RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part U   **Intact Stability**

Rules for the Survey and Construction of Steel Ships
Part U   **2018   AMENDMENT NO.2**
Guidance for the Survey and Construction of Steel Ships
Part U   **2018   AMENDMENT NO.2**

ClassNK
NIPPON KAIJI KYOKAI

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part U   Intact Stability

2018   AMENDMENT NO.2

Rule No.117   25 October 2018

Resolved by Technical Committee on 31 January 2018

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part U   INTACT STABILITY

Chapter 1   GENERAL

1.1   General

1.1.1   Application*

Sub-paragraph -4 has been added as follows.

1   The requirements on intact stability (hereinafter referred to as "stability" in this Part) in this Part apply to ships which are 24 *metres* in length for freeboard and over. However, fishing vessels, mobile offshore drilling units and dynamically supported craft may be excepted.
2   The stability of ships intended for the carriage of cargoes having moisture contents which exceed transportable moisture limit are to be in accordance with the requirements provided in this Part. In addition, the special considerations deemed necessary by the Society are to be taken into account.
3   Special consideration may be given to the ships registered for a restricted service.
4   Where deemed as necessary by the Society, the application of additional requirements for intact stability may be required.

EFFECTIVE DATE AND APPLICATION

1.   The effective date of the amendments is 25 April 2019.
2.   Notwithstanding the amendments to the Rules, the current requirements apply to ships for which the date of contract for construction is before the effective date.
3.   Notwithstanding the provision of preceding **2.**, the amendments to the Rules may apply to ships for which the date of contract for construction is before the effective date upon request.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part U **Intact Stability**

2018   AMENDMENT NO.2

AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

Part U   INTACT STABILITY

U1   GENERAL

U1.1   General

U1.1.1   Application

Sub-paragraph -4 has been added as follows.

1   With respect to sailing ships and multihull crafts, special requirements deemed necessary by the Society may apply in addition to the requirements in **Part U of the Rules**.

2   With respect to ship stability, consideration is to be given to the dynamic stability phenomena effects in waves.

(1)   Excessive stability may produce undesirable effects in ships.

(2)   Any ship exhibiting large stability righting lever variations between wave trough and wave crest conditions may experience parametric roll or pure loss of stability or combinations thereof.

(3)   Ships without propulsion or steering ability may be endangered by resonant roll while drifting freely.

(4)   Ships in following and quartering seas may not be able to keep constant course despite maximum steering efforts which may lead to extreme angles of heel.

3   "The special considerations deemed necessary by the Society" specified in **1.1.1-2**, **Part U of the Rules** means to be in accordance with the following **(1)** or **(2)**:

(1)   For ships intended for the carriage of nickel ore with a moisture content that exceeds the transportable moisture limit, the requirements specified in **"Guidelines for the Safe Carriage of Nickel Ore"**

(2)   For ship intended for the carriage of cargoes other than nickel ore, evaluation methods deemed appropriate by the Society

4   "Where deemed as necessary by the Society" specified in **1.1.1-4**, **Part U of the Rules** means in cases where the ship is not to be secured by mooring at jetties, etc. or another equivalent method, or is intended to operate for lifts in the floating condition. In such cases, intact stability during lifting operations is to be subject to stability requirements separately specified by the Society for the following ships:

(1)   Ships intended to operate involving the lifting of the ship's own structures or for lifts in which the maximum heeling moment due to the lift is greater than that given in the following. The calculations are to be completed at the most unfavourable loading conditions for which the lifting equipment is to be used.

$$M_L = 0.67 \times \Delta \times G_0M \times \left(\frac{f}{B}\right)$$

M_L :   Threshold value for the heeling moment, in $(t \cdot m)$, induced by the (lifting equipment and) load in the lifting equipment.

G_0M :   The initial metacentric height, in (m), with free surface correction, including the effect of the (lifting equipment and) load in the lifting equipment.

f :   the minimum freeboard, in (m), measured from the upper side of the weather deck to the waterline.

B :   the moulded breadth of the ship, in (m), as defined in **2.1.4**, **Part A of the Rules**.

Δ :   the displacement of the ship, including the lift load, in (t).

(2)   Ships which are engaged in lifting operations where no transverse heeling moment is induced and the increase of the ship's vertical centre of gravity (*VCG*) due to the lifted weight is greater than 1%.

Annex U1.1.1-4 has been added as follows.

Annex U1.1.1-4   GUIDANCE FOR REQUIREMENTS ON INTACT STABILITY DURING LIFTING OPERATIONS

1.1   General

1.1.1   General
1   Ships, as applicable, are to be satisfied for all loading conditions intended for lifting and with the hook load at the most unfavourable positions.
2   For each loading condition, the weight and centre of gravity of the load being lifted, the lifting appliance, and counter ballast, if any, are to be included.
3   The most unfavourable position may be obtained from the load chart and is chosen at the position where the total of the transverse and vertical moment is the greatest.
4   Additional loading conditions corresponding to various boom positions and counter ballast with different filling level, if applicable, may need to be checked.

1.1.2   Definitions
For the purpose of this annex, waters that are not exposed are those where the environmental impact on the lifting operation is negligible. Otherwise, waters are to be considered exposed. In general, waters that are not exposed are calm stretches of water, i.e. estuaries, roadsteads, bays, lagoons; where the wind fetch is six nautical miles or less.

1.1.3   Load and Vertical Centre of Gravity for Different Types of Lifting Operations
1   In lifting operations involving a lifting appliance consisting of a crane, derrick, sheerlegs, a-frame or similar:
(1)   The magnitude of the vertical load (P_L) is to be the maximum allowed static load at a given outreach of the lifting appliance.
(2)   The transverse distance (y) is the transverse distance between the point at which the vertical load is applied to the lifting appliance and the ship centreline in the upright position.
(3)   The vertical height of the load (KG_{load}) is taken as the vertical distance from the point at which the vertical load is applied to the lifting appliance to the baseline in the upright position.
(4)   The change of centre of gravity of the lifting appliance(s) needs to be taken into account.
2   In lifting operations not involving a lifting appliance consisting of a crane, derrick, sheerlegs, a-frame or similar, which involve lifting of fully or partially submerged objects over rollers or strong points at or near a deck-level:
(1)   The magnitude of the vertical load (P_L) is to be the winch brake holding load.
(2)   The transverse distance (y) is the transverse distance between the point at which the vertical load is applied to the ship and the ship centreline in the upright position.
(3)   The vertical height of the load (KG_{load}) is taken as the vertical distance from the point at which the vertical load is applied to the ship to the baseline in the upright position.

1.2   Stability Criteria

1.2.1   General
1   The stability criteria included herein, or the criteria contained in this annex, as applicable is to

be satisfied for all loading conditions intended for lifting with the lifting appliance and its load at the most unfavourable positions.

2   The lifting appliance and its load(s) and their centre of gravity (*COG*) is to be included in the displacement and centre of gravity of the ship, in which case no external heeling moment/heeling lever is applied.

1.2.2   Lifting Operations not conducted under Environmental and Operational Limitations

1   All loading conditions utilized during the lifting operations are to comply with the stability criteria given in **2.2** and **2.3**, **Part U of the Rules**.

2   During the lifting operation, as determined by **3.2.2** and **11.2.2**, **Part O of the Rules** and **U1.1.1-4**, **Part U of the Guidance**, the following stability criteria is to also apply:

(1)   The equilibrium heel angle, θ_1, is not to be greater than the maximum static heeling angle for which the lifting device is designed and which has been considered in the approval of the loading gear.

(2)   During lifting operations in non-exposed waters, the minimum distance between the water level and the highest continuous deck enclosing the watertight hull, taking into account trim and heel at any position along the length of the ship, is not to be less than 0.50 *m*.

(3)   During lifting operations in exposed waters, the residual freeboard is not to be less than 1.00 *m* or 75% of the highest significant wave height H_S, in (*m*), encountered during the operation, whichever is greater.

1.2.3   Lifting Operations conducted under Environmental and Operational Limitations

     For lifting conditions carried out within clearly defined limitations set forth in the following **(1)**, the intact criteria set forth in the following **(2)** may be applied instead of the criteria included in **1.2.2**.

(1)   Limits
     (a)   The limits of the environmental conditions are to specify at least the followings:
          (i)   The maximum significant wave height, H_S
          (ii)   The maximum wind speed (1 minute sustained at 10 *m* above sea level)
     (b)   The limits of the operational conditions are to specify at least the followings:
          (i)   The maximum duration of the lift
          (ii)   Limitations in ship speed
          (iii)   Limitations in traffic/traffic control

(2)   The following stability criteria are to apply with the lifted load is at the most unfavourable position:
     (a)   The corner of the highest continuous deck enclosing the watertight hull is not to be submerged.
     (b) $A_{RL} \geq 1.4 \times A_{HL}$

          where:

          A_{RL}: The area under the net righting lever curve, corrected for crane heeling moment and for the righting moment provided by the counter ballast if applicable, extending from the equilibrium heeling angle, θ_1, to the angle of down flooding, θ_F, the angle of vanishing stability, θ_R, or the second intersection of the righting lever curve with the wind heeling lever curve, whichever is less, see Fig. 1.

          A_{HL}: The area below the wind heeling lever curve due to the wind force applied to the ship and the lift at the maximum wind speed specified in **1.2.3(1)**, see Fig. 2.

     (c)   The area under the net righting lever curve from the equilibrium heel angle, θ_1, to the

down flooding angle θ_F, or 20 degrees, whichever is less, is not to be at least 0.03 $m \cdot rad$.

Fig. 1   Intact criteria under Environmental and Operational limitations
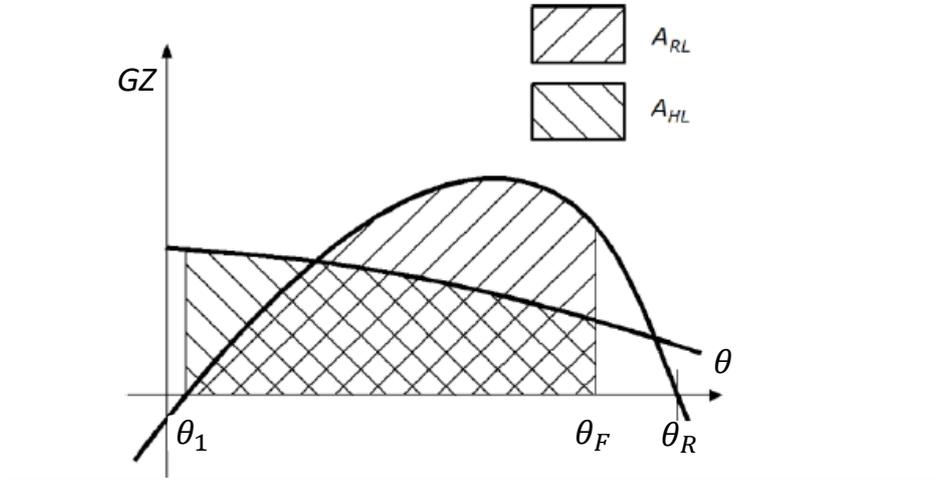
1.2.4   Sudden Loss of Hook Load

A ship engaged in a lifting operation and using counter ballasting is to be able to withstand the sudden loss of the hook load, considering the most unfavourable point at which the hook load may be applied to the ship (i.e. largest heeling moment). For this purpose, the area on the side of the ship opposite to the lift (A_2) is to be greater than the residual area on the side of the lift (A_1), as shown in Fig. 2, by an amount given by the followings:

(1) $A_2 > 1.4 \times A_1$, for lifting operations in waters that are exposed.

(2) $A_2 > 1.0 \times A_1$, for lifting operations in waters that are not exposed.

Fig. 2
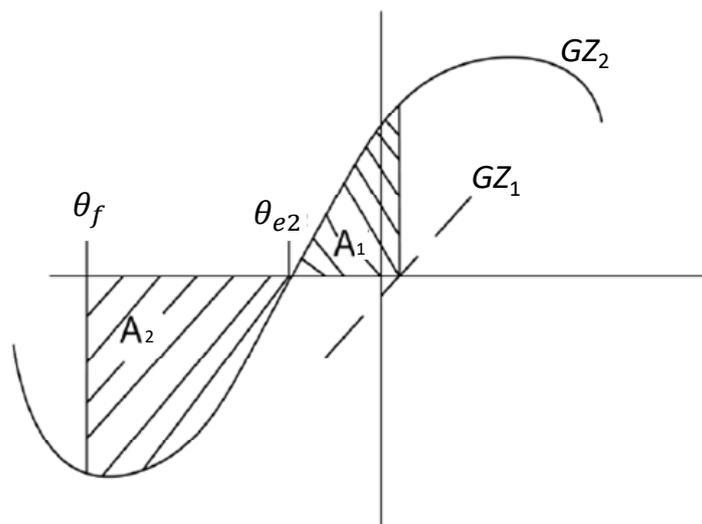
where:
GZ_1:   net righting lever (GZ) curve for the condition before loss of crane load, corrected for crane heeling moment and

for the righting moment provided by the counter ballast if applicable.

GZ_2: net righting lever (GZ) curve for the condition after loss of crane load, corrected for the transverse moment provided by the counter ballast if applicable.

θ_{e2}: the angle (degrees) of static equilibrium after loss of crane load.

θ_f: the angle (degrees) of down-flooding or the heel angle (degrees) corresponding to the second intersection between heeling and righting arm curves, whichever is less.

1.3　　Alternative Method

1.3.1　　General
1　　The criteria in **1.3** may be applied to a ship engaged in a lifting operation, as determined by **3.2.2 and 11.2.2, Part O of the Rules** and **U1.1.1-4, Part U of the Guidance**, as an alternative to the criteria in **1.2**, as applicable. For the purpose of this section and the stability criteria set out in **1.3.2**, the lifted load which causes the ship to heel is translated for the purpose of stability calculation to a heeling moment/heeling lever which is applied on the righting lever curve of the ship.

2　　The heeling moment applied to the ship due to a lift and the associated heeling lever is to be calculated using the following formulae:

$$HM_\theta = P_L \times y \times \cos\theta$$

$$HL_\theta = \frac{HM_\theta}{\Delta}$$

where:

HM_θ: the heeling moment, in ($t \cdot m$), due to the lift at θ

P_L: the vertical load, in (t), of the lift, as defined in **1.1.3-1(1)**

y: the transverse distance, in (m), of the lift, *metres*, as defined in **1.1.3-1(2)**

θ: the angle (degrees) of heel

HL_θ: the heeling lever, in (m) due to the lift at θ

Δ: the displacement, in (t) of the ship with the load of the lift

3　　For application of the criteria contained in **1.3.2** involving the sudden loss of load of the lift in which counter-ballast is used, the heeling levers that include the counter-ballast is to be calculated using the following formulae:

$$CHL_1 = \frac{(P_L \times y - CBM) \times \cos\theta}{\Delta}$$

$$CBHL_2 = \frac{CBM \times \cos\theta}{(\Delta - P_L)}$$

where:

CBM: the heeling moment, in ($t \cdot m$), due to the counter-ballast

CHL_1: combined heeling lever, in (m), due to the load of the lift and the counter-ballast heeling moment at the displacement corresponding to the ship with the load of the lift

$CBHL_2$: heeling lever, in (m), due to the counter-ballast heeling moment at the displacement corresponding to the ship without the load of the lift

1.3.2　　Stability Criteria
1　　For the loading conditions intended for lifting, but before commencing the operation, the stability criteria given in **2.2** and **2.3, Part U of the Rules** is to be complied with.

2   During the lifting operation, as determined by **3.2.2** and **11.2.2**, **Part O of the Rules** and **U1.1.1-4**, **Part U of the Guidance**, the following stability criteria is to apply: The equilibrium heel angle θ_e referred to in **1.3.2** means the angle of first intersection between the righting lever curve and the heeling lever curve.

(1)   The residual righting area below the righting lever and above the heeling lever curve between θ_e and the lesser of 40 degrees or the angle of the maximum residual righting lever is to not be less than:
    (a) $0.080 \ m \cdot rad$, if lifting operations are performed in waters that are exposed
    (b) $0.053 \ m \cdot rad$, if lifting operations are performed in waters that are not exposed
(2)   The equilibrium angle is to be limited to the lesser of the followings:
    (a)   10 degrees
    (b)   The angle of immersion of the highest continuous deck enclosing the watertight hull
    (c)   The lifting appliance allowable value of trim/heel

3   A ship engaged in a lifting operation and using counter ballasting is to be able to withstand the sudden loss of the hook load, considering the most unfavourable point at which the hook load may be applied to the ship (i.e. largest heeling moment). For this purpose, the area on the side of the ship opposite from the lift (AREA2) in Fig. 3 is to be greater than the residual area on the side of the lift (AREA1) in Fig. 3 by an amount given by the followings:

AREA2－AREA1 > K,

where:

K = $0.037 \ m \cdot rad$, for a lifting operation in waters that are exposed
K = $0 \ m \cdot rad$, for a lifting operation in waters that are not exposed

Fig. 3
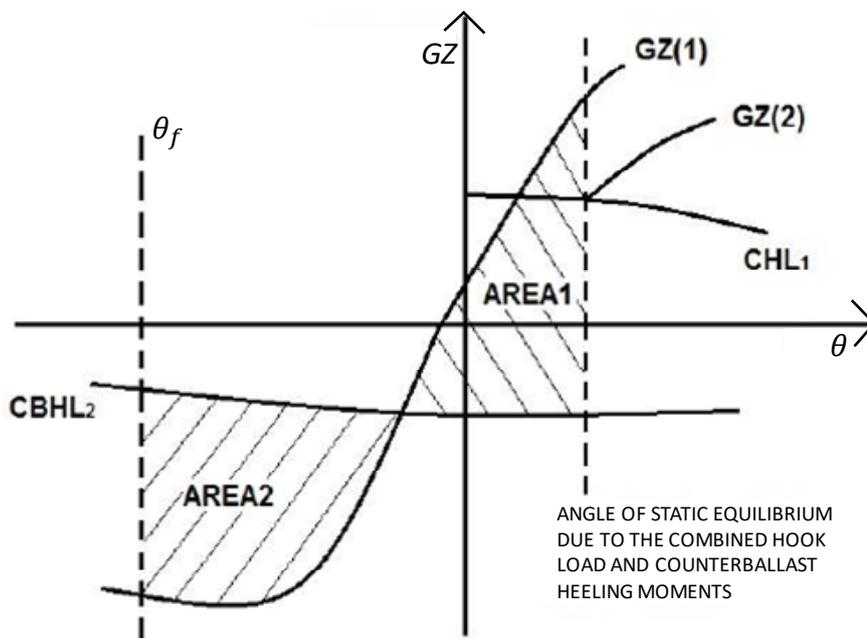
where:
GZ(1):   The righting arm curve at the displacement corresponding to the ship without hook load.
GZ(2):   The righting arm curve at the displacement corresponding to the ship with hook load.
AREA2:residual area between *GZ*(1) and *CBHL*$_2$ up to the lesser of the down-flooding angle or the second intersection of *GZ*(2)and *CBHL*$_2$.

AREA1:residual area below $GZ(1)$ and above $CBHL_2$ up to θ_e.

1.3.3   Model Tests or Direct Calculations

Model tests or direct calculations, performed in accordance with a methodology that demonstrate the survivability of the ship after sudden loss of hook load, may be allowed as an alternative to complying with the requirements of **1.2.4** or **1.3.2-3**, provided that:
(1)   The effects of wind and waves are taken into account.
(2)   The maximum dynamic roll amplitude of the ship after loss of load will not cause immersion of unprotected openings.

1.4   Stability Booklet

1.4.1   General

1   For ships engaged in lifting, loading conditions reflecting the operational limitations of the ship, while engaged in lifting is to be included in the stability booklet.
2   Use of counter ballast, if applicable, is to be clearly documented.
3   The adequacy of the ships stability in the event of the sudden loss of the hook load is to be demonstrated.

1.4.2   Additional Stability Booklet

1   For ships engaged in lifting operations, for which this annex applies, additional documentation is to be included the following **(1)** to **(19)** in the stability booklet:
(1)   Maximum heeling moment for each direction of lift/inclination as a function of the counter-ballast heeling moment, if used, the draught, and vertical centre of gravity.
(2)   Where fixed counter ballast is used, the following information is to be included.
    (a)   Weight of the fixed counter ballast
    (b)   Centre of gravity (*LCG*, *TCG*, *VCG*) of the fixed counter ballast
(3)   Loading conditions over the range of draughts for which lifting operations may be conducted with the maximum vertical load of the lift. Where applicable, righting lever curves for both before and after load drop is to be presented for each loading condition.
(4)   Limitations on crane operation, including permissible heeling angles, if provided
(5)   Operational limitations, such as:
    (a)   Maximum Safe Working Load (*SWL*)
    (b)   Maximum radius of operation of all derricks and lifting appliances
    (c)   Maximum load moment
    (d)   Environmental condition affecting the stability of the ship
(6)   Instructions related to normal crane operation, including those for use of counter ballast;
(7)   Instructions such as ballasting/de-ballasting procedures to righting the ship following an accidental load drop.
(8)   Identification of critical down-flooding openings.
(9)   Recommendations on the use of roll reduction systems.
(10)   Drawing of the crane showing the weight and centre of gravity, including heel/trim limitations established by the crane manufacturer.
(11)   A crane load chart, with appropriate de-ratings for wave height.
(12)   Load chart for lifting operations covering the range of operational draughts related to lifting and including a summary of the stability results.
(13)   A crane specification manual provided by the manufacturer is to be submitted separately for information.

(14) The lifting appliance load, radius, boom angle limit table, including identification of offlead and sidelead angle limits and slewing angle range limits and reference to the ship's centerline.

(15) A table that relates the ship trim and heel to the load, radius, slewing angle and limits, and the offlead and sidelead limits.

(16) Procedures for calculating the offlead and sidelead angles and the ship *VCG* with the load applied.

(17) If installed, data associated with a Load Moment Indicator system and metrics included in the system.

(18) If lifting appliance (crane) offlead and sidelead determine the maximum ship equilibrium angle, the stability booklet is to include a note identifying the lifting appliance as the stability limiting factor during lifting operations.

(19) Information regarding the deployment of (stability) pontoons to assist a lifting operation, if fitted.

2 The information in **1.4.2-1(2)** to **(19)** may be included in other ship specific documentation on board the ship. In that case, a reference to these documents is to be included in the stability booklet.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 25 April 2019.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to ships for which the date of contract for construction is before the effective date.

3. Notwithstanding the provision of preceding **2.**, the amendments to the Guidance may apply to ships for which the date of contract for construction is before the effective date upon request.