Transverse Acceleration k_{ct}	0.80	0.80	-0.80	-0.80
Vertical BM Load Case	N/A	N/A	N/A	N/A

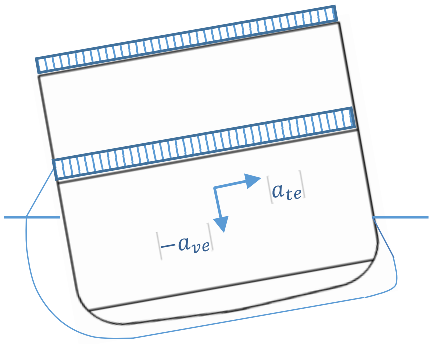
Notes

1 To account for the mean stress effect on the fatigue damage, the mean stress level can be determined using the static loads for the maximum racking moment loading condition.

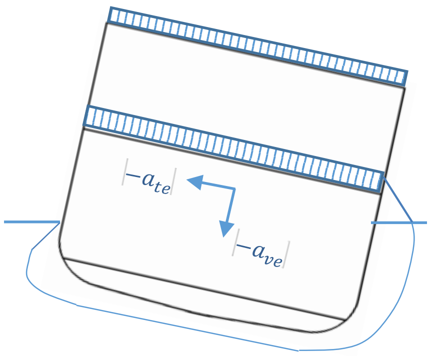
(Revise Section 5, Figure 3, as follows:)

FIGURE 3
Loading Pattern (Global FE Analysis) *(1 June 2018)*

Load Case	LCG1	LCG2
Dominant Load Parameter	Maximum Racking Moment	
Vehicle Load	Maximum Racking Moment	
Wave Heading (μ)	–90° beam	–90° beam
Draft (d_m)	d_f	d_f
External Pressure k_{ce}	1.00	1.00
Longitudinal Acceleration $k_{c\ell}$	0.00	0.00
Vertical Acceleration k_{cv}	–0.60	0.60
Transverse Acceleration k_{ct}	0.80	0.80
Vertical BM k_{cmv}	N/A	N/A



Load Case	LCG3	LCG4
Dominant Load Parameter	Maximum Racking Moment	
Vehicle Load	Maximum Racking Moment	
Wave Heading (μ)	90° beam	90° beam
Draft (d_m)	d_f	d_f
External Pressure k_{ce}	1.00	1.00
Longitudinal Acceleration $k_{c\ell}$	0.00	0.00
Vertical Acceleration k_{cv}	–0.60	0.60
Transverse Acceleration k_{ct}	–0.80	–0.80
Vertical BM k_{cmv}	N/A	N/A



SECTION 6 ACCEPTANCE CRITERIA

(Revise Section 6, Table 2, as follows:)

TABLE 2
Allowable Stresses (kgf/cm²) for Various Finite Element Mesh Size *(1 June 2018)*

Mesh Size	*Stress Limit*	*Mild Steel* (S_m = 1.000)	*HT27* (S_m = 0.980)	*HT32* (S_m = 0.950)	*HT36* (S_m = 0.908)
1 × LS	1.00 × $c_f S_m f_y$	2400 × c_f	2646 × c_f	3040 × c_f	3269 × c_f
$^1/_2$ × LS (1)	1.06 × $c_f S_m f_y$	2544 × c_f	2805 × c_f	3222 × c_f	3465 × c_f
$^1/_3$ × LS (1)	1.12 × $c_f S_m f_y$	2688 × c_f	2963 × c_f	3404 × c_f	3661 × c_f
$^1/_4$ × LS (1)	1.18 × $c_f S_m f_y$	2832 × c_f	3122 × c_f	3587 × c_f	3857 × c_f
$^1/_5$ × LS ~ $^1/_{10}$ × LS (1)	1.25 × $c_f S_m f_y$	3000 × c_f	3308 × c_f	3800 × c_f	4086 × c_f
Thickness (1, 2)	$c_f f_u$ or 1.50 × $c_f S_m f_y$	4100 × c_f	$c_f f_u$ or 1.50 × $c_f S_m f_y$	4500 × c_f	4903 × c_f

Notes:

1 Stress limits greater than 1.00 × $c_f S_m f_y$ are to be restricted to small areas in way of structural discontinuities.

2 When the fatigue strength of the detail is found satisfactory, the hot spot stress in the detail may be allowed up to the minimum tensile strength of the material.

3 c_f is to be taken as 0.95.

4 For intermediate mesh size, the stress limit may be obtained by linear interpolation.

APPENDIX 1 STRUCTURAL MODELING AND ANALYSIS

(Revise first paragraph of Subsection A1/7, as follows:)

7 Boundary Constraints for Local and Hull Girder Sub Load Cases *(1 June 2018)*

For each standard design load case listed in Section 5 except for the LCG1 through LCG4, the load components can be categorized into local and hull girder sub load cases. For each sub load case, the boundary constraints are different. Within a linear, elastic domain, the results for the local and hull girder sub load cases can be combined to obtain the final results of the standard design load cases.

(Following text remains unchanged.)

(Revise title of Subsection A1/9, as follows:)

9 Boundary Constrains and for Load Cases LCG1 through LCG4 *(1 June 2018)*

(Following text remains unchanged.)

(Revise title of Appendix 1, Figure 4, as follows:)

FIGURE 4
Boundary Constraints for Sub Load Cases LCG1 through LCG4 *(1 June 2018)*

(Figure remains unchanged.)

APPENDIX 3 RULE BASED FATIGUE STRENGTH ASSESSMENT

5 Fatigue Damage Calculation

(Revise Paragraph A3/1.7, as follows:)

5.7 Fatigue Damage *(1 June 2018)*

The cumulative fatigue damage, D_f, is to be taken as:

$$D_f = 0.5 \times \alpha_1 D_{f\_14} + 0.5 \times \alpha_1 D_{f\_23}$$

where

α_1 = 1.0 for maximum racking moment condition

D_{f_14} and D_{f_23} are the fatigue damage accumulated due to load case pairs 1&4 and 2&3, respectively (see Section 5, Table 2 for load case pairs).

(Following text remains unchanged.)

7 Fatigue Inducing Loads and Load Combination Cases

(Revise Paragraph A3/7.5, as follows:)

7.5 Combinations of Load Cases for Fatigue Assessment *(1 June 2018)*

The maximum racking moment condition is to be considered in the calculation of stress range. For this loading condition, four (4) load cases, as shown in Section 5, Table 2, are defined to form two (2) pairs. The combination of load cases is to be used to find the characteristic stress range corresponding to a probability of exceedance of 10^{-4}, as indicated below.

7.5.1 Standard Load Combination Case

7.5.1(a) Calculate dynamic component of stresses for load cases LCG1 through LCG4, respectively.

7.5.1(b) Calculate two sets of stress ranges, one each for the following two pairs of combined loading cases:

- LCG1 and LCG2.
- LCG2 and LCG3

7.5.2 Vessels with Either Special Loading Patterns or Special Structural Configuration

For vessels with either special loading patterns or special structural configurations/features, additional load cases may be required for determining the stress range.